U.S. Army Corps
of Engineers

Omaha District

Yellowstone River
Conservation District Council

Yellowstone River
Cumulative Effects Analysis
APPENDICES: Study Reports & Datasets

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1.0 INTRODUCTION

This Appendix summarizes data and analysis to identify land-use change along the Yellowstone River from four studies conducted individually for the Yellowstone River Cumulative Effects Assessment (CEA), sponsored by the US Army Corps of Engineers and Yellowstone River Conservation District Council.

1. The Land-use Mapping and Interpretation project.
2. Yellowstone River Riparian Vegetation Mapping project.
3. Yellowstone River Channel Migration Zone Mapping project.
4. Geomorphic Parameters and GIS Development, Yellowstone River project.

The summary of data selects from a small portion of the total data collected for these sources, and is used to highlight the major findings of Land-use change along the Yellowstone River valley. Full presentation of the supporting data can be found in the above reports, available on line from the Montana State Library. The Appendix information and resulting conclusions are limited by the defined project area for the CEA supporting studies, which consists of the river channel migration zone (CMZ), a 100-year flood inundation boundary produced from an elevation model (i.e., does not reflect the detailed topographic details found in the CEA Yellowstone River Hydraulics Analysis), plus a buffer of 500 meters. This boundary allows detailed comparisons of land-use change associated with changes to the river channel and within the riparian area, but does not attempt to represent total land-use change within the Yellowstone River valley, which periodically widens to an area well beyond the project study boundaries.

Additionally the majority of studies within the CEA umbrella rely on photographic imagery for their data and analysis. The earliest aerial imagery for the entire river corridor dates to the 1948 to 1950 period. That date provides the baseline condition for land-use change analysis, and additional data points exist for the river corridor in photography from 1976, 2001 and 2011, from which trend data is developed.

1.1 Major Findings in Support of Cumulative Effects Analysis

The following findings show land-use change that supports various aspects of cumulative effects analysis:

1. First, a short discussion of the purposes of the land-use study and its use of available data. During the course of the Land-use Mapping study that is part of the Cumulative Effects overall studies (DTM, 2013), the researchers evaluated and detailed the difficulty of correlating information between the several governmentally developed databases to the land-use identification based on aerial imagery, the basis of the CEA data collection. Because no database used for other purposes (e.g., deciding taxation, or regulating subdivisions, etc.) classifies land use in the same way, nor do any use common definitions, DTM Consulting determined that it was impossible to use those classifications to supplement or further analyze the land uses they observed through aerial photography. To assess the relationship of land-use change to change in ecological conditions, this cumulative effects assessment of land-use change relies on the direct observation via aerial imagery of the land surface at four points in time (1950, 1976, 2001, and 2011), and based on those observations and the use of technological tools, identified acreage associated with various kinds of land-use conversion of the surface from the historical natural vegetation cover that predated human uses.

2. The analysis of land-use change that is associated with cumulative effects largely falls into two areas:

- Land-use conversion that directly alters the extent of riparian and wetland vegetation cover.
    - Conversion to agricultural use is the largest contributor to loss of riparian and wetland vegetation, and occurs along the entire corridor.
    - Urban areas constitute the second largest conversion from natural conditions, but in a discontinuous way being limited to the boundaries of towns and cities.
    - Exurban housing development has also contributed to loss of natural riparian and wetland habitats, but is most often associated with the Upper Yellowstone from Yellowstone National Park to the Billings area.
- In other types of land use, land-use conversion may cover a small area, but can directly influence the natural cycle of vegetation recruitment and colonization of riparian and wetlands by isolating the river from the floodplain:
    - Dikes, levees, river revetments (rip rap and other channel training features) are the largest factors in floodplain isolation. These features may be built strictly to contain and control the channel's access to the floodplain, for instance a levee built to protect urban housing or similar structural construction.
    - Dikes and levees may also result from the construction of transportation ways, like vehicle roadways and railroad beds. While not related to the intended use of the resulting construction, the prism shape of such roadbeds effectively acts as a levee structure, in some instances for many linear miles.
    - Single features also change land use in the floodplain, in some instances for long distances after their occurrence (e.g., dams, diversions, bridges).
    - In this analysis of direct land-use conversion from undeveloped conditions caused by these limited areal extent features, the area (in acres or square miles) will hardly register at the reach or regional scale when compared with irrigated agriculture or urban/exurban expansion. Nevertheless floodplain isolation is an extensive cause of riparian and floodplain change. The combination of floodplain isolation, direct land-use conversion and other factors changing the nature of the floodplain will need to be associated with each other to determine overall cumulative effects.

3. Irrigated agriculture is associated with the largest acreages of land-use conversion from riparian vegetation and habitat to agricultural fields.
    - The amount of irrigated agriculture land-use conversion grows from upper river to lower river, as (1) the route of the river moves into a plains environment, the river valley widens and the climate change from alpine to plains allows more development of row cropping; and (2) large irrigation projects become viable.
4. Urban development of the larger communities, such as Billings, Miles City and Glendive convert the second largest acreage, by converting natural riparian areas and agricultural areas.

- Because Montana is a largely rural state, with few cities distributed among a few small towns, the areas of urban land-use change are highly localized.

5. Exurban expansion of rural housing subdivisions have also converted lands, often from present agricultural operations to residential areas, but also through conversion of previously undeveloped lands.

   - The most extensive area of exurban conversion along the Yellowstone is in the Park County (PC) region, and occurs from the upper end of the Paradise Valley near Yellowstone National Park to just downstream of Livingston.

   - Further exurban development is found near urban areas, even small ones like Big Timber and Columbus, and again more extensively in the vicinity of Billings and Laurel.

   - Downstream from Billings, exurban development and consequent land-use conversion is limited, in spite of the fact that many lands have been legally subdivided, but not developed into housing, roads and other attributes of housing subdivisions.

6. Railroad beds and road prisms, necessarily raised grades to achieve a level surface for trackage or pavement, are often located as near as possible to the stream gradient (often immediately adjacent to the Yellowstone River), and thus act as dikes which isolate long stretches of floodplain.

   - Agriculture and urban areas are sometimes protected by the railroad grade (dike) thus creating a complex relationship between two factors in land-use change (e.g., land-use conversion to agricultural fields versus floodplain isolation behind dikes).

7. Irrigation diversion structures within the river channel impose a very small area of land-use change on the river valley, but can affect the aquatic environment by separating habitat areas and can have a wider effect on the valley through the distribution of irrigation water with widespread land-use conversion to agriculture.

8. The amount of land-use change on a large river like the Yellowstone also has varied with the degree of risk of flood damage from channel migration.

   - In general there has been less land-use conversion inside the channel migration zone (CMZ).

   - Where land-use conversion has occurred within the CMZ it is often associated with high investment cost land uses (e.g., bridge and road construction, industrial facilities like refineries, urban water and sewer infrastructure, amenity based housing subdivision, higher cost pivot sprinkler irrigation, etc.).

9. Lands not totally converted to human use are mapped in the DTM study using the category “non-irrigated agricultural lands”. Other than small areas within the exurban and urban mapped lands this category represents most of the lands that have not been developed extensively within the study area, and combines within in it any land that is used for grazing or other multiple uses. Because, the non-irrigated lands retain some to most vegetation and other habitat characteristics typical of the pre-settlement study area, it is used in this analysis of land-use conversion as a land

cover type that does not totally exclude native plants, wildlife and open space and which could sustain some elements of the natural environment.

- The amount of non-irrigated agricultural lands are discussed as “undeveloped” agricultural lands or open land in this appendix and are portrayed as potential retained open space, native plants and wildlife habitat within the study area. Technical Appendix 6 Biology: Terrestrial Plants (Riparian Systems) addresses these open lands in more detail, including different habitat quality represented in riparian forest, shrub lands and grasslands.

10. One category of land use (livestock grazing) in the agricultural category was unreachable utilizing the methods of the land-use study. Grazing analysis requires detailed data collection on the ground, a methodology found not to be feasible within the means and objectives of the river study. While individual ranch studies have found that grazing can affect riparian areas, it was not possible to document such effects given the data sources that were available for all data points in the time continuum from 1950 through 2011.

2.0 OVERVIEW OF LAND-USE MAPPING WITHIN THE YELLOWSTONE CORRIDOR

There are five regions delineated within the Yellowstone Valley used in this land-use analysis. From the top of the river in Montana at Gardiner to its confluence with the Missouri River in northwest North Dakota, the regions are as follows: (1) Region PC includes the river valley within Park County, (2) Region A includes the valley from Springdale at the Park County-Sweet Grass County line to the mouth of the Clark's Fork River in Yellowstone County, (3) Region B includes the river valley from the mouth of the Clark's Fork River to the mouth of the Big Horn River, all in Yellowstone County, (4) Region C includes the river valley from the mouth of the Big Horn River in Yellowstone County to the mouth of the Powder River in Prairie County, and (5) Region D includes the river valley from the mouth of the Powder River in Prairie County to the Yellowstone – Missouri River confluence in McKenzie County, North Dakota. Most of the regions are divided at major hydrological divisions (e.g., the Region B – Region C boundary is the mouth of the Big Horn River). Region PC, however, was originally studied under another project, and many of the Yellowstone River Cumulative Effects Study data sets were utilized by this study. Thus, Park County was maintained as its own region, defined by the county lines without reference to hydrological boundaries. As there was no directly comparable land-use study between the two efforts, Region PC was included in the same land-use mapping and analysis effort as the remainder of the Yellowstone Valley.

The land-use study utilized three boundaries to compare and contrast the various land uses through time. These included (1) the *Channel Migration Zone* (CMZ), an area within the valley where the river channel can be expected to move laterally, or migrate, over the next 100 years, plus the historic area now utilized by the migrating river channel; (2) the *inundation boundary*, which approximates the area included within the 100-year floodplain; and (3) the *total mapped area*, which adds a 500 meter buffer to the inundation boundary, and thus covers a greater portion of the valley than the other two categories.

The first set of figures (Figure 2-1 and Figure 2-2) depict the total mapped area within the Yellowstone Valley, at the four points in time where aerial photography coverage of the Yellowstone Valley was most extensive: 1950, 1976, 2001 and 2011. The data are complete for the entire river except for the North Dakota portion of the river in the 1976 imagery. There are different amounts of acreage in each valley region within the mapped area and its two further breakdowns of inundation area and CMZ. Region PC is the smallest region at about 35,000 acres of mapped land surface, Regions A and B are similar in size at approximately 55,000 acres, and Regions C and D, where the valley widens and the stream gradient has dropped, are the largest at about 123,000 acres and 105,000 acres respectively. With the different sized regions, this study identifies the amount of acreage in various land uses but also looks at the percentage in each land-use category, which allows for more meaningful comparisons among the regions. The five regions differ from one another substantially in content and in rates of change over the 60-year time period analyzed.

Overall, the Yellowstone Valley was overwhelmingly in agricultural land use in 1950, well over 90%. The two regions in the lower valley, Region C and Region D, have remained primarily agricultural in terms of land use. However the upper three regions show definite trends away from agriculture. While agriculture was still the most extensive land use in 2011, different land uses have become significant parts of the landscape, each with their own distinctive footprint. Region PC, by percentage, changed to the greatest degree. Agricultural land use occupied 95% of the mapped area in 1950, but had dropped to under 80% by 2011. The largest new land use was exurban development, which expanded throughout the study period. Region A land use change was not dramatic, but a combination of land uses combined to occupy more than 10% of the mapped area in the region by 2011. Region B is dominated by the Billings urban area, and it is the one region in the valley that shows significant urban encroachment on the river and exurban development based on commuting to an urban workplace.

Region PC shows a definite loss of agriculture land use during the study period. Agricultural lands totaled nearly 33,000 acres in 1950, or almost 94 percent of the region's total land surface. Agricultural lands show a drop in acreage of about 2,000 acres by 1976, and continue dropping over the four time measurements, falling to just over 27,000 acres in 2011 or 78.5 percent of the region. In Region PC, exurban development grew from 158 to 4,046 acres, a total of 3906 acres translating to a growth of 2,560 percent. Including urban expansion, the two categories are close to balancing out the decline in agricultural land. While not a huge change in absolute numbers, the percentage change in exurban development shows just how dramatic the exurban growth was along the river corridor in Region PC.

Region A also lost acreage devoted to agricultural land, but it was not as dramatic relative to its region as in Region PC. Its 54,515 acres of agricultural land in dropped faster than Region PC between 1950 and 1976 (about 2,500 acres), and then lost about 3000 acres between 1976 and 2011. The percentage of land devoted to agriculture was about 95percent in 1950, dropping to 87 percent by 2011.

The acreage lost was nearly equal, both near 5,500 acres, but the percentage lost was considerably different considering the larger number of acres in Region A. In Region PC, by 2011 there were 15.5 percent fewer acres in agricultural land, but in Region A the comparable figure was 8 percent. And there was a contrast in what categories of land replaced the agricultural lands. In Region A there was some growth in exurban development (almost 1800 acres), but an almost equal acreage went to transportation (over 1,200 acres). Nearly the entire remainder of acreage change in Region A was land lost to the river channel, which covered an area 1,200 acres larger in 2011.

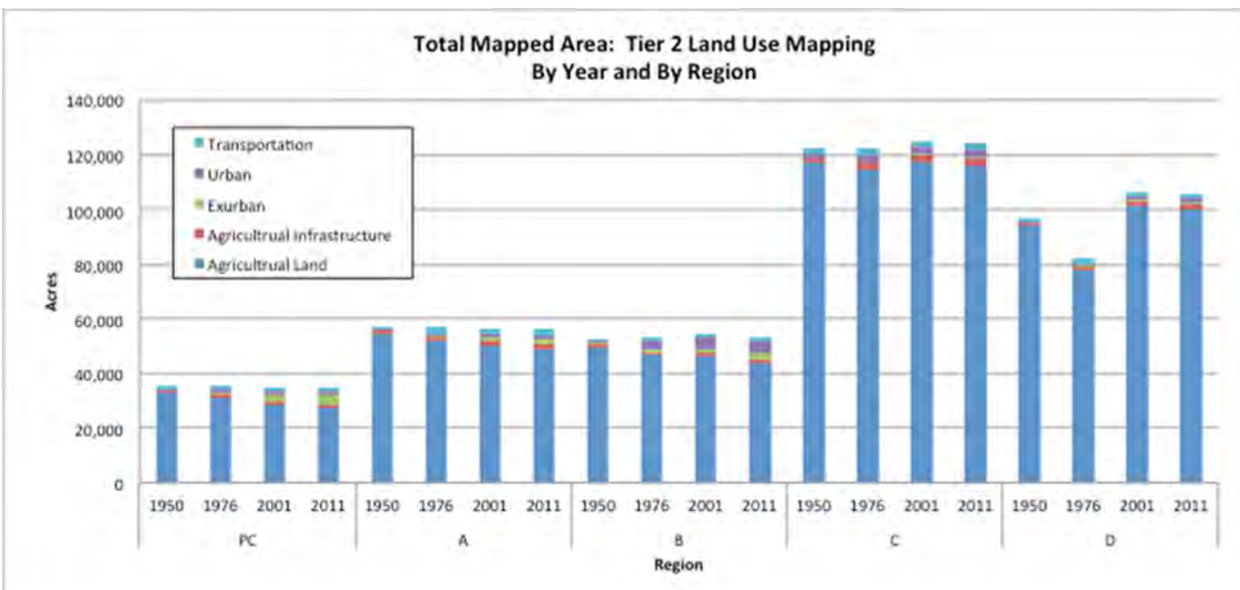

Figure 2-1 Major categories of Tier 2 Land Use within the Yellowstone Corridor. (Tab - Tier 2 LU by Region).

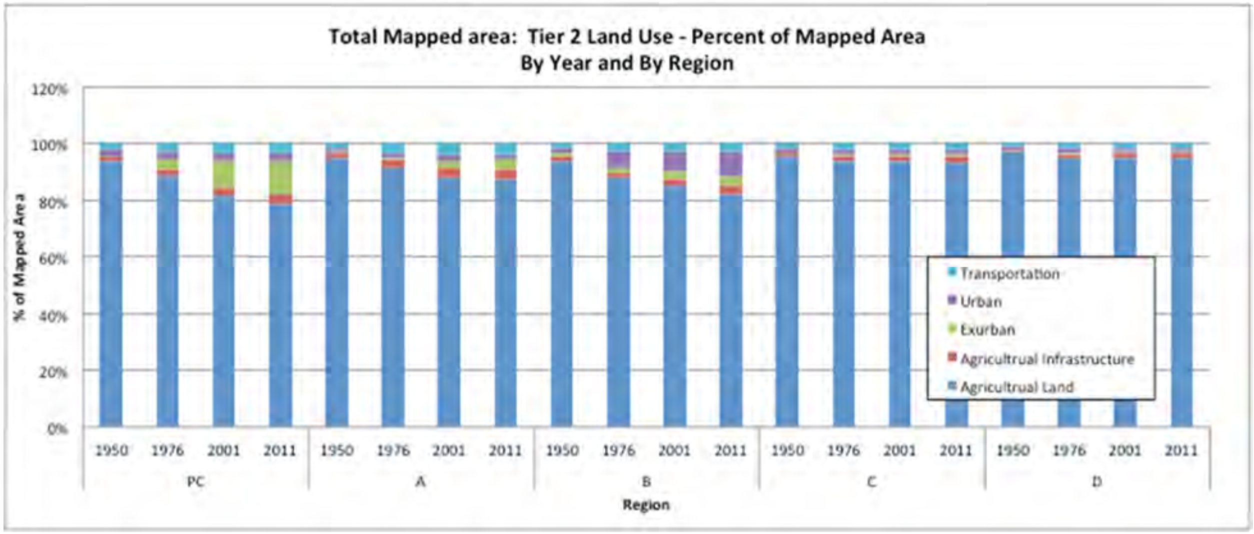

Figure 2-2 Percent of mapped area in each of the major categories of Tier 2 Land Use within the Yellowstone Corridor. (Tab - Tier 2 LU by Region).

Region B also experienced some loss of agricultural land similar to the upper two regions in that the amount of acreage was similar at 5,900 acres. Again, as in the upper river regions there are differences in the pattern. In Region B the decline in overall agricultural land use is offset to some extent by growth in part of the agricultural land use, where irrigated agricultural land increased by about 2,700 acres. And the Billings area shows a second difference from the upper river in that urban area growth was the largest new land use to appear in the region, which saw growth in Region B of almost 3,500 acres. Exurban growth was also substantial at 1,500 acres, but did not dominate the changed land use like in Region PC. The total loss in agricultural land was 12 percent with half occurring in the first 26 years between 1950 and 1976, then a period of near stability, and the second half of the loss happening in the 10 years after 2001. The overall decline in agricultural lands falls about halfway between the losses in Region PC and Region A.

The gain in irrigated agricultural land (as opposed to the general agriculture category that includes non-irrigated cultivation and pasture lands) was 22 percent, but cancelled out less than half of the overall loss in agricultural lands. Moreover none of the irrigated agriculture growth occurred in the area encompassed by Billings' growth. In the meantime, the urban gain (on a much smaller base than the agricultural lands from 1950) was 407 percent and the exurban gain was 356 percent. In the Billings area there was a definite trend towards urbanization that quickened in the final 10 years of the study period. About 60 percent of the growth occurred between 1950 and 1976; then there was 20 percent growth in the 25 years to 2001. The final 20 percent of the growth happened in the short span of 10 years from 2001 to 2011.

There were no clear trends in Regions C and D. In Region C, agricultural land accounted for nearly 96 percent of the land surface in the region in 1950. By 2011, agricultural land had fallen to a little less than 93.5 percent of the land in the region, a difference of 2.5 percent, but only 1,444 acres of a 1950 base of nearly 120,000 acres of agricultural land. None of the major land-use categories stand out as replacing the loss of agricultural land. Urban, exurban, or transportation growth had all grown about 500 acres each, about 0.4 percent each of the land in the region. Region C is much larger than any of the regions above it along the Yellowstone, roughly two and a third times larger in total acreage than either Region B or Region C, and three and a half times as large as Region PC, yet changes are much smaller than those regions in either acreage or percentage. On a timeline, change in agricultural land use was both variable and mitigated by increases in irrigated agricultural land. The overall loss of 1,444 acres of agricultural land hides a larger amount of variability in non-irrigated agricultural lands than anywhere upstream of Region C. From a baseline of 69,800 acres in 1950, that amount fell by 3900 acres by 1976, only to rebound by 2001 to within 330 acres of the 1950 amount, and falling again over the next 10 years by about 1,850 acres to 66,633 acres in 2011. Other major land uses—urban, exurban and transportation—had slow but steady growth of around 500 acres each through the 60 years of the study period. Compared to the growth rates of non-agricultural land use in the upper regions of the river, change was very slight in the region.

Transportation land use is worth special mention here. While the category showed a small increase in acreage, it masked a change in the mix of transportation modes. All of the growth came from the Interstate Highway system which was constructed in the region between 1950 when that land use was at 0 acres, and 1976 when the Interstate acreage was 760. Railroads on the other hand reached their height in acreage (in the river corridor) by 1976 at 1089 acres but had dropped to 434 acres after the abandonment of the Milwaukee Railroad route in the late 1970s. That abandonment shows up in reduced railroad acreage, but still exists as a kind of legacy dike that includes most river reaches in Region C. The impacts of that abandoned railroad route are covered in the chapters on hydraulics and geomorphology.

There is growth in a more minor area of land use that is also worth special mention. Agricultural infrastructure, including canals, agricultural associated roads, and structures grew to 2,579 acres across the region, on a base of 1,257 acres in 1950. Most of the growth of 1,322 acres (more than double the 1950 agricultural infrastructure) occurred by 1976 when infrastructure acreage was 1,057. This growth, while not a major land-use conversion either river-wide or even in this region, could nevertheless be significant because it represents a widespread phenomenon affecting most of the river corridor. Agricultural infrastructure is by its nature scattered throughout the farming and ranching lands that dominate the river's land-use categories. The building of agricultural infrastructure has an unintended consequence of fragmenting remaining patches of riparian vegetation and can affect wildlife species susceptible to having contiguity of habitat disturbed. This issue will be covered in more detail in the terrestrial biology chapters, particularly avian populations.

Region D also lacks major trends in land-use change. This region again is dominated by agricultural land use, which covered over 94,000 acres of Region D lands in 1950, rising to over 100,000 acres in 2011. These acreage figures translate to 92.2 percent in 1950 and 94.7 percent in 2011, making this the only Yellowstone River Region to experience an outright growth in agricultural land use. The overall agricultural land-use category masks a more significant gain in irrigated agricultural lands, which grew from 25,384 in 1950 to 40,773 in 2011. Because there was no data from McKenzie County in North Dakota for 1976 due to a lack of aerial photography, the observer cannot see an accurate picture of growth trends in irrigation throughout the 60-year study period.

Nonetheless, the growth in irrigation was substantial in this region, adding more than 15,000 acres of irrigated agricultural land use. At the same time non-irrigated agricultural land use declined by over 9,500 acres. During the study period, the amount of space taken up in active river channel also declined by about 3,400 acres, creating new lands available for land-use conversion. All other land uses (agricultural infrastructure, urban, exurban, and transportation) increased in size over the 60-year study period, albeit by small amounts, ranging from about 900 to 1,900 acres. None of these other land uses individually totaled more than 1.8 percent of the region in 2011. The reasons for such substantial growth in irrigated acres will be covered in more depth in later sections of this Appendix, as well as being examined in the context of significant changes in hydrology and hydraulics in those technical appendices.

2.1 Summary of Mapped Area Discussion

When considering the total mapped area, some regional conditions and trends are apparent. The overwhelming observation is that agricultural land use dominates the landscape along the entire course of the Yellowstone River (Figure 2-1 and Figure 2-2), although as this Appendix looks more closely at reaches within the regions there are some exceptions for short distances along the river. These differences are more obvious as the Appendix focuses more closely on the river channel in later sections. In Regions PC, A and B the overall amount of land devoted to agricultural land use has declined steadily between 1950 and 2011, although Region A shows some leveling of the rate of decline between 2001 and 2011 (see Figure 2-2). The regional picture masks some complexities in these trends, which will show up in discussions of the inundation zone and CMZ sections. Region C has remained remarkably stable, while in Region D irrigated agricultural land use has actually increased by about 15,000 acres.

2.2 Agriculture Land-use Change

This analysis is primarily devoted to changes in the use of irrigated agriculture, with some reference to non-irrigated agricultural lands. Irrigated agriculture is the major source of complete conversion to non-native conditions in this general land-use category. Non-irrigated agricultural lands are generally not converted completely and in many cases not at all, thus providing the area for remaining native biological forms (wildlife, avian life, native trees and forests, native shrub land, etc., which are covered in detail in Technical Appendix 6 Biology: Terrestrial Plants (Riparian Systems).

The use of irrigation and associated farming techniques along the Yellowstone convert the land use from variable vegetation types into homogenous fields that are usually leveled and prepared for systematic application of irrigation water, thus converting irrigated lands from pre-settlement native land cover, topographic variability and habitat to new structure and use. Irrigated agriculture was well established in the Yellowstone valley at the point in time that this study begins—the 1948-1950 aerial photography of the river corridor—and overall only a moderate amount of acreage was added to the 1950 totals by 2011.

This description of agricultural land use is divided into two subject areas, the CMZ and the 100-year inundation boundary, often referred to as the 100-year floodplain. Because the inundation boundary was developed using Geographical Information System technology based on projected elevations, it is a general approximation of the 100-year floodplain. While it is generally accurate, it may have local differences from other ways of calculating the floodplain in the Technical Appendix and other chapters on hydraulics of the river system. Therefore, in the interests of fully disclosing study methods, we use the term inundation boundary in Technical Appendix 1 Land-use to refer to what surfaces are generally flooded in 100-year probability weather and run-off events.

Other studies in this series of technical appendices show that the most critical area of the floodplain for sustainability of natural resources is the CMZ. It is in this area that the active channel migrates back and forth across a limited portion of the floodplain in any given 100-year period. Over the long term the historical occupation of the floodplain by channel may exceed the present CMZ, but for a one hundred year planning period (far beyond most human planning models), the present CMZ may well sustain native aquatic life and riparian vegetation and wildlife if it stays intact as a natural area. The CMZ has become an area of land-use conversion to some extent, but except in some localized areas there are still substantial acres of relatively natural CMZ. Thus, this study breaks out the CMZ from the overall floodplain to illustrate how natural or not the CMZ remains for any given region or reach of the river. The CMZ is also a principal subject in the Technical Appendices and chapters on hydrology, hydraulics and geomorphology.

While the percentage of CMZ remaining without significant land-use conversion (such as for irrigated agriculture or for urban use) is one useful measure of the ability of the river to sustain native life forms and natural processes, those acreage figures and percentages are not a complete story of the significant natural condition within the CMZ. Equally important to how the river works to support wildlife, fish and natural vegetative species are those natural processes that form water features in which aquatic life lives and landforms that support riparian forests and other vegetation as well as terrestrial wildlife. Thus the simple amount of natural land left in the CMZ is not the only critical factor in a healthy river system; the CMZ and its channel migration through the CMZ create the basis for continuing sustainability of critical native life.

In a river-long comparison of Tier 2 Land Use (Transportation, Urban, Exurban Agricultural Infrastructure, Agriculture), it is interesting to note that except for Region B, the general picture of land-use does not significantly change at the regional level when moving from total mapped area to inundation area to CMZ. At year 2011, agricultural land is within 2 to 3 percentage points of its Total Mapped Area figure in all Regions but Region B (see all Tier 2 figures: Figure 2-3 through Figure 2-6). Region B, as a percentage of total lands, actually lost the least amount of agricultural land. While it has seen a similar or even greater growth of population through time to Region PC (the other region that moved the greatest extent away from concentration on agricultural land use), more of that population is within urban areas in Region B, while in Region PC much of the growth change has been in exurban development.

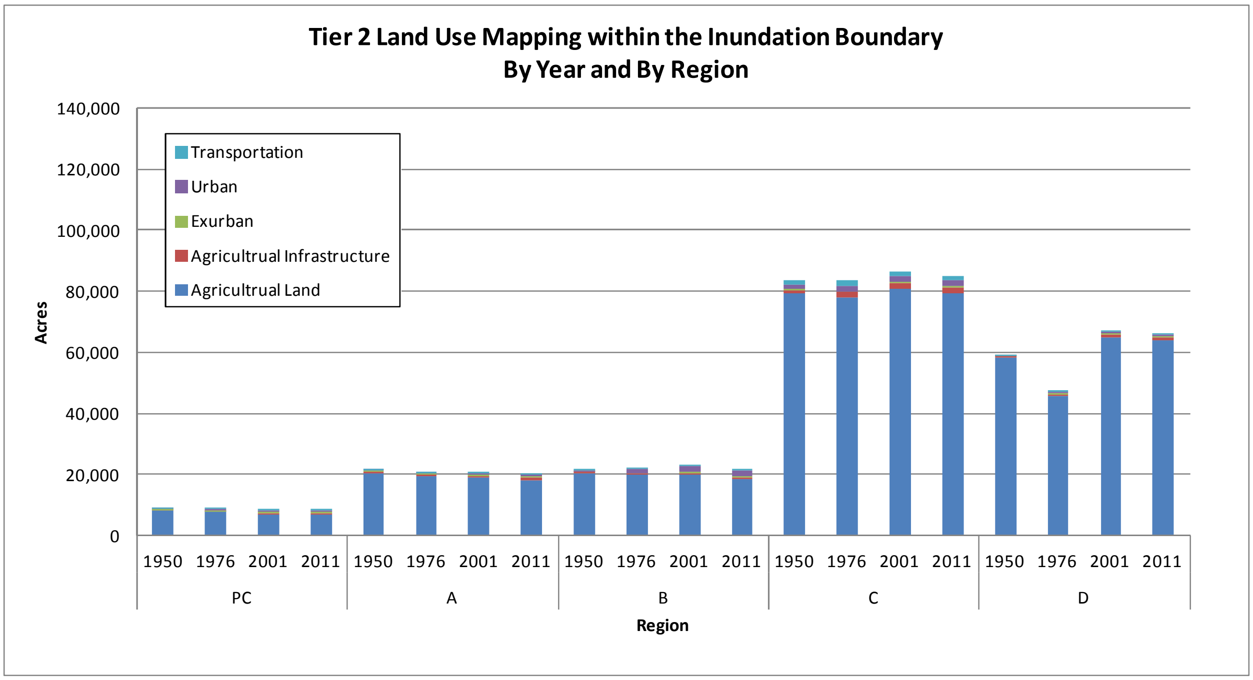

Figure 2-3 **Major categories of Tier 2 Land Use within the mapped 100-year inundation boundary of the Yellowstone Corridor. (Tab - Tier 2 LU by Region).**

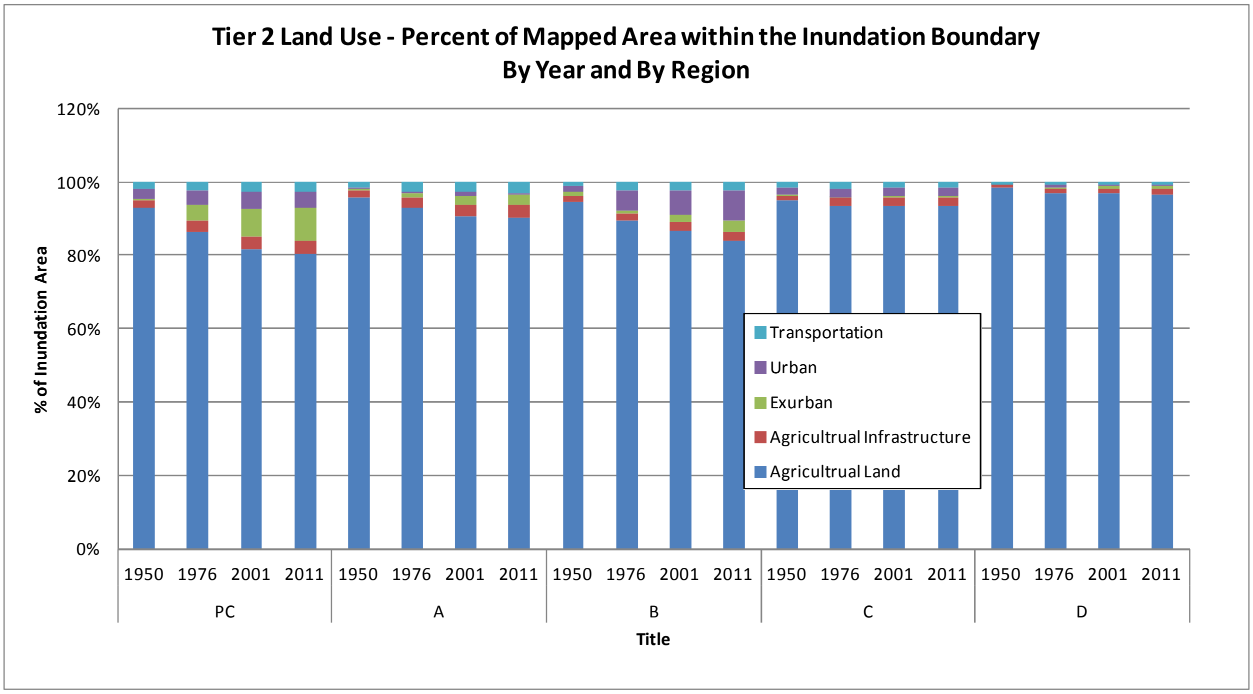

Figure 2-4 **Percent of the mapped 100-year inundation boundary with for the major categories of Tier 2 Land Use mapping. (Tab - Tier 2 LU by Region).**

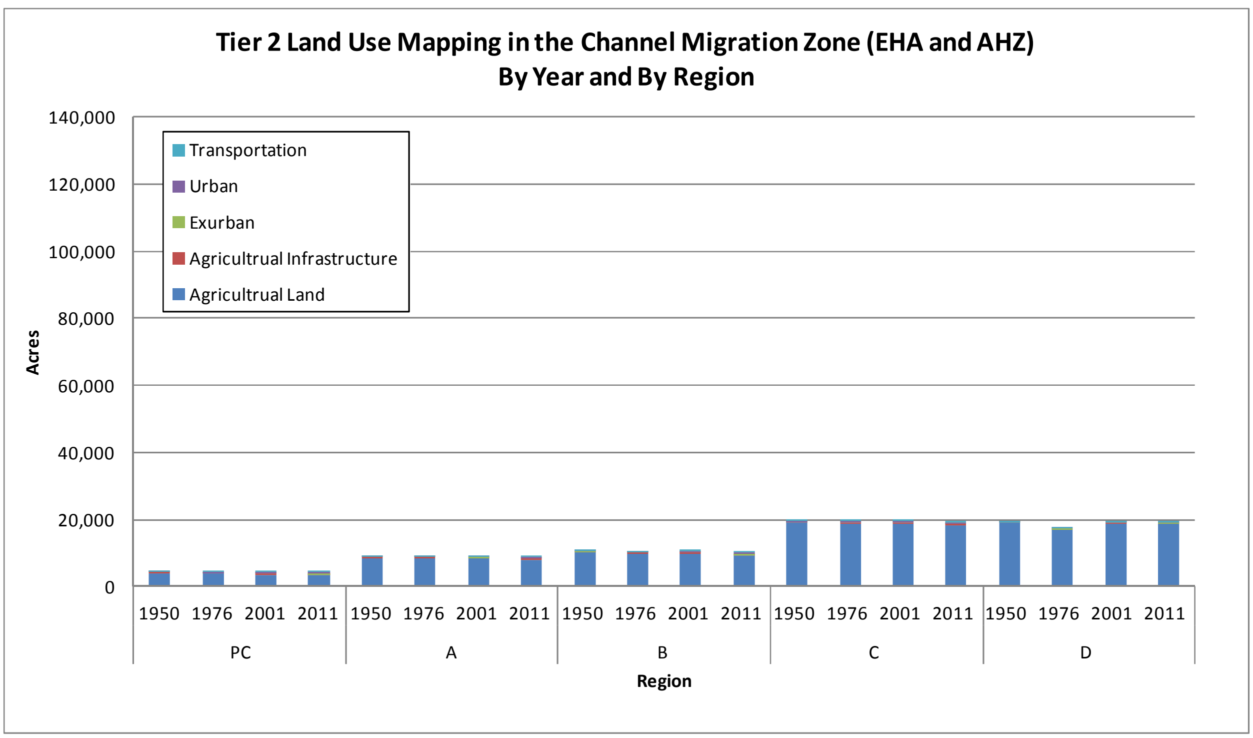

Figure 2-5 **Major categories of Tier 2 Land Use within the mapped Channel Migration Zone. (Tab - Tier 2 LU by Region).**

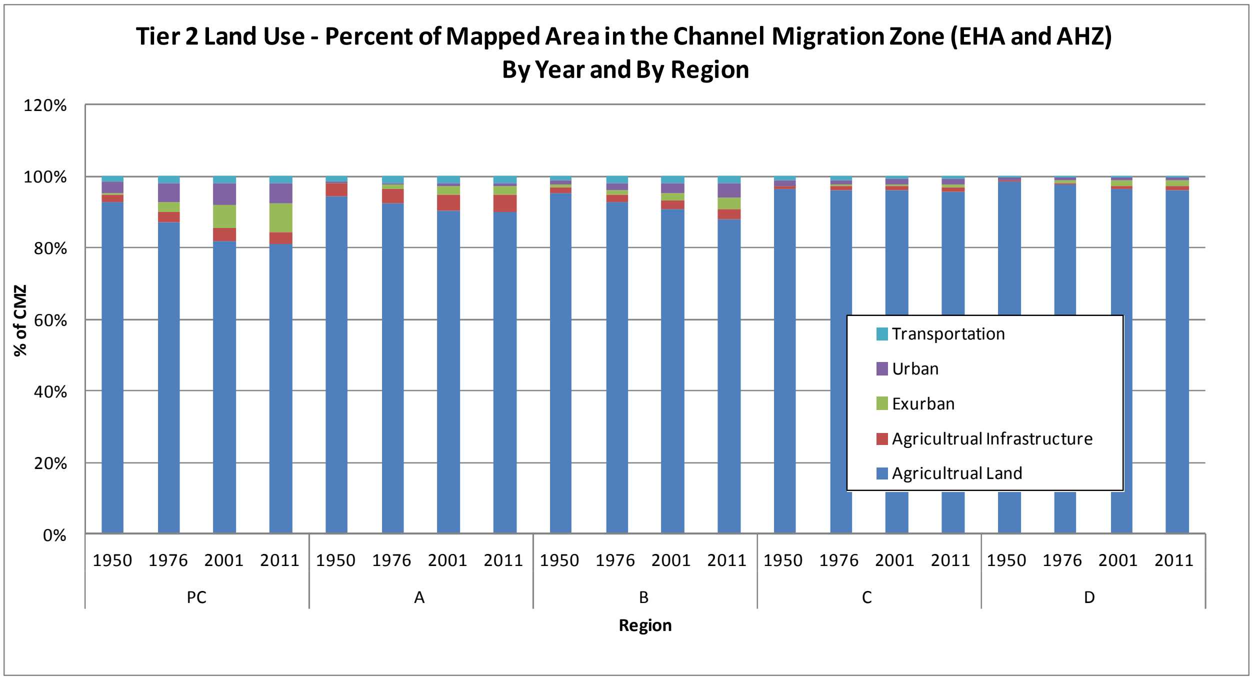

Figure 2-6 Percent of the Channel Migration Zone with for the major categories of Tier 2 Land Use mapping. (Tab - Tier 2 LU by Region).

A different context for agricultural conversion for the entire study area is to examine irrigated agriculture in the inundation area. In 1950, regional conversion to irrigated agriculture ranged from 29 percent of total floodplain acreage in Region PC to 50 percent in Region C. Along the entire river corridor, almost 40 percent of the floodplain acreage had been converted to irrigated agriculture. Without even considering other categories of land-use conversion, 40 percent converted in a way that excludes native vegetation and wildlife is a substantial effect on the native life forms.

By 2011, the total acreage in irrigated agriculture had risen only slightly to 44 percent, but that figure masks some significant regional differences. For example, in Region PC, 2011 irrigated agriculture had fallen to about 17 percent of that region. Most of that decline did not revert to a less intensive land use, but instead went to exurban expansion and near Livingston to urban growth. That land-use conversion introduces not only landscape change but also the constant presence of people into that landscape. On the surface, Region A seems to repeat the Region PC pattern. However, very few acres have been converted to exurban development in Region A, and more detailed consideration of Region A, below, reveals that most of that conversion occurred in the last reach of the region, near Laurel. However in this Region, even larger parcels not subdivided changed ownership during the 60-year study period. Where most of the land at 1950 was devoted to hay-based ranching, by the end of the study period many owners were either absentee most of the year, or urban dwellers not relying on ranching for all of their income. That social factor may be an important agent of the change in land-use conversion in Region A.

Another regional difference occurred in Region D where the 1950 and 2011 irrigated agriculture inundation area percentages were 30 and 47 percent, respectively, a substantial rise in irrigation activity. Figure 2-7 and Figure 2-8 illustrate acreage taken up in irrigated agriculture as acres and percentage of the inundation area in the regions and for the entire river valley.

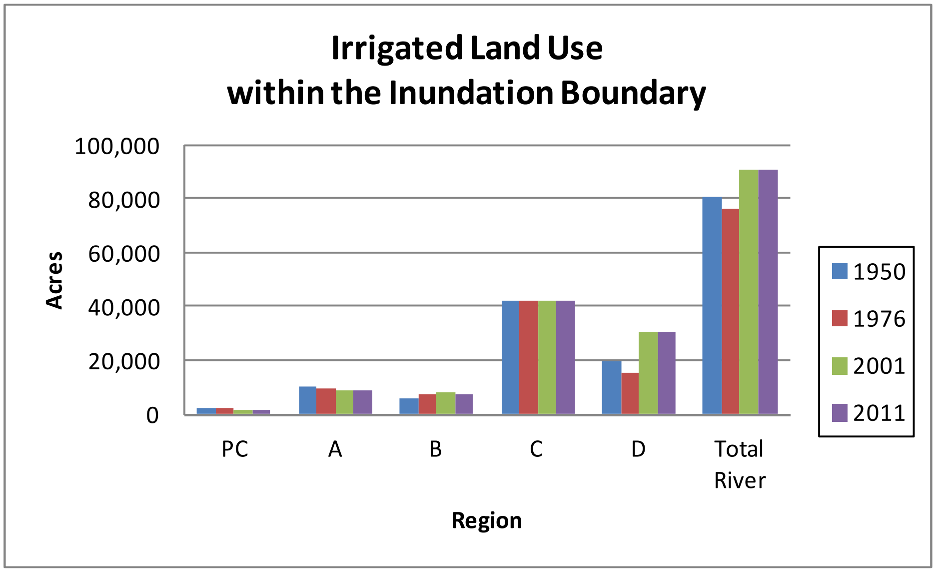

Figure 2-7 Inundation Area Acres in Irrigated Agriculture, 1950-2011.

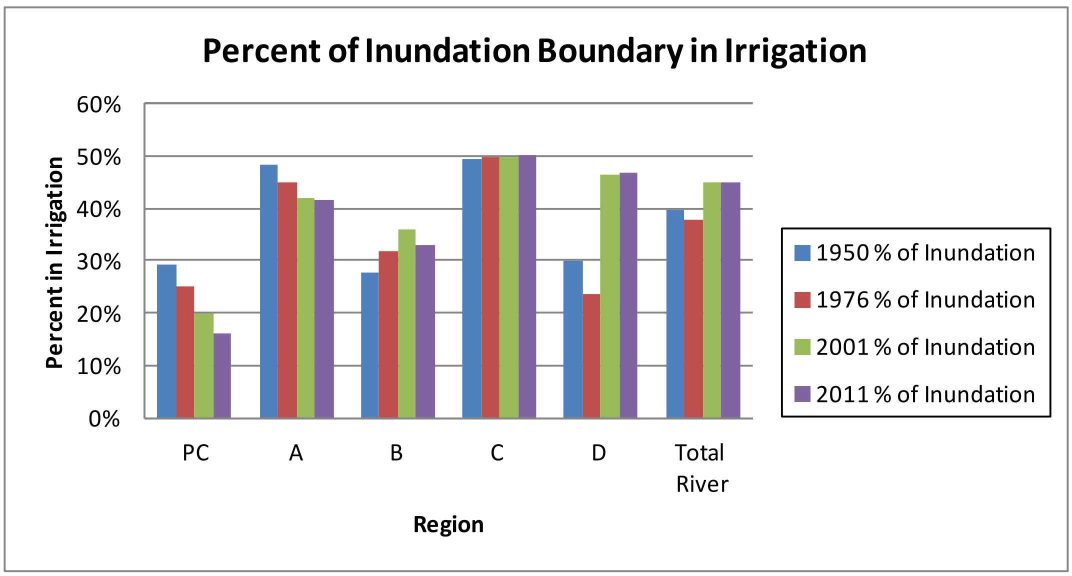

Figure 2-8 Percent of Inundation Area in Irrigated Agriculture, 1950-2011.

Turning to the CMZ for the entire study area in 1950, regional conversion in the CMZ to irrigated agriculture ranged from 18 percent of regional acreage in Region PC to 37 percent in the adjacent Region A. Along the entire river corridor, just over 25 percent of the CMZ acreage had been converted to irrigated agriculture. By 2011, the total acreage in irrigated agriculture in all regions had risen from 25 to 32 percent, but as with other topics that figure masks some significant regional differences (Figure 2-9 and Figure 2-10). For example, in Region PC, 2011 irrigated CMZ agriculture had fallen from 18 to only 8 percent of that region but nearly the same number of acres (between 350 and 400) appeared in exurban land use by 2011, indicating the same sort of switch to another intensive land use seen for the inundation area in Region PC. As in the inundation area for Region A, the CMZ seems to follow a similar trend as Region PC. But also as in the inundation area, the reasons are not entirely clear, as an increasing exurban development trend covers well less than one-third of the irrigation acreage decline in the CMZ in Region A.

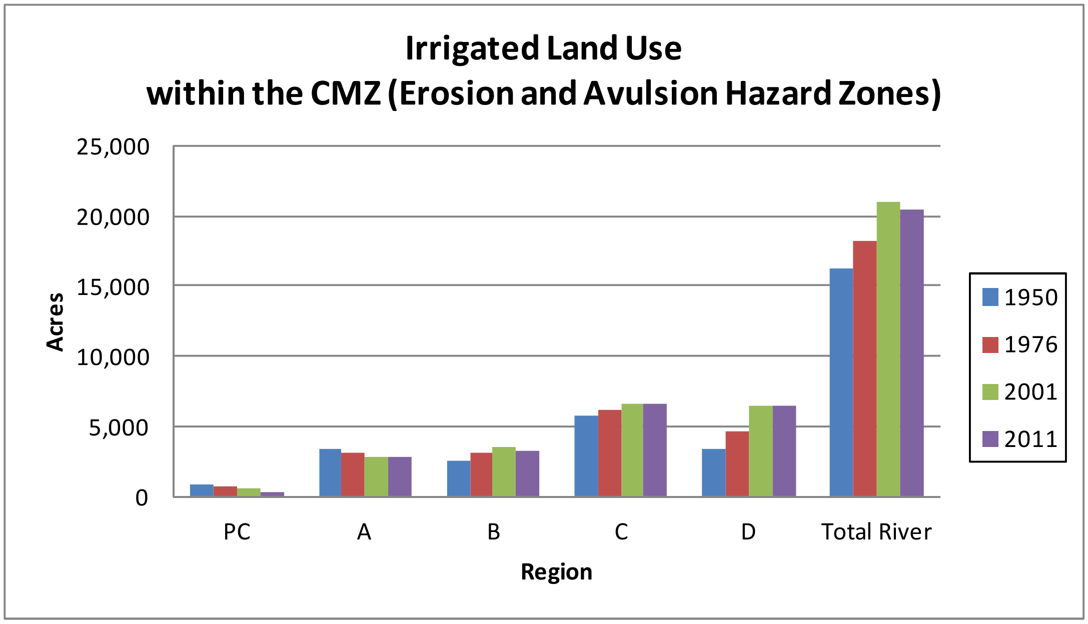

Figure 2-9 CMZ Acres in Irrigated Agriculture 1950-2011.

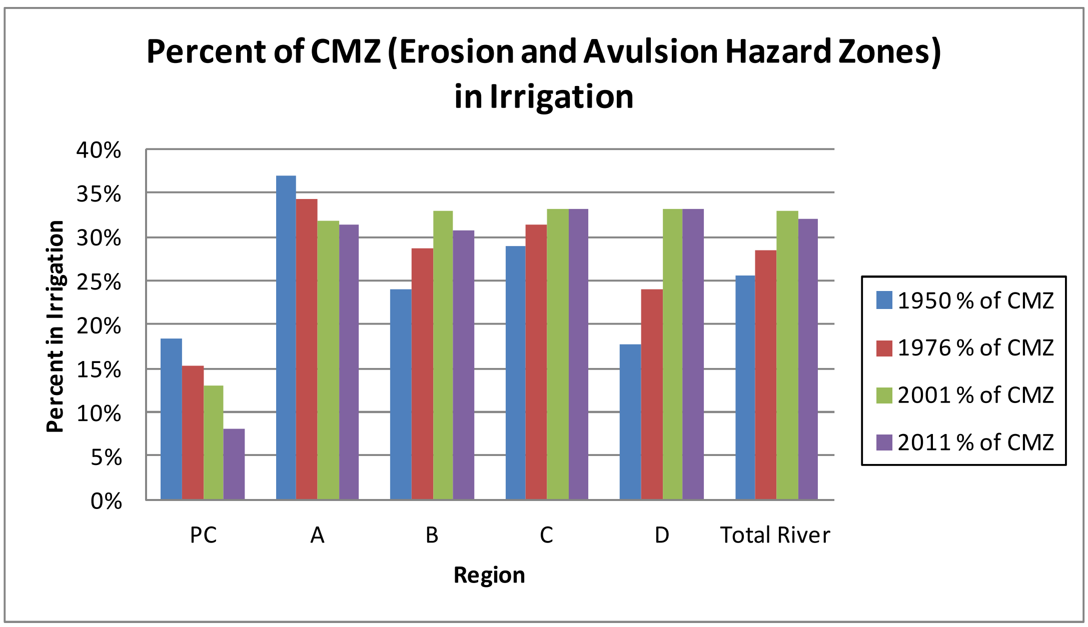

Figure 2-10 Percentage of CMZ in Irrigated Agriculture 1950-2011.

Once Region B is reached, however, the trend reverses. In all of the regions and reaches where row crops predominate (e.g. corn, sugar beets, etc.), there is increasing encroachment into the CMZ with irrigated agriculture. Predictably, the trend is present in the last reach of Region A, where row cropping begins to be substantial. Although raw acreage changes are not great, mostly rising from around 3,000 acres to 5,200 acres per region for Regions B through D, the rate of change is more substantial. In Region D the 1950 and 2011 irrigated land percentages were about 17.5and 33 percent, respectively, indicating a substantial rise in irrigation activity, and a reason to be concerned about changes to the CMZ. Regions B and C changes are smaller, but still indicate a definite change (see Figure 2-9 and Figure 2-10 for comparisons between regions showing both actual CMZ acreage and percentage of CMZ in irrigated agriculture by region and for the entire river).

The following sections explore the regions and their agricultural land use in more detail by region and where relevant by reach. Each section is organized by coverage of the entire inundation zone first followed by discussion of the CMZ. Where relevant variation is found at the reach level, those instances are described as appropriate.

Region PC – The Park County Region (Region PC) begins at Gardiner, Montana as the Yellowstone River emerges from Yellowstone National Park, and is the uppermost region studied for Land Use along the river. The PC region divides conveniently into three sub-regions for the purposes of description. These are: (1) the Upper PC Reaches (PC1 through PC3) from Gardiner to the end of Yankee Jim Canyon; (2) the Middle PC Reaches (PC4 through PC 12) encompassing the Paradise Valley; and the Lower PC Reaches (PC13 through PC 21), a mixed use area around Livingston, Park County seat, to the east boundary of Park County.

Inundation Area -The uppermost reaches in Park County have seen little change since 1950 within either inundation area or CMZ. The inundation area total acreage in these three reaches is only 758, of which 36 acres were irrigated farmland in1950, and that had dropped to less than 1 acre by 2011. This is the smallest proportion of irrigated acres of any multiple reach area in the entire Yellowstone Valley in either time period. This uppermost portion of the Yellowstone Valley is a narrow mountain valley more similar to the river in Yellowstone National Park than any downstream valley area. The inundation area is very narrow and as the popularity of recreation and use of Yellowstone National Park grew between 1950 and 2011 the small acreages of farming were abandoned and even where not converted directly to housing or other recreation use, the acreages were no longer farmed. Considerable land-use conversion has occurred along the higher valley terraces, but the inundation area and CMZ have been little changed during the study time period. For example, exurban development from residential to industrial has grown in all three reaches in the total mapped area. Table 2-1 shows the difference in change parameters among total mapped area, Inundation Area and CMZ for the uppermost Region PC Reaches.

Table 2-1
Selected Land Use Acreage in Upper Yellowstone River Reaches.

Reach	Length in River Miles	LU Element	Year of Observation: 1950 Mapped Area	2011 Mapped Area	1950 Inundation	2011 Inundation	1950 CMZ	2011 CMZ
PC1	4.6	Ag Lands-Irr	42	36	0	0	0	0
		Ag Lands-No Irr	1605	1364	36	21	7	3
		Exurban	32	158	0	10	0	1
PC2	3.2	Ag Lands-Irr	251	194	0	0	0	0
		Ag Lands-No Irr	908	833	20	24	4	10
		Exurban	9	146	0	4	0	2
PC3	10.3	Ag Lands-Irr	635	404	35	0	0	0
		Ag Lands-No Irr	3433	3280	127	163	16	26
		Exurban	11	303	0	12	0	4

The second segment of Region PC, the Paradise Valley is about 40 river miles where the river first opens out into a wider valley. This section begins at the mouth of Yankee Jim Canyon and ends where the valley briefly narrows into a canyon again just above Livingston. The Paradise Valley retains much of the grandeur of the mountain scenery and recreation opportunities around Yellowstone National Park. Nevertheless, in 1950 the valley was overwhelmingly characterized by ranching agriculture.

There are nine reaches in Paradise Valley (PC4 – P12) and they show ranching and farming activity well established by 1950, but a decline in irrigated acres by 2011. These nine reaches began 1950 with 677 floodplain acres under irrigated cultivation and by 2011 there had been a drop in irrigation to 467 acres (Figure 2-11). The decline is not spread evenly along the valley. The majority of the loss in irrigation came in two reaches, PC7 and PC10. PC7 is associated with the Emigrant community and Chico Hot Springs resort, while PC 10 is near the most well-known spring creek fisheries in Paradise Valley. Both reaches figure heavily in Paradise Valley’s growth of exurban development (See also section on Urban and Exurban land-use conversion).

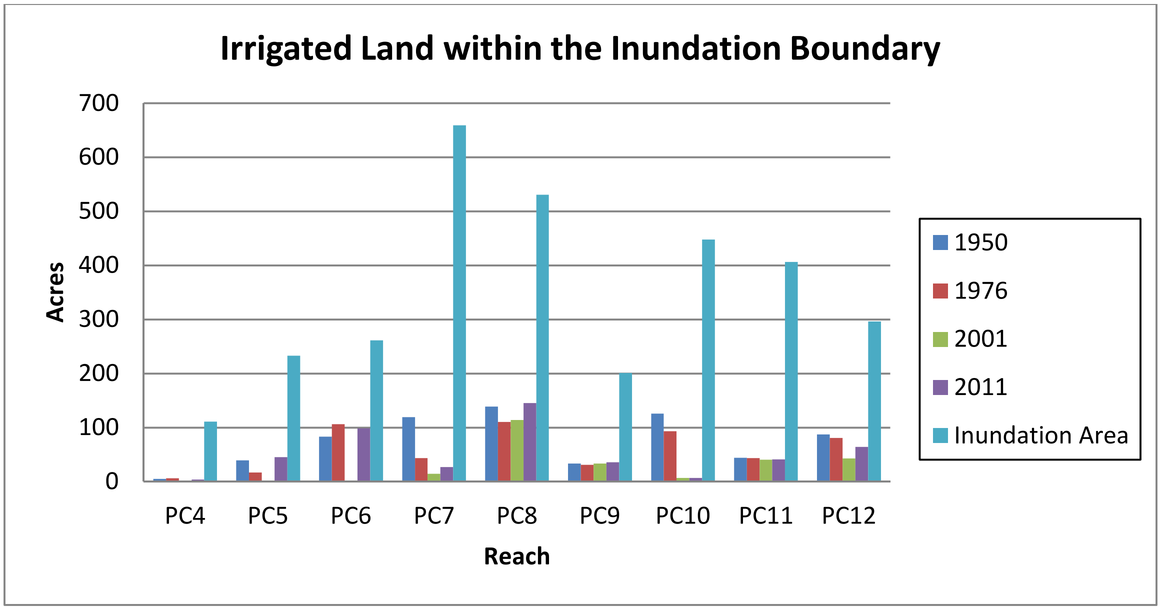

Figure 2-11 Irrigated Agricultural Land Use in the Paradise Valley Inundation Area.

The third segment of the PC Region (Reaches PC13 through PC21) encompasses the narrow canyon just downstream from Carter's Bridge in a single reach, the commercial center for Park County and the PC Region (Livingston in reaches PC14 and PC15), a limited valley area downstream of Livingston (compared to Paradise Valley), and a second canyon area at the end of this segment. Region PC ends with reach PC21 at the Park County – Sweet Grass County line.

In 1950, the three reaches immediately downstream from Livingston (PC16 – PC18) did have measurable irrigated agricultural acreage in the inundation area but had fallen dramatically by 2011 (see details in Figure 2-12. The downward trend in irrigated agricultural land use was more pervasive in this portion of the region than in the Paradise Valley segment, with only one reach (PC19) experiencing an increase in irrigation over the 60-year study period. These declines in irrigated acreage did not necessarily translate to an increase in native vegetation, however, as exurban and urban growth in the Livingston vicinity was substantial (See section on urban and exurban development in this Technical Appendix).

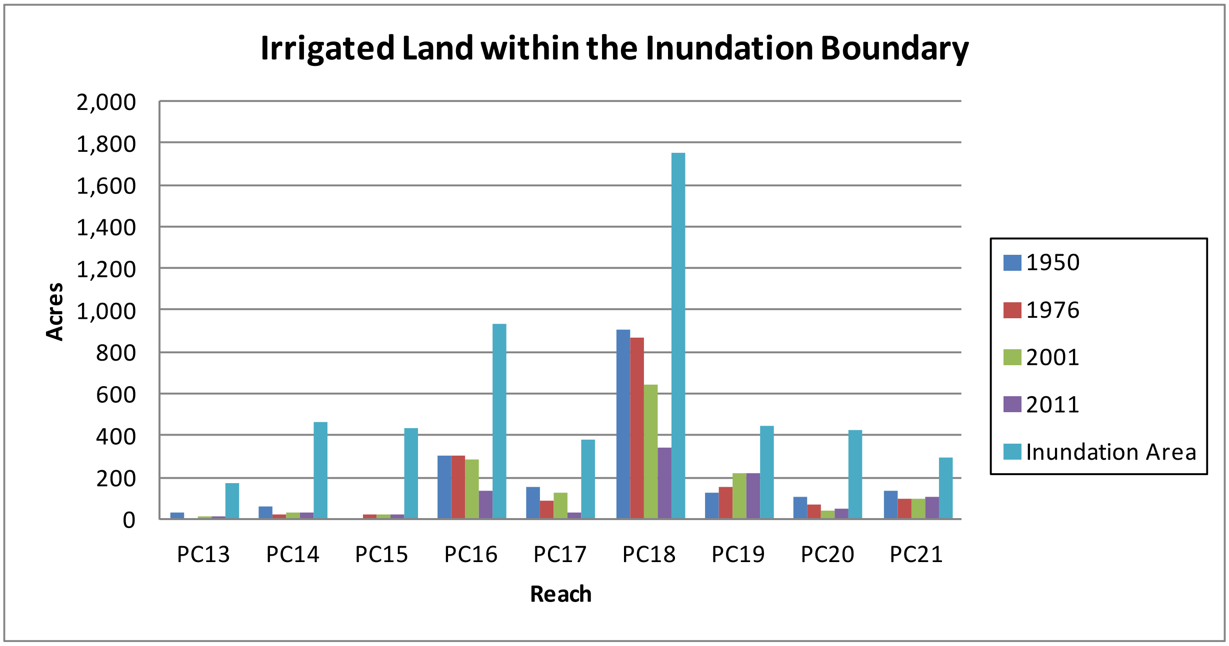

Figure 2-12 Irrigated Agricultural Land Use in the Inundation Area for Lower Region PC.

2.2.1.1 *CMZ Discussion*

For the entire Region PC, the conversion of CMZ lands to irrigated agriculture has stayed small from 1950 to 2011, with only four of the twenty-one reaches exceeding 100 acres of CMZ conversion in any time period and none exceeding 200 acres (Figure 2-13). In fact, agricultural conversion of land to irrigated fields is a diminishing part of the landscape between 1950 and 2011 in the Region PC CMZ, similar to the trend in the inundation area. Only five of the Region PC reaches show an increase in cultivation, and none of those had more than 20 acres cultivated in any time period the study measured.

Similar to the inundation zone, downward changes in agricultural use tend to be counteracted by increase in urban or exurban land use. Only five of the twenty-one reaches in the region experienced negligible or no increase in exurban development within the CMZ, defined as 2 acres or less of exurban development, in the 60-year study time period. Ten reaches had moderate exurban growth, between 3 and less than 20 acres per reach. Six reaches saw growth greater than 20 acres of exurban development. Of those six reaches, two had exurban growth of more than 35 acres. Both of these reaches (PC14 and PC15) were in the Livingston urban area, which also saw urban growth, 15 and 66 acres, respectively.

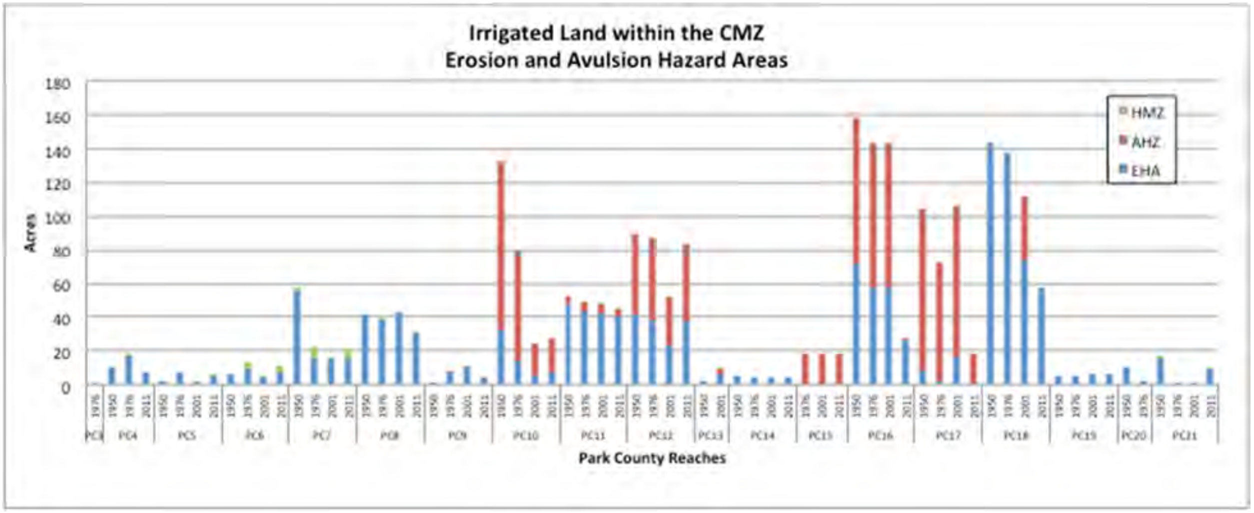

Figure 2-13 Irrigated Agriculture Land Use in the CMZ, Region PC (Key: HMZ – Historic Migration Zone; AHZ – Avulsion Hazard Zone; EHA – Erosion Hazard Zone. The three classes comprise the total CMZ).

2.2.1.2 *Summary, Region PC*

Over the 60 years covered by the Yellowstone cumulative effects study, the amount of agriculture has diminished, but Region PC has a somewhat different relationship with agriculture than the downstream areas where row crops predominate. For the river as a whole, in 1950 40 percent of the inundation area was devoted to irrigated agriculture, and that rose to 45 percent by 2011. Region PC did not add to those results. Even in 1950, the amount of inundation area devoted to irrigated agriculture lagged the rest of the river at 29 percent, and irrigation had fallen to 16 percent of the floodplain by 2011. Yet the fall in agriculture was localized. Most of the loss in acreage came in two reaches in Paradise Valley and three reaches immediately downstream of Livingston. Some of the canyon reaches have never had much irrigated agriculture, in contrast to the remainder of the river valley all the way to North Dakota, where only urban expansion has nearly eliminated irrigated agriculture in a few reaches. Of the remainder of the 21 reaches in this region, over 50 percent of the reaches in the region, have maintained an agriculture presence very close to that in 1950.

Non-irrigated agricultural land shows a mixed history for the PC Region. Fourteen of the 21 reaches in this region experienced a loss of acreage of non-irrigated agricultural lands. Those 14 negative reaches lost a total of 962 acres, or 6.7 percent of the total inundation area. Losses were from other land-use conversions, mainly urban and exurban development, but even to transportation in the form of the Interstate Highway system has contributed to loss of agriculture in some reaches. Of the 7 reaches experiencing an increase in non-irrigated agricultural land, PC 18 stands out as an anomaly. It lies downstream of Livingston and the Highway 89 Bridge, and it gained 440 non-irrigated acres, apparently through an unusual combination of abandoned farmland related to exurban development, industrial activity and the transportation infrastructure of Interstate Highway 90. The 21 Region PC reaches can be viewed in detail in Figure 2-14 and Figure 2-15.

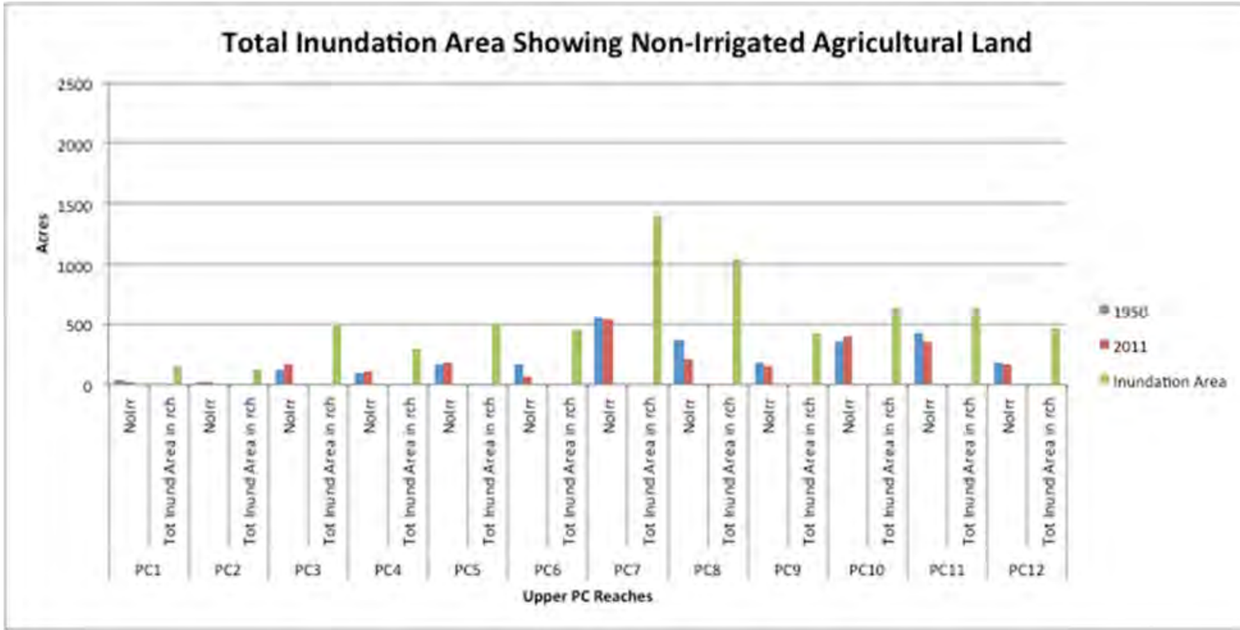

Figure 2-14 **Non-Irrigated Agricultural Land Compared to Total Inundated Area by Reach, Reaches 1 – 12, Region PC.**

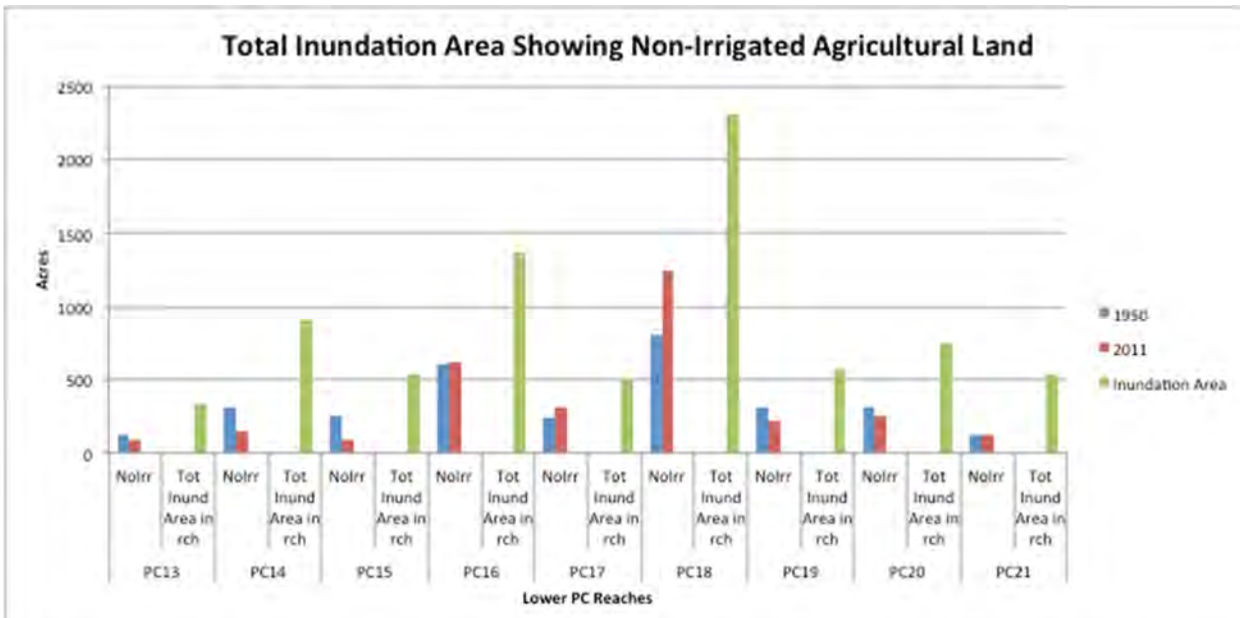

Figure 2-15 **Non-Irrigated Agricultural Land Compared to Total Inundated Area by Reach, Reaches 13 - 21, Region PC.**

Because of factors related to exurban housing development and the attractiveness of recreation in the area noted in discussion above of both the inundation area and the CMZ, the non-irrigated agricultural lands have become the only land use that supports a sustainable natural river valley. As noted above, 14 of the 21 reaches have lost acreage in this category. The additional losses to other land uses make the acreage ever more critical to maintaining a sustainably natural river for wildlife habitat and native vegetation. Several of these reaches already exhibit substantial losses in non-irrigated agricultural land use compared to total inundation area (see Reaches PC6, PC8, PC14, and PC15 in Figure 2-14 and Figure 2-15).

2.2.2 Region A – Agriculture

Region A covers the area from Springdale at the western border of Sweet Grass County to the mouth of the Clark's Fork River in Yellowstone County to the east. It traverses all of two counties (Sweet Grass and Stillwater), bounds the north side of Carbon County for a considerable distance, and terminates in a fourth county, Yellowstone County.

The region is dominated by agricultural land use, either irrigated crops or open lands generally used as grazing land. The predominant crop grown in Sweet Grass County and most of Stillwater County is hay. The valley transitions to mostly row crops like corn and sugar beets at the eastern end of Stillwater County into Yellowstone County.

In upper Sweet Grass County only three reaches show substantial departure from the predominant land-use pattern, A4, A6 and A9. A4 encompasses the community of Big Timber (the county seat), A6 a rural exurban development and A9 the small community of Reed Point at the Sweet Grass – Stillwater County line. A similar land-use pattern dominates most of lower Stillwater County with departures at the community of Columbus (the county seat) in reach A13, and towards the east boundary of the Region, where the valley widens near reach A16. Row crops begin to replace hay for lands in irrigated agriculture, and the Region terminates in a growing urban area around the city of Laurel at reach A18.

The dominant urban area on the entire river is Billings near the upper end of Region B and its influence is felt into Region A with substantial numbers of Yellowstone valley residents commuting to Laurel or Billings from at least as far west as Columbus.

2.2.2.1 *Inundation Area Discussion*

The upper portion of this region (reach A1 through A13) is overwhelmingly agriculture in nature. Agricultural lands in the inundation area are consistently over 90 percent per reach in 1950. Although there is a repeating pattern in most reaches of declining agricultural land use at each measurement stage (1976, 2001, 2011), by 2011 agricultural land use still occupied over 85 percent of the inundation area in all but four reaches. Two of the reaches bordered communities: reach A13 (Columbus) and A 18 (Laurel) where agricultural land use had fallen from over 95 percent of the two reaches to 70 and 75 percent respectively. One reach, A6, had the only sizeable rural subdivision until the final three reaches in the region, and its agricultural land use had fallen to 75 percent. Finally, a single reach, A11, experienced severe channel re-routings over the 60-year study period, and gained 27 percent in channel area at the expense of agricultural land use.

The only other land-use consistently appearing in Region A reaches is transportation, ranging from 0 to 3 percent per reach in 1950, and after the interstate highway system was completed, ranging from 0 percent (3 reaches) to 9 percent (2 reaches) in 2011. There is one major bridge over the Yellowstone in this region (reach A11), and its presence as a U.S. Highway 10 bridge in 1950, and an Interstate 90 bridge in 2011, put the percentage of transportation land use outside the norm in this reach for both years at 5 and 9 percent.

Even singling out the three principal towns in this region (Big Timber, Columbus, Laurel) does not change the reliance on agriculture. Those three reaches, A4 for Big Timber, A13 for Columbus, and A18 for Laurel, had converted from 1 to 2 percent of reach acreage to urban or exurban use in 1950, rising to 2 to 21 percent of reach acreage in 2011, for the three reaches. Figure 2-16 and Figure 2-17 detail major categories of land use for the inundation area in Region A.

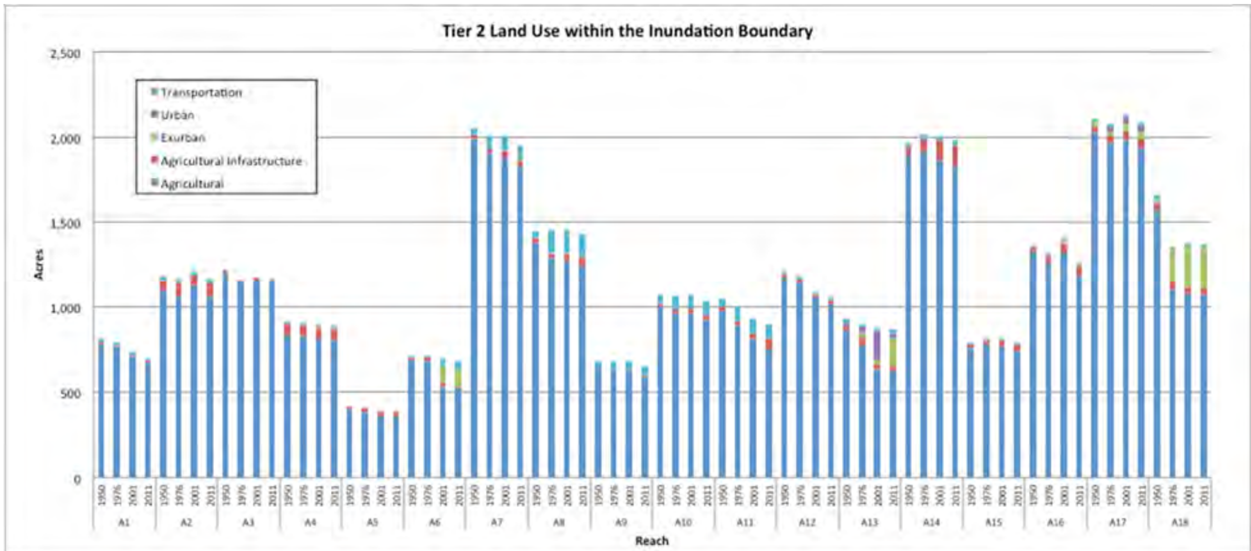

Figure 2-16 Land Use in the Region A Inundation Area, Showing the Dominance of Agriculture Land Use throughout the Region Particularly In the Early Years of the Study Period.

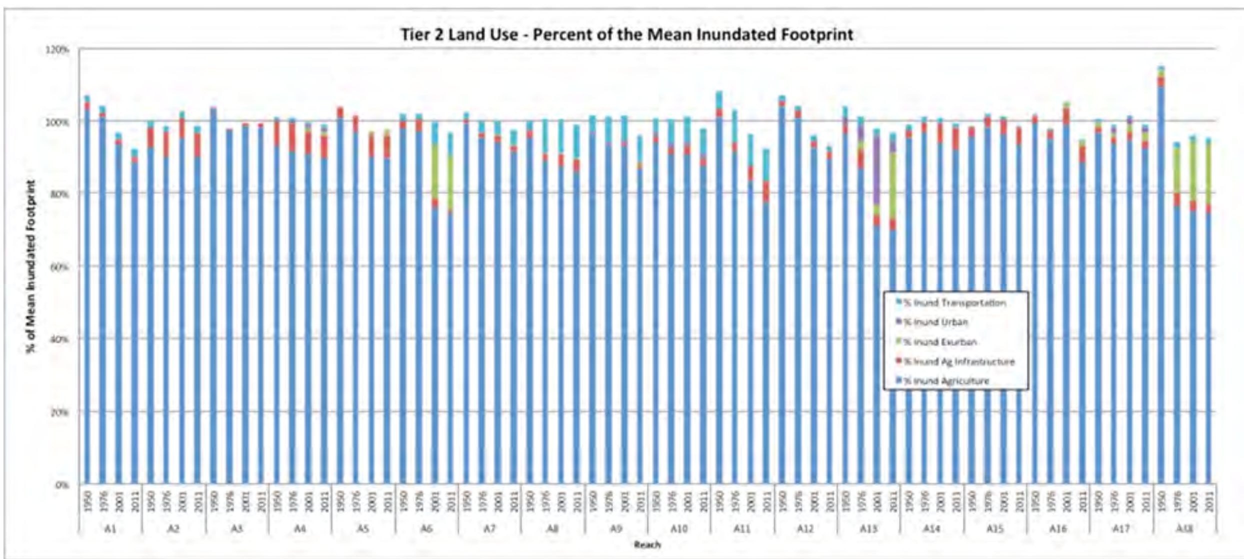

Figure 2-17 Percent of Inundation Area in Major Land Use Groups. (Some bars exceed 100 percent because of the effect of river channel area on land acreages in some reaches.)

Turning to non-irrigated agricultural lands, the category of land use that most represents open, undeveloped lands where light agricultural use (such as grazing) can co-exist with native vegetation and wildlife, the floodplain use of Region A presents a mixed picture. If a hypothetical benchmark of 40 percent is determined to be an adequate level of non-irrigated agricultural land use to maintain a sustainable natural community coexisting with irrigation and other land uses, then just over half of the reaches (10 of 18) in Region A meet that criteria. Seven of those reaches are clustered towards the lower end of the Region, while three are scattered in the upper half. An examination of Figure 2-18 and Figure 2-19 show that very little non-irrigated agricultural land remained in at least six of the nine reaches in the upper half of Region A, relative to either agricultural land use as a whole, or other land uses. Figure 2-20 also indicates where other land uses have reduced the potential of restoring non-irrigated agricultural land use, particularly in some previously discussed reaches like A6 (a rural subdivision location), A11 (Interstate 90 bridge over the river), A13 (Columbus), and A18 (Laurel).

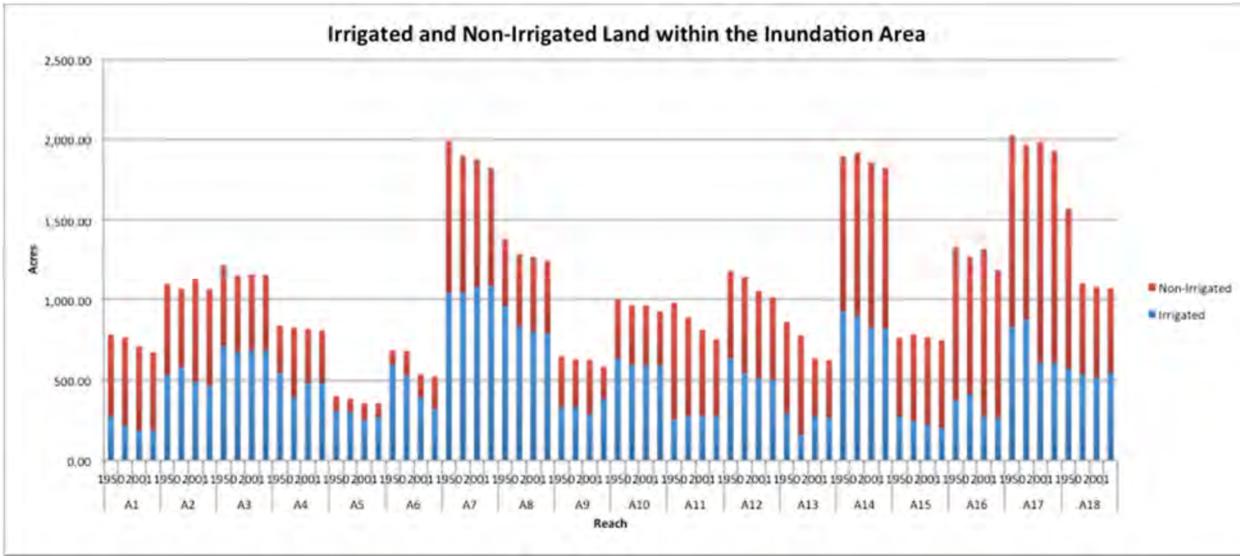

Figure 2-18 Irrigated and Non-Irrigated Lands in the Region A Inundation Area, 1950-2011.

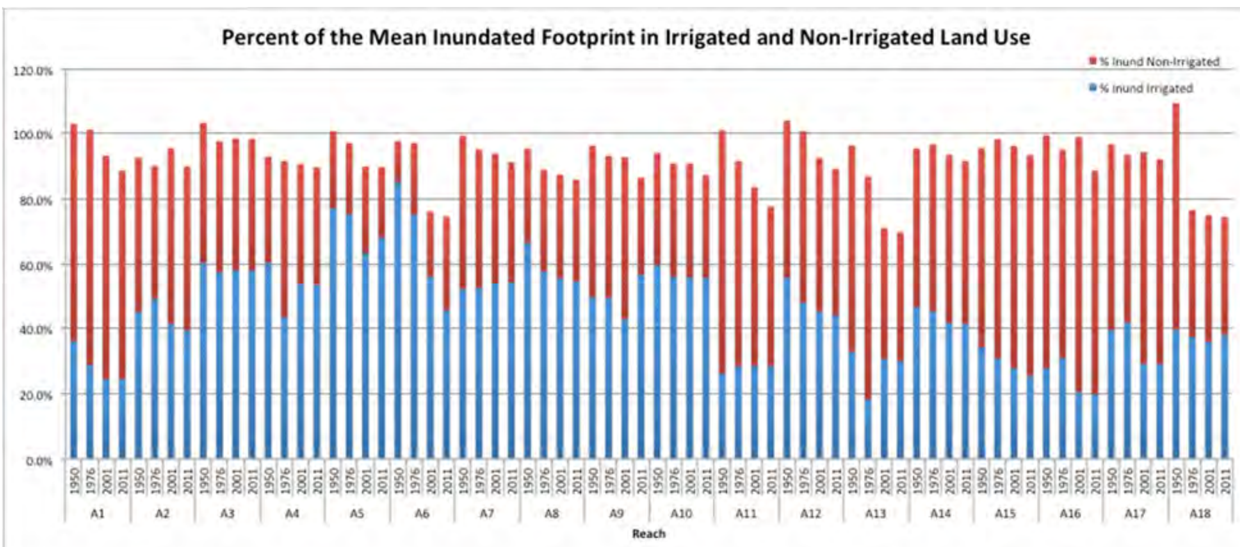

Figure 2-19 Irrigated and Non-Irrigated Land Relative to Total Inundation Area. (Some bars exceed 100 percent because of the effect of river channel area on land acreages in some reaches.)

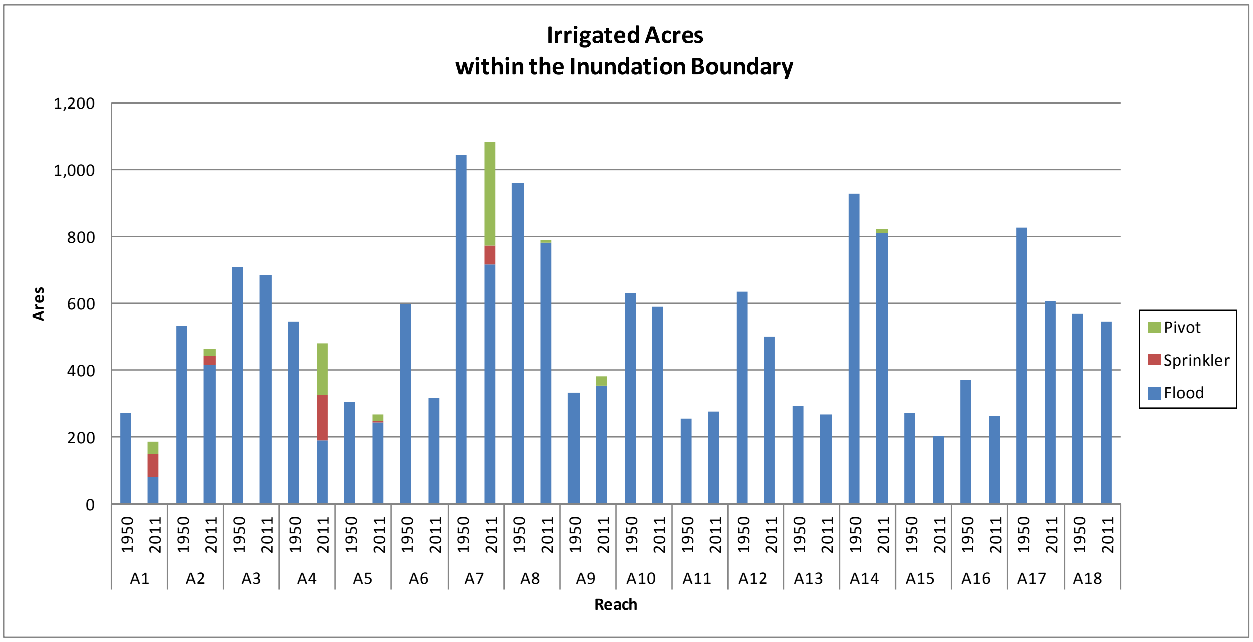

Figure 2-20 Change in Irrigated Agriculture, 1950-2011.

A trend in Region A is towards less land converted to irrigated agriculture, with all eighteen reaches declining between 1950 and 2011 to some extent (Figure 2-18 and Figure 2-19. The change is not precipitous like it is in Region PC, where overall agricultural acreage declined by about 50 percent. However the decline has been measurable where fourteen reaches have lost from 5 to 10 percent of 1950 levels of agricultural land use, and the four reaches where other land uses have predominated (exurban development, urban development, transportation) have declined in agricultural use by around 25 percent.

One other observation of note in this region is the appearance of pivot irrigation. In 1950, all irrigation was flood irrigation via canals and ditches. Pivot equipment has not been used extensively but had been installed to some extent in six reaches (Figure 2-20) by 2011. Pivot equipment is a high value investment. High value investments located near the river channel have been associated with increased riverbank armoring. The use of pivot irrigation near the river channel could lead to further declines in natural river sustainability.

2.2.2.2 CMZ Discussion

In the CMZ, irrigated agriculture declined in acreage in 11 of 18 reaches. Even with the decline in irrigated land use, six reaches were at or near 40 percent of the CMZ devoted to irrigated agriculture, thus showing substantial loss of native vegetation and habitat in those reaches. Details of CMZ irrigation acreage and percentage of CMZ occupied by irrigated agricultural land use are presented in Figure 2-21 and Figure 2-22. Of the reaches noted in the inundation area for other land uses (e.g., urban, exurban, transportation), only one reach, A6, saw a substantial decline in irrigated agriculture between 1950 and 2011. This presumably means that the rural subdivision located in this reach is in large part within the CMZ.

Two other reaches with significant amounts of other land use were present when the study period began, 1950. A11 and A 13 had reduced amounts of agricultural land use in the CMZ at 1950 and that stay relatively stable through the succeeding 60 years indicating that the transportation infrastructure in A11 and the town of Columbus in A13 occupied considerable CMZ space.

Five of the six reaches with pivot irrigation methods noted in the inundation area also had some pivot equipment installed in the CMZ. Three of the five reaches had 10 acres or less of pivot irrigation land use, and the remaining two reaches had 50 acres or less (Figure 2-21). The cautionary note about use of pivot irrigation in the inundation area applies to a greater extent in the CMZ, because this entire area is susceptible to river channel capture and thus becomes a likely site of bank armoring where pivots are adjacent.

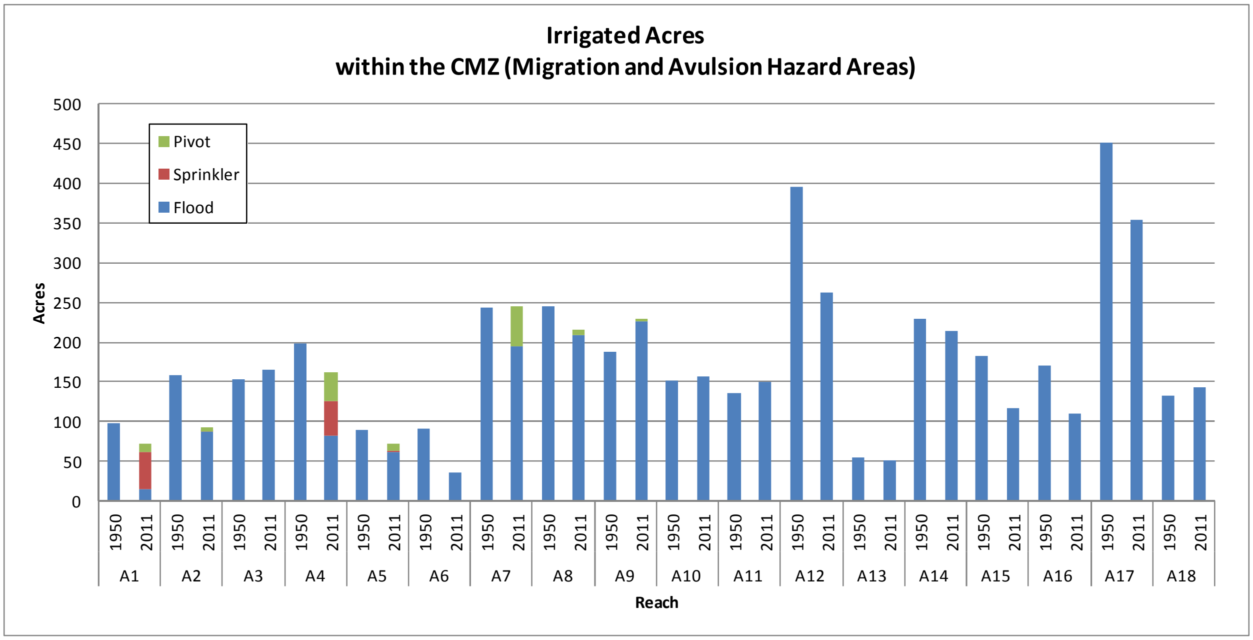

Figure 2-21 Irrigated Agricultural Land Use in the CMZ, 1950 and 2011

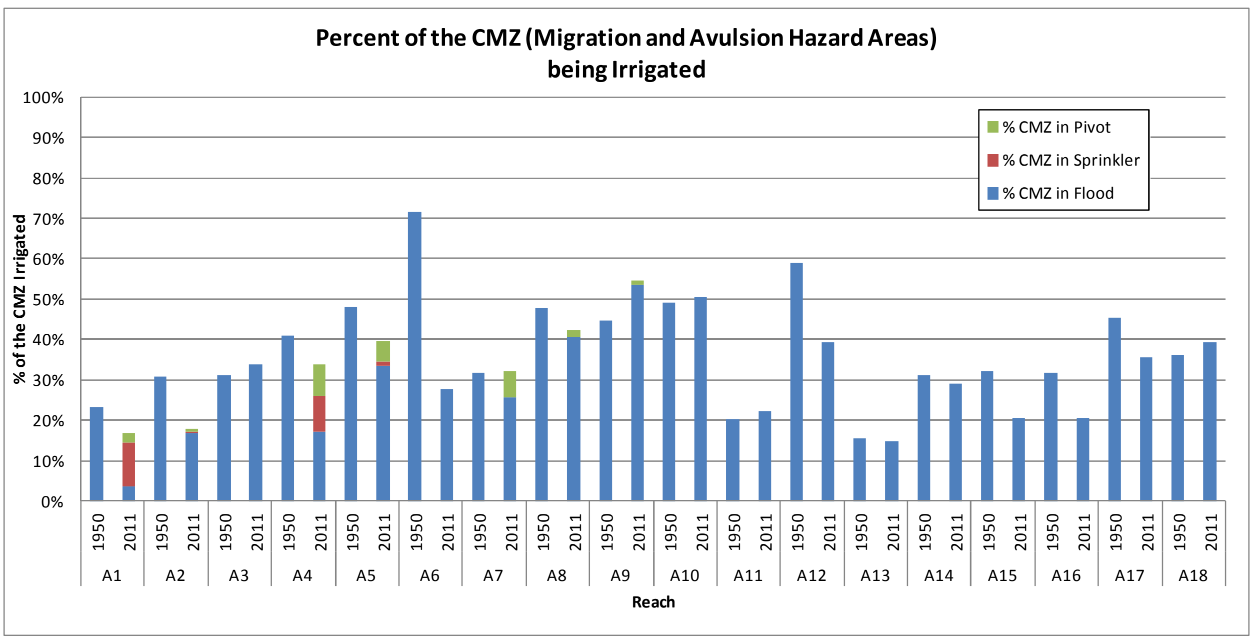

Figure 2-22 Percent of CMZ being Irrigated by Type of Irrigation Method.

2.2.3 Region B – Agriculture

Region B divides into three segments based on type of land use, the first being the reaches that flow between Laurel and Billings and then past the city of Billings (B1 – B3) where the valley begins as a wide expanse but is hemmed in at B3 by encroaching rimrock exposures on both sides of the valley. This section includes the most intensively urban landscape in the entire Yellowstone Valley. In the descriptions and analysis that follows, the reader should be mindful that the project area and its data sources do not cover the entire Yellowstone Valley. Thus, while the graphics will show the overwhelmingly urban nature of Reach B2, the actual acreage numbers are not representative of the overall size of the Billings urban and exurban land use in the first three reaches of Region B.

The second set of reaches make up the segment served by the Huntley Irrigation Project, a Bureau of Reclamation sponsored project from the first decade of the twentieth century. The valley widens with the first reach in this area, B4, and narrows somewhat at the end of the irrigation project near the town Pompeys Pillar (Reach B8). The final reaches of Region B follow a narrower valley, once again hemmed in by rimrock formations on both sides of the valley. This third segment (B8 – B12) end at the confluence of the Yellowstone and Big Horn rivers. The final reaches are agricultural, similar to the middle section, but are differentiated by smaller acreages relative to valley size. A private irrigation district starting at Waco Diversion in reach B9 serves part of the valley on the south side of the river.

2.2.3.1 *Inundation Area Discussion*

From the mouth of the Clark's Fork River where Region B begins to the downstream end of Billings in Reach B3, the amount of land in agriculture land use is affected by urbanization and associated exurban development. By 2011, urbanization had modified the agricultural pattern in the Billings area. While Reach B1 retains close to the Region's pattern of at least 80 percent of CMZ in either irrigated or non-irrigated agricultural land, Reaches B2 (the principal Billings reach) and B3 are skewed away from agriculture, particularly irrigated agriculture. The significant amount of urban and exurban acreage in the Billings reaches also affects overall trends for all of Region B if simply recorded as part of an overall average, in that urban development alone comprised about 20 percent of Reach B1, more than 75 percent of Reach B2, and about 13 percent of Reach B3 in 2011. In terms of total acreage of these three reaches, urban development grows to reach about 5,500 of the total 7,300 acres, enough to mask gains in irrigated agricultural land use further down the valley in Region B.

Also it should be noted that Reach B1 is roughly three times larger than any other Region B reach. Because of the discrepancy in acreage to the rest of the regional reaches, reach percentages show a more accurate picture of relative land use amounts throughout the region. Figure 2-23 and Figure 2-24 show these relationships.

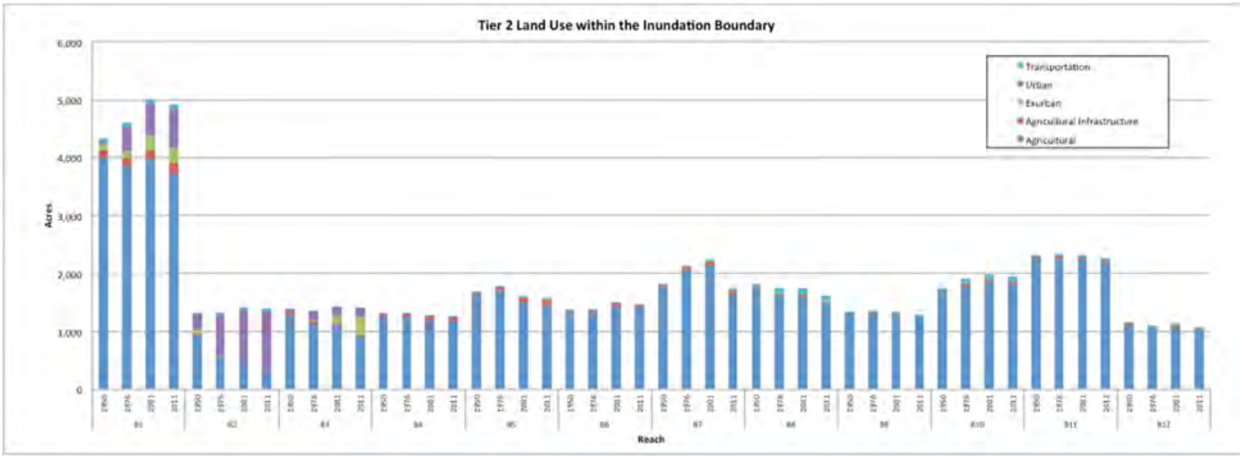

Figure 2-23 Agricultural and other Land Uses within the Inundation Area of Region B, 1950-2011.

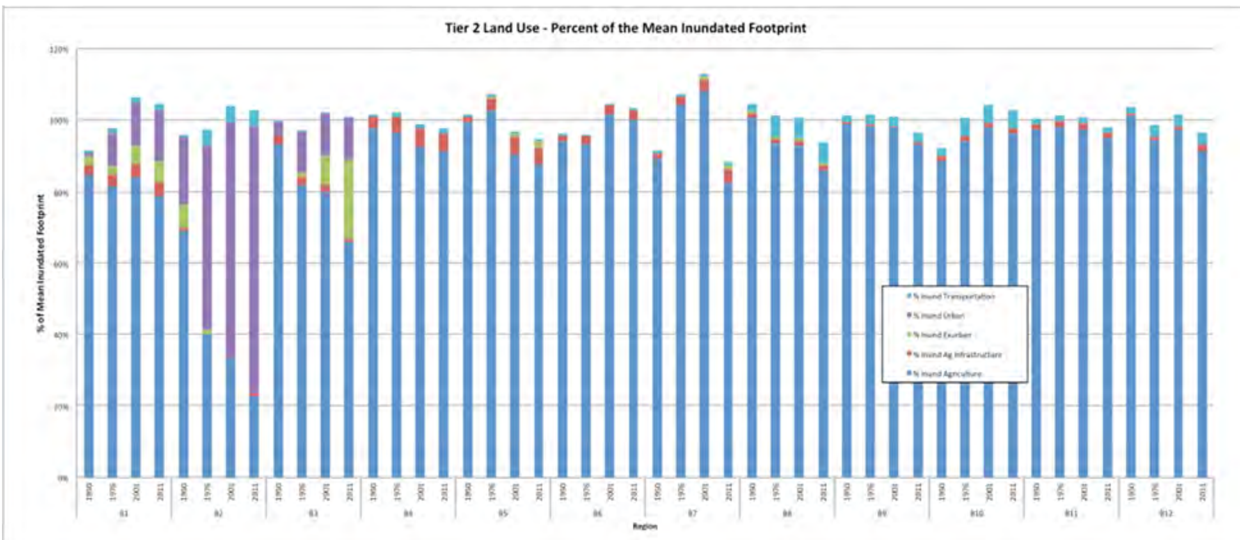

Figure 2-24 Land Use Percentages in the Mean Inundation Area, Region B 1950-2011. (As with other figures in this series, individual year figures for a reach can exceed 100 percent due to the dynamic changes to channel area from year to year which change the amount of land within the inundation area.)

Agricultural land use after the Billings reaches is typical of reaches along the remainder of the river, as will be seen in discussions about the rest of Region B and later discussion in sections addressing Regions C and D (see Figure 2-24for a graphic representation of agricultural land use below Reach B3). From reach B4 downstream to the end of the region, agriculture is the overwhelmingly predominant land use, never dropping below 80 percent of the mean inundation area in any reach.

Methods of irrigation have remained almost constant from 1950 to 2011. Only in four reaches of the inundation zone in Region B has there been any shift to forms of irrigation other than gravity fed ditch flood irrigation. Of the four, three reaches have seen a shift to some pivot irrigation. In Reach B1 151 acres were put into pivot irrigation by 2001, and another 50 acres by 2011 or about 15 percent of the irrigation in Reach B1. The other two reaches, B9 and B12, began using some pivot equipment only after 2001. B9 had 649 acres in irrigation, of which 369 were pivot, or 57 percent. B12 had 378 acres in irrigation, of which 57 were pivot, or 15 percent. In 2011, there were 7,314 acres in irrigation, of which 627 e pivot, or 9 percent. All agricultural land use for Region B totaled 18,458. Figure 2-25 shows the amount of pivot irrigation as a graphic

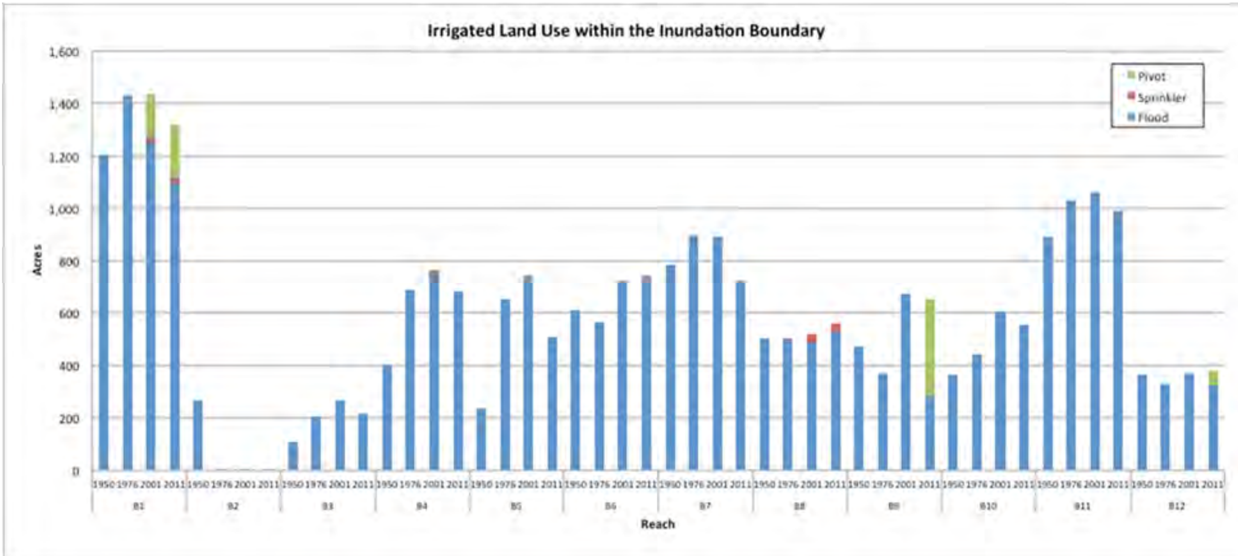

Figure 2-25 Irrigation type for Region B, 1950-2011.

One land use, although small, does stand out. Agricultural infrastructure had converted a small but regular acreage, especially in reaches B4 through B8. The Huntley Project Irrigation District provides irrigation water for about 28,500 acres in these reaches via a diversion dam in Reach B4. This is a Bureau of Reclamation Project, the second such project to deliver water for beneficial use. It was authorized by the Secretary of the Interior in early 1905 and delivered its first water in 1908. Its infrastructure includes the diversion dam, three canals, an off-stream storage reservoir, laterals, and drains, totaling about 450 miles. Coupled with farm structures this infrastructure land use covers 275 acres throughout these reaches (an average acreage per reach of 55), and has some presence in nearly all irrigated parcels of land in the inundation area in this segment of the Yellowstone.

Agricultural infrastructure also is present in the final four reaches of the region, as a result of the privately constructed Waco diversion and irrigation system. In contrast to the federally assisted system at Huntley Irrigation District, the final four reaches have 94 total acres, for an average of 24 acres per reach in the inundation area.

One other important parameter is the amount of open agricultural land remaining, not converted to Irrigation. In the inundation area, the first thing that attracts attention is the absence of irrigated land in Reach B2 by the year 2011 and the small acreage of irrigated land in B3 (Figure 2-27 and Figure 2-28). As noted previously, these two reaches take in the area where the city of Billings is adjacent to the river and urban and exurban land use predominates.

Second, in spite of an overall declining trend in general agricultural land use, and in irrigated agricultural land use for Region B as a whole, irrigated agricultural land use grew in ten of the twelve reaches in the region. Those increases came in spite of an overall decline in agricultural land use in 10 of 12 reaches. As expected one of the reaches where irrigated land use declined was B2 in the Billings area, but B3, also heavily influenced by non-agricultural land use, actually had a small gain in irrigated acreage of about 110 acres.

In the overall inundation area, there is a definite trend towards loss of non-irrigated lands in the agricultural land-use category. It is most helpful to examine the relative percentage of the inundation area devoted to each of these pieces of the agricultural land-use picture, as depicted in Figure 2-28. Only two reaches are a subject of concern in 2011. B2 and B4, which have both substantial reductions in non-irrigated acres. Reach B2, the principal Billings Reach, has lost 55 percent of its 1950 non-irrigated acreage (a loss of 369 acres), and now totals only 308 acres or 23 percent of the inundation area in B2. B4, which has lost 42 percent of its 1950 non-irrigated acreage and now occupies only 39 percent of its reach inundation area, has also dropped below a 40- percent level for the reach. We are suggesting that 40 percent marks a level, as yet hypothetical, where further losses could affect the river's sustainability. Of the remaining ten reaches in Region B, none are close to the 40- percent figure. However, six reaches have dropped significantly from their 1950 occupation level, with their 2011 percentage of the inundation area all dropping 9 to 27 percentage points from their 1950 levels. The remaining four reaches also are in a downward trend for non-irrigated agricultural land use, but have lost lesser amounts and their 2011 percentage of the inundation area are within 3 to 7 percentage points of the 1950 levels.

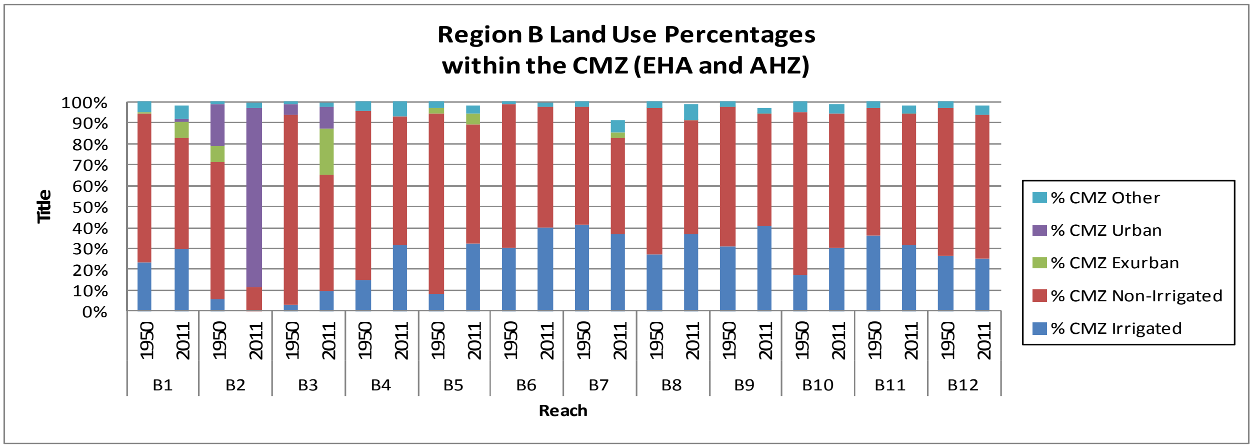

Figure 2-26 Region B Land Use Percentages in the CMZ, 1950 and 2011.

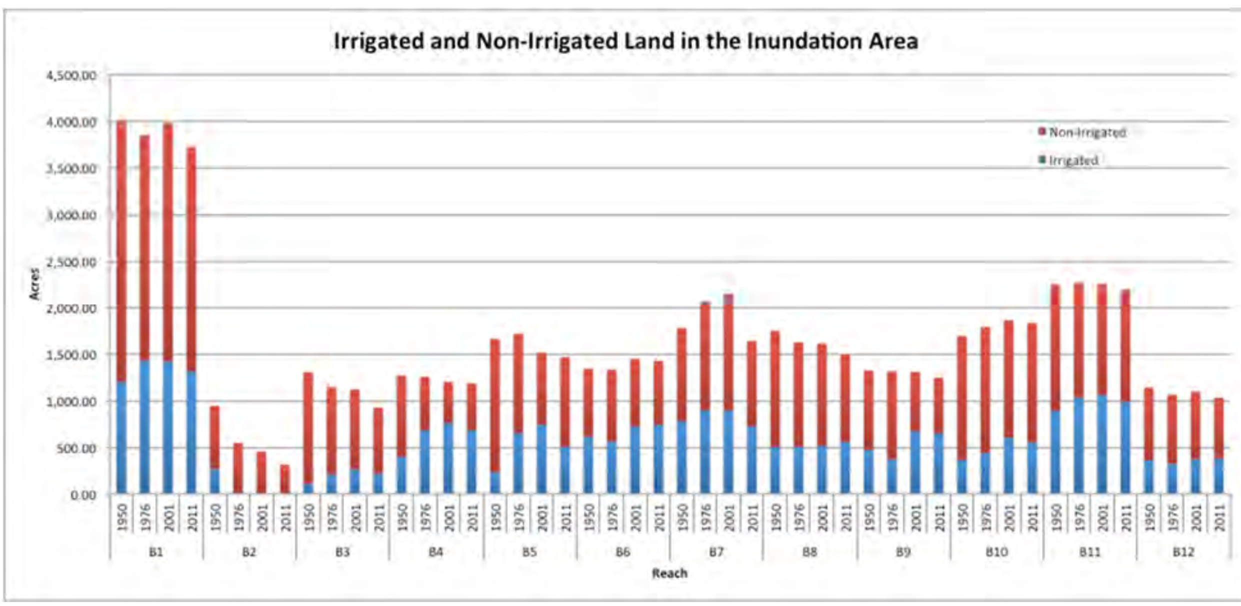

Figure 2-27 Changes in Irrigated and Non-Irrigated Agricultural Land Use in the Inundation Area, Region B Reaches.

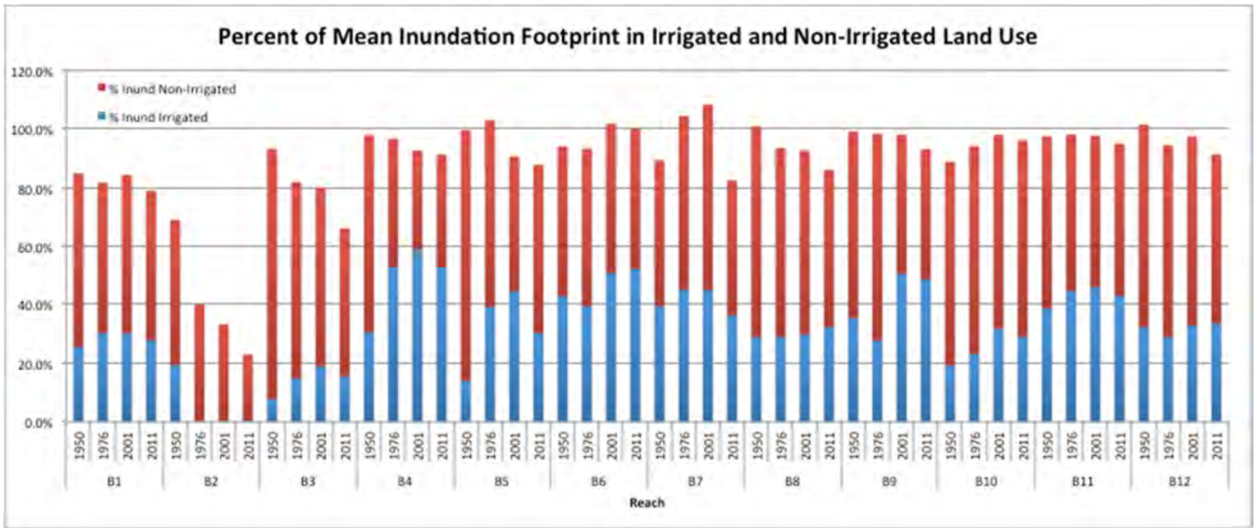

Figure 2-28 Percentage of Inundation Area in Irrigated and Non-irrigated Land Use, 1950-2011.

2.2.3.2 *CMZ Discussion*

The Billings area constricts the rural environment more severely than any other area on the river. Within the CMZ in Reach B2, the percentage of land in rural categories is much smaller than either all of Region B or the entire river. The contrast between Reach B1 and B2 is apparent, where B2 completely departs from the more normal Yellowstone River pattern while B1 is more similar to the rest of the region. Figure 2-29 illustrates the influence of Billings on rural landscape. Exurban development exerts some influence on the CMZ in Reaches B1 and B3, but seems to be an issue only on the periphery of Billings. In all other reaches, agricultural land use is around 90 percent of the CMZ.

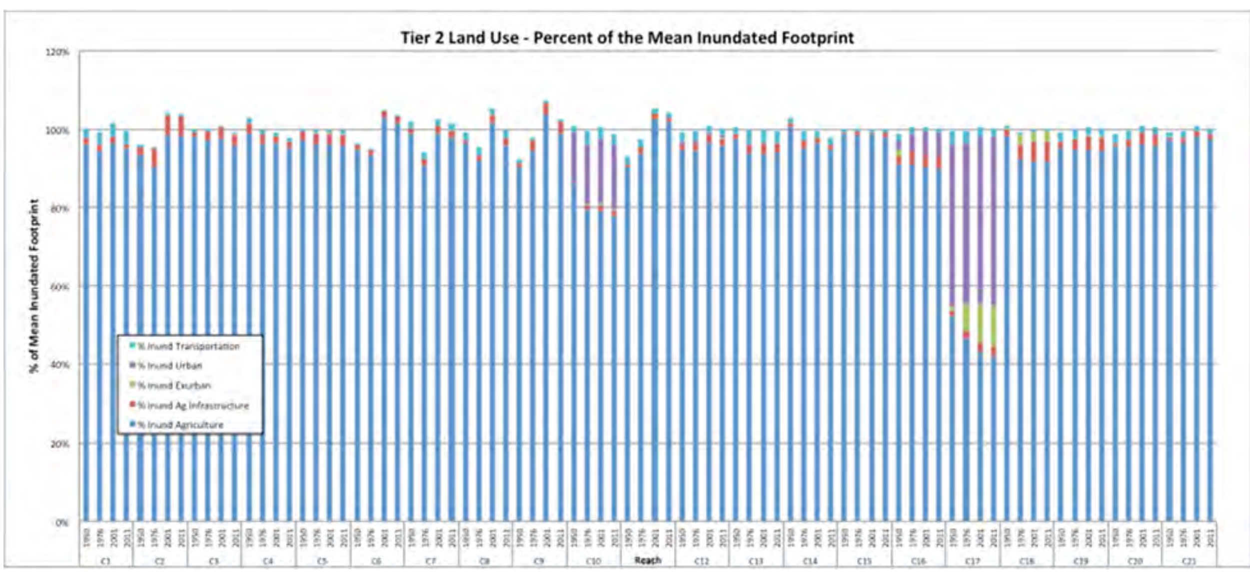

Figure 2-29 Agricultural and Urban/Exurban Land Use in Region B, 1950 and 2011.

Similar to the inundation area, but not to the same degree, the encroachment of irrigated agriculture into the CMZ is large enough to be an area of concern for some reaches. In particular, two reaches (B6 and B9) had irrigated agriculture land use at 40 percent of the CMZ, while seven other reaches had neared or surpassed 30 percent of the CMZ. A total of nine reaches, then, in the region had substantial acreage in the CMZ in irrigated agricultural land use by 2011.

2.2.3.3 *Summary, Region B*

Considering all of Region B, it shows a division into two very different conditions. At the top of the region lies the city of Billings. It is the one metropolitan area on the entire river that has significantly changed the relationship among the land uses, and has made urban conversion the primary land use in one reach, B2 and has made a combination of urban and exurban land use a substantial part of the total land use in the immediately adjacent reaches, B1 and B3. In making this change, it has also reduced potential for native vegetation and wildlife habitat by restricting non-irrigated agricultural land use (see Technical Appendix 4 Geomorphology for information on the effects on the river channel itself as well as secondary effects on the floodplain in these reaches).

Below Billings there is a rapid transition to predominantly agricultural land use, a condition that obtains through the rest of this region and throughout the entire lower Yellowstone River. Billings marks the end of the portion of the river valley that has made a substantial shift from predominantly agricultural use to a more mixed array of land uses. These lower reaches, B4 through B12, show the first substantial growth in agricultural land-use conversion during the 60-year study period in any of the three upper river regions from the top of the study area at Gardiner, Montana to Billings in Region B. While it is true that the general agricultural land-use footprint was in place when the study period began in 1950, and was reduced to some extent to 2011, more land has been converted to irrigated agricultural land use in the downstream Region B reaches. Thus, within the agricultural land-use areas there has been a conversion to intensive use and away from non-irrigated agricultural use.

Within Region B there are subtle shifts in the agricultural land use below Billings. Immediately downstream of Billings lies the Huntley Irrigation Project, a federal Bureau of Reclamation effort, and the rest of the region is the result of private irrigation efforts. The construction of canals, laterals, and drains with federal assistance has led to a larger footprint of agricultural infrastructure in Reaches B4 through B8 where the Huntley project ends. While some agricultural infrastructure is identifiable in the remaining reaches of Region B, the valley narrows at Reach B8 and this brings the transportation infrastructure land use into closer proximity to the river, and thus a larger footprint than upstream. The combination of a small amount of exurban development, the conversion of more land to irrigated agriculture, the increase in agricultural infrastructure, and the greater intrusion of transportation into the immediate area of the river in the lowest reaches of the region have increased the loss of non-irrigated agricultural land use available to native vegetation and wildlife habitat.

2.2.4 Region C – Agriculture

Region C begins at the mouth of the Big Horn River and introduces a larger floodplain, less stream gradient and more agricultural land use acres available. This is a long region covering 120 valley miles and 21 reaches and has maintained the dominance of agriculture as the principal land use throughout the region. Forsyth and Miles City stand out as the only communities of size along this portion of the valley. The wide valley has extensive irrigation the entire length of the region. Even though the region passes close to the Hysham Hills a geologically uplifted and timbered area, the valley remains wide with irrigated fields. Two features stand out in the upper part of Region C. The Mission Valley (Primarily Reach C7) and Hammond Valley (Reach C9) are especially wide portions of the Yellowstone valley, with a braided channel and extensive riparian areas. As Region C ends the Yellowstone enters an area where the stream is incised and the floodplain narrows near the beginning of Region D. The mouth of the Powder River is the terminus of Region C.

2.2.4.1 *Inundation Area Discussion*

All of the Region C reaches show substantial homogeneity in terms of percentage of each land use, with the exception of the reaches with the two communities of size in the region. The two valley demarcations (Mission and Hammond—Reaches C7 and C9) clearly show more complexity in the structure of the river valley than their neighbor reaches, characterized by widening with increased riparian forest, extensive braiding and island formation. These two reaches are easily identified on Figure 2-30, as they represent a sudden rise in acreage per reach towards the upper end of Region C. However, examining percentages of land use in the same two reaches (Figure 2-31) establishes that they have a similar land-use pattern to the rest of the valley.

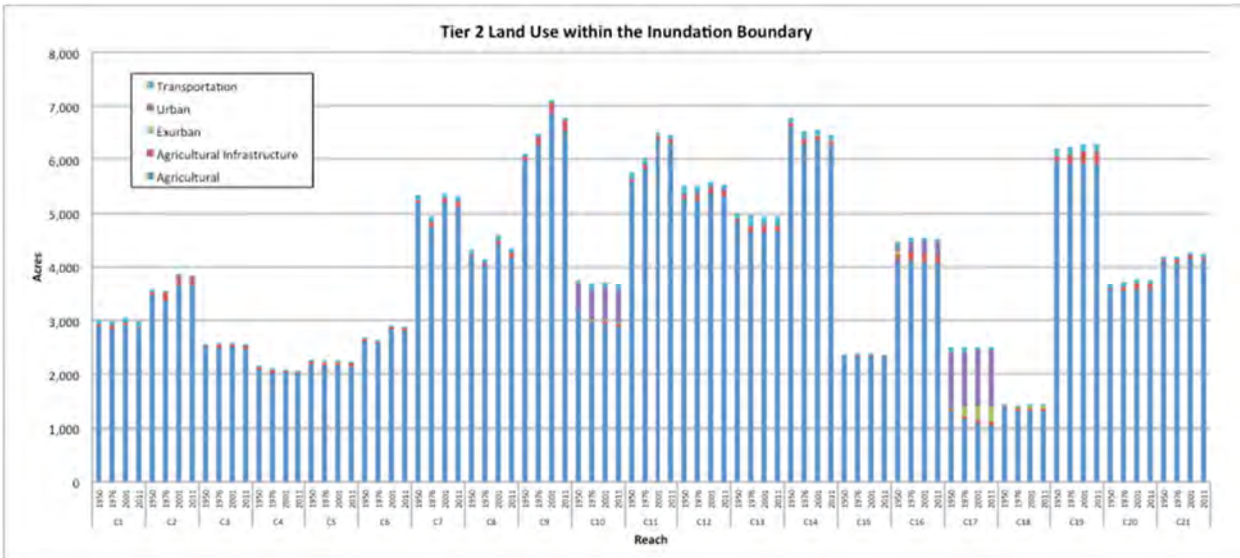

Figure 2-30 Agricultural and Other Land Uses in the inundation Area, Region C 1950-2011.

There are no active federal irrigation projects in Region C, but at least three local irrigation districts operate diversion dams and irrigate extensive segments of the wide valley. Ranchers diversion is highest in the Region (Reach C1) just below the confluence of the Big Horn and the Yellowstone Rivers, with a diversion that provides irrigation to the north side of the valley from near the entrance of the Big Horn River to the vicinity of Hysham. The Yellowstone diversion, located between the communities of Myers and Hysham in Reach C3, provides irrigation water to the south side of the valley from near Hysham to Armells Creek in Reach C9. The third diversion, Cartersville irrigation district, is located at Forsyth but provides water starting in Reach C11 to irrigators on the north side of the valley past Cartersville, an old station point on the now extinct Milwaukee Road railroad, to Reach C13 across the river from Hathaway, a small community upstream from Miles City. Other lands in Region C are irrigated as well, but this irrigation, done by diversion or pumps by private irrigation districts and individuals, does not cover nearly as large areas of valley mileage.

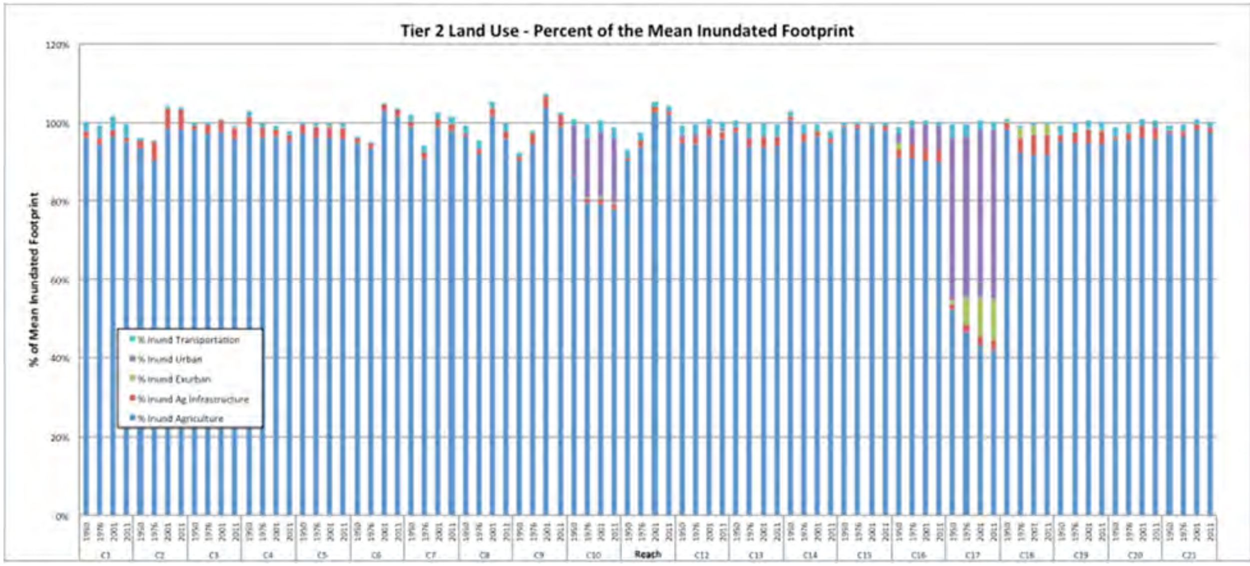

Figure 2-31 Land Uses in the Inundation Area of Region C, Expressed as Percentages.

Two of these smaller operations do stand out, however. The Tongue and Yellowstone (T&Y) Irrigation District, irrigates small acreages on the east bank of the Tongue River from a diversion dam about 12 miles up the Tongue River, as well as larger acreages on the south bank of the Yellowstone River, just downstream of Miles City. The T&Y diversion dam does have the distinction of being the first large-scale diversion dam in the watershed in Montana, having been constructed by a group of Miles City business leaders in 1885 (State Engineer's Office, 1948). The other medium-sized irrigation district is the Kinsey District, irrigating about 6,200 acres on the north side of the Yellowstone from the mouth of Sunday Creek eight miles downstream of Miles City and past the small town of Kinsey for a total of ten valley miles. The district is of note because it was approved in 1938 as part of the Great Depression era federal Rural Resettlement Projects, which purchased lands from groups of homestead farmers that had filed on substandard agricultural lands and which awarded federal loans to groups of farmers to establish irrigation. Although the Kinsey area was an attractive area for irrigation, two previous private efforts had failed to establish the necessary infrastructure (State Engineer's Office, 1948).

Acreages of land within the inundation boundary vary dramatically between Region C reaches, from approximately 1,500 acres (C18) to approximately 7,000 acres (Figure 2-30). (Reaches were defined by geomorphological features and were not intended to demarcate the Yellowstone Valley into equal-sized segments.) However, regardless of reach acreage, the percentage of agricultural land use for nearly all reaches was over 90 percent in all of the time periods (Figure 2-31). Only the communities of Forsyth and Miles City in Reaches C10 and C17 vary from that percentage figure. Miles City with its larger population has the greatest effect on agricultural land use, dropping it to around 42 percent by 2011.

Overall, throughout Region C and the inundation area, agricultural land-use acreages are remarkably consistent. In 1950, the total agricultural land use for the Region C inundation area was 79,405. In 2011 the same parameter was 79,466 acres, a difference of 0.1 percent. Even considering each time period measurement, the variation was not large, -2.0 percent in 1976 and 1.5 percent in 2001. The consistency carried through to each type of agricultural land use. The variation in irrigated agricultural land use from 1950 to 2011 was +358 acres, and for non-agricultural land use, it was -297.

Individual reaches did vary over the 60-year study period. Five reaches experienced a growth in acreage devoted to agricultural land use. That involved an interesting dynamic in that all five reaches had a corresponding loss in a land cover category, river channel acreage, and that cumulative loss was a substantial 1,893 acres. The changes resulting to irrigated and non-irrigated agricultural land use were not easy to predict. Two reaches produced a total increase to irrigated agricultural land of 171 acres. But there were also gains to non-irrigated agricultural land in those reaches, and in the other three reaches as well, a total of 2,282 acres. One reach, C12, was anomalous in that it had only 40 acres of channel loss, but experienced a decline in irrigated agriculture of 484 acres and an increase of 534 acres of non-irrigated agricultural lands. These reaches are detailed in Table 2-2.

Table 2-2
Changes in Agricultural Land Use Compared to Changes in Channel Area.

	Reach C2			Reach C6			Reach C9			Reach C11			Reach C12		
	Channel	IrrAg Lands	Non-Irr Ag	Channel	IrrAg Lands	Non-Irr Ag	Channel	IrrAg Lands	Non-Irr Ag	Channel	IrrAg Lands	Non-Irr Ag	Channel	IrrAg Lands	Non-Irr Ag
1950 area in acres	1058	2464	1003	1285	1752	865	3295	3433	2255	2208	3010	2582	1435	3675	1584
2011 area in acres	765	2539	1107	1087	1554	1248	2618	3529	3015	1523	2927	3383	1395	3191	2118
Diff. Fm 1950	-293	75	104	-198	-198	383	-677	96	460	-685	-83	801	-40	-484	534
Net Change in Channel	-1893														
Net Change, Irrigated Ag	-594														
Net Change, Non-Irrigated Ag	2282														

The remaining 16 reaches in Region C either experienced a slight decline in agricultural land use, or it remained static over the four time periods. Those changes did not have a direct relationship with river channel changes in that the river only gained a net of 369 acres in those 16 reaches.

Similar to the high agricultural land use reaches in Region B, all of the reaches in Region C have a visible presence of agricultural infrastructure in the inundation area. The amount ranges from 1 to 5 percent of the inundation area per reach. Only three reaches have less than 2 percent in agricultural infrastructure land use, with the other 18 reaches greater than 2 percent. The average reach in Region C is approximately 4,000 acres, eighteen of the twenty-one reaches have greater than 80 acres of agricultural infrastructure, and three approach 200 acres.

The relationship between irrigated and non-irrigated agricultural land use in the inundation area shows the dominance of agriculture as the activity directing land use. Between the two agricultural land-use categories, irrigated and non-irrigated, over 90 percent of every reach except two is devoted to agricultural activity of some kind. The two non-conforming reaches are the locations of the two principal urban land-use areas in Region C. C10 is the location of Forsyth and C17 is the location of Miles City. Forsyth brought the percentage of agricultural use down to just under 80 percent by 2011, while Miles City with its larger size began the 60-year study period with 52.2 percent of Reach C17 in agriculture, a figure that had fallen to 42 percent by 2011. All in all the story of Region C agricultural land use is that it changed very little. Were it not for the two urban communities, the total of 79,466 acres in agriculture in 2011 and its overall increase from 1950 or 65 acres would hardly budge the lines on the graphics (Figure 2-33).

With the small net change in inundation area reach acreage, there is a corresponding balance between reaches gaining and losing irrigation over the 60-year study period.

A more disturbing trend is the number of reaches where irrigated agriculture has reached 60 percent of the inundation area, or at least 50 percent with an upward trend in irrigation. Twelve of the twenty-one Region C reaches show losses or negative trends away from non-irrigated land use with over 50 percent of the land in irrigation. See acreage and percentage statistics for the Region C reaches in Figure 2-32 and Figure 2-33.

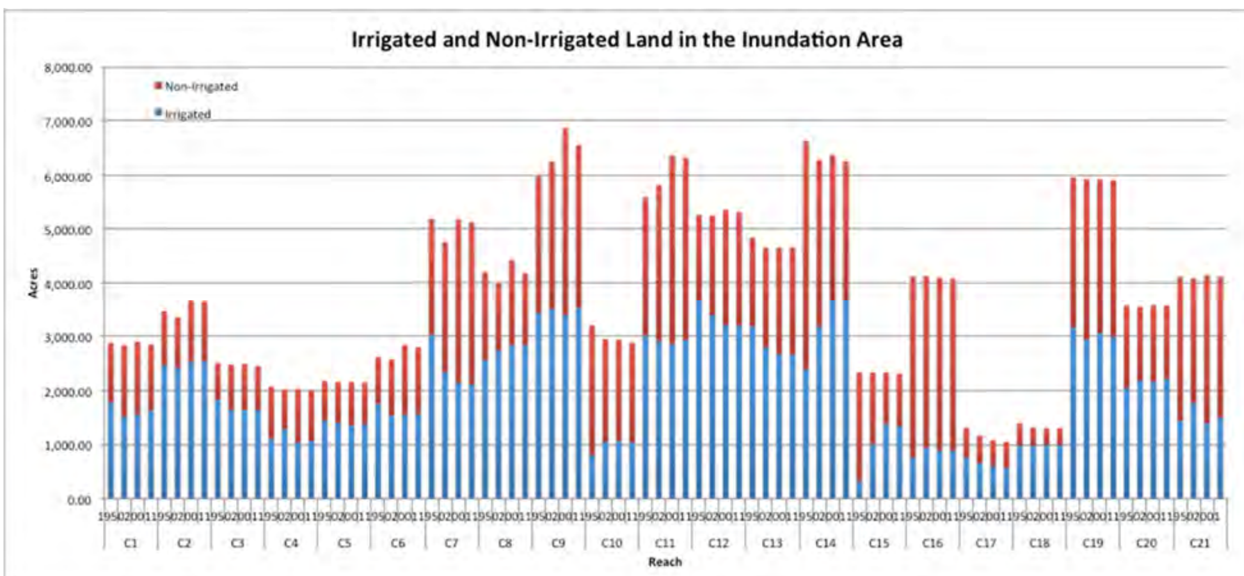

Figure 2-32 Irrigated and Non-Irrigated Agricultural Land Use in Region C, 1950-2011.

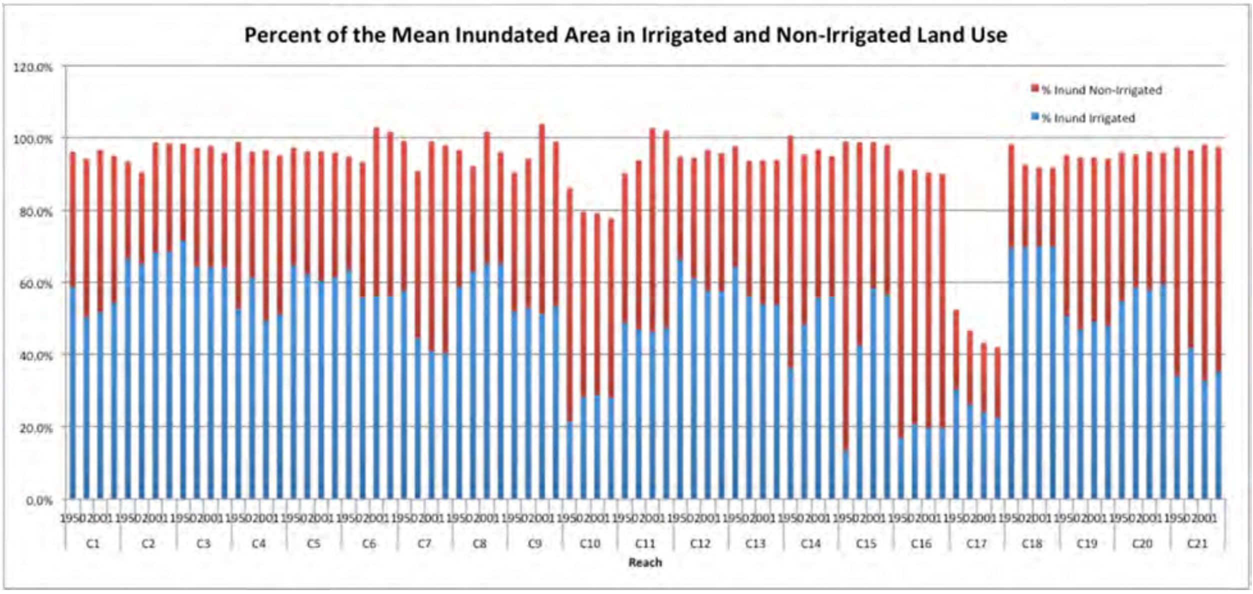

Figure 2-33 Region C Irrigated and Non-Irrigated Percent Relationship, 1950-2011.

2.2.4.2 *CMZ Discussion*

To an even greater extent than in the inundated area, the CMZ is predominantly in agricultural land use. This can be seen in the raw acreages (Figure 2-34), but because the reach length and overall acreage size varies so much in this region, it is best looked at as percentages (Figure 2-35) to understand the consistency of the relationship. Except for the Miles City reach (C17) all twenty other reaches are at least 90 percent in general agricultural land use. And of those 20, seventeen are above 95 percent. Besides the Miles City reach (51.8 percent) the other land uses that make a greater than 5 percent appearance in any one reach are urban land use in the Forsyth reach (C10), exurban land use in C18, immediately downstream of Miles City, and a combination of non-agricultural use at the small town of Rosebud (C12). Rosebud's location is within an erosion hazard area on a high terrace adjacent to the river, so urban land use, transportation land use and agricultural infrastructure land use combine to occupy a little over 6 percent of the CMZ.

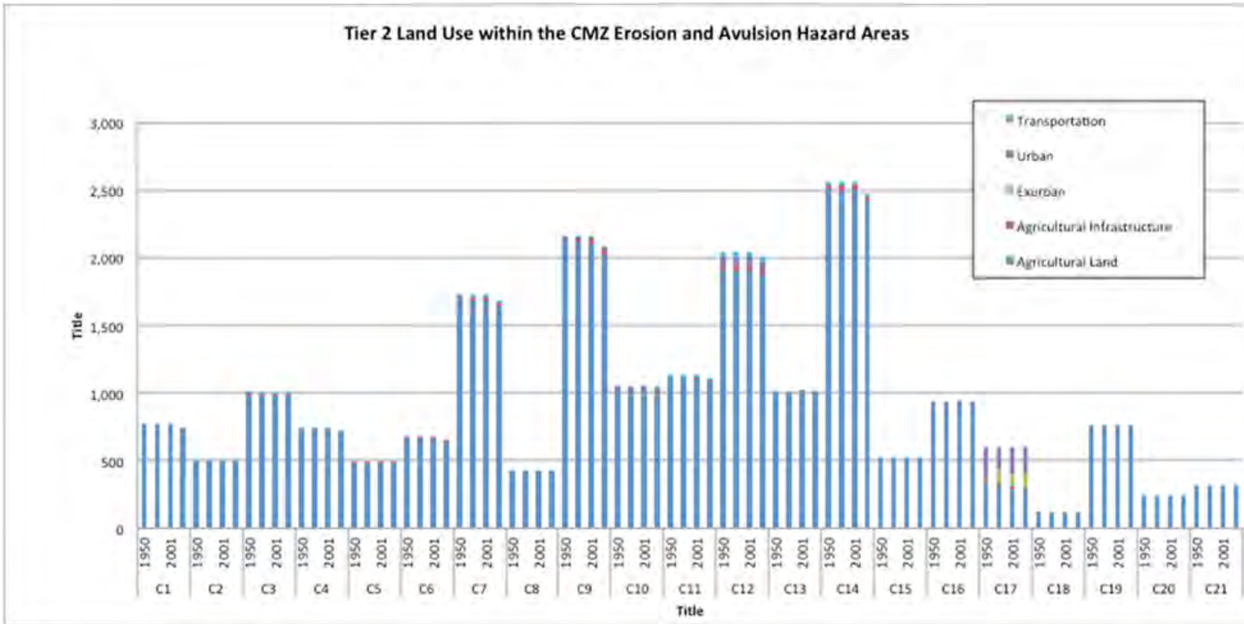

Figure 2-34 Major Land Use Acreage in the CMZ, Region C, 1950-2011.

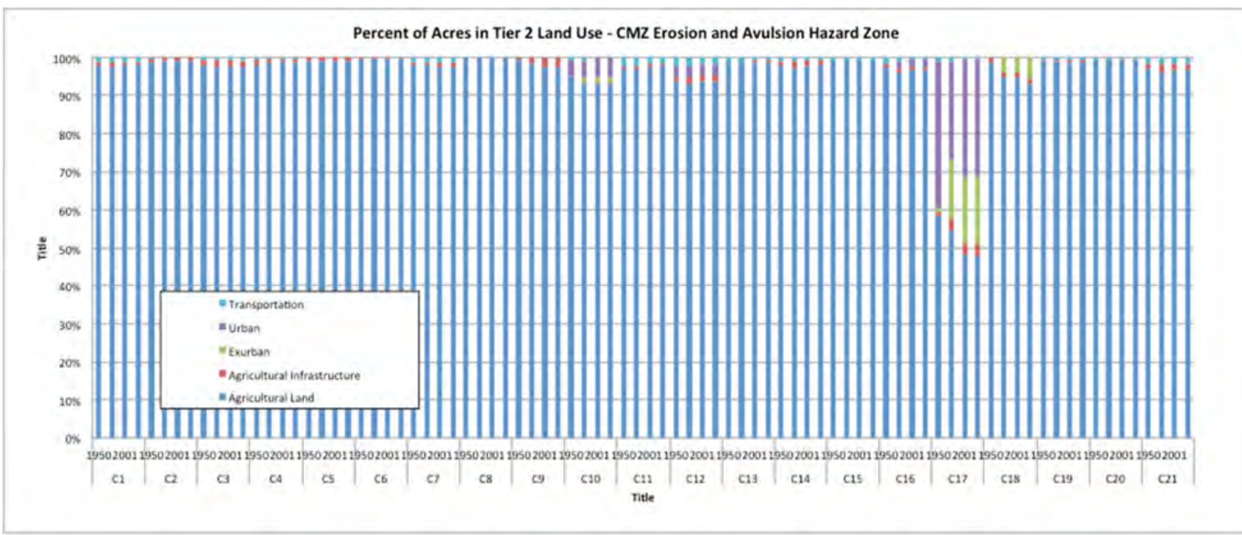

Figure 2-35 Percent in Major Land Use Categories, Region C CMZ, 1950-2011.

The only other land uses making regular appearances in the CMZ are agricultural infrastructure and transportation, neither at levels higher than 2 to 2.5 percent of their respective reaches, and most at lower levels than 2 percent. Particularly in the CMZ, the appearance of these land uses have significance far outweighing their physical presence size. See Technical Appendix 9 Avian for discussion on the effect of agricultural infrastructure on some species, and Technical Appendix 2 Hydrology on the effect of transportation in isolating floodplain from the river.

Regarding the relationship between irrigated agriculture and non-irrigated agriculture, the greater the presence of irrigated agriculture in the CMZ, the more potential of habitat replacement and the greater risk of bank armor interfering with channel migration and thus renewal of native vegetation and wildlife habitat. Encroachment of irrigated agriculture is not a problem on the final seven reaches of Region C, nor at present in C1, C8 and C10. (However, the low irrigation agriculture numbers in C10 and C18 may be due to competing land use from urbanization, as these are the reaches containing Forsyth and Miles City.) (Figure 2-36) The other reaches, C2 through C7, C9, and C11 through C14 are at risk from irrigated agriculture in terms of converted lands, and potential for bank armoring preventing normal channel formation and migration processes. All of these reaches have or have had in the past at least 40 percent of the agricultural land in their reaches in irrigation (Figure 2-37).

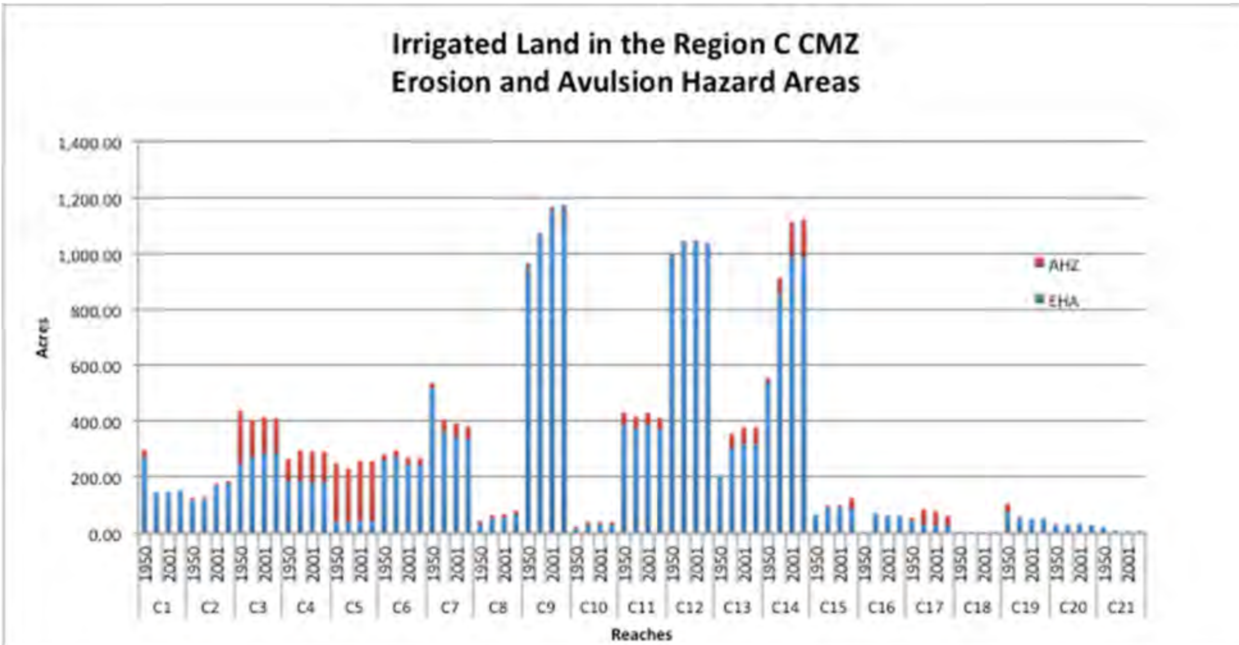

Figure 2-36 Irrigated Land in the CMZ, Region C (Erosion and Avulsion Hazard Areas).

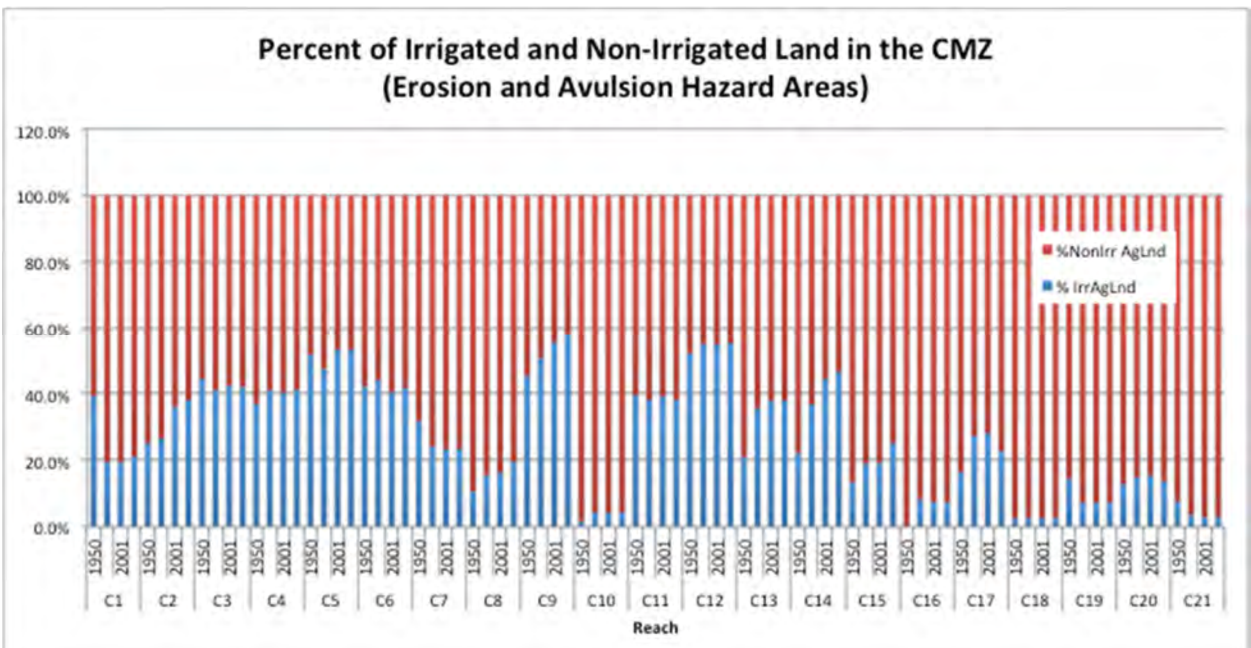

Figure 2-37 Percent of CMZ Erosion and Avulsion Hazard Areas in Irrigation and Non-Irrigation.

Of special concern are Reaches C7 and C9. These are locally labeled the “Mission Valley” and the “Hammond Valley”, respectively. These are the reaches discussed above in the Inundation Area

Discussion as having particularly complex channel dynamics, accompanied by a large amount of cottonwood forest and vegetated islands. C7 has declined in irrigated agriculture to 23 percent of all agricultural lands over the 60-year study period, but at one time with different channel locations, was at 32 percent irrigation land use. C9 has experienced the opposite trend. In 1950 it had irrigated land use at 45 percent, one of the highest levels of irrigation in the CMZ in Region C. And since 1950 it has continued growth in irrigated agriculture with an accompanying reduction in open, non-irrigated agricultural lands. In 1976 irrigation land use was at 51 percent, 2001 at 56 percent and 2011 at 58 percent. These are perhaps critically high levels to maintain sustainable river functions in this reach.

2.2.4.3 *Summary, Region C*

To summarize the entire C region, agriculture is by far the largest land use. As pointed out in the introduction to Technical Appendix 1 Land-use, ironically Region C has experienced the greatest amount of *de jure* subdivision, apparently in a reaction to tightening subdivision requirements by the Montana legislature. However, most of the land was converted to agriculture well before 1950 and remains in that land-use category today (Figure 2-31 and Figure 2-35). Overall, these 21 reaches do not show major change in agricultural land use.

While Region C has been relatively stable in land use, irrigated agricultural land use had already reached a level by 1950 that could be of concern in maintaining sustainable river vegetation and wildlife habitat, and while there has been some increase in some reaches in the relative amount of non-irrigated land use, the risk remains (see Figure 2-33 and Figure 2-37 for indications of high levels of irrigation land use reaches).

Four reaches have seen some conversion from agriculture to urban, exurban and transportation land uses, associated with river communities. These issues will be described in the Urban/Exurban land-use sections below.

Finally, two land uses intrude on this otherwise agricultural landscape, both related to development of the agricultural businesses along the river corridor. All of the Region C reaches show a presence of agricultural infrastructure. While small, never more than 2 to 5 percent of a reach, and more often less than 2 percent, infrastructure presents a special problem for bird life in that it, along with irrigated agriculture, breaks up the otherwise large patches of riverine native plant communities. This can be a problem for maintaining the populations of some bird species. See Technical Appendix 9 Avian for further discussion.

The other land use with an unintended effect is transportation. Its actual footprint on the landscape is small, as indicated by the figures referenced above. However, the roadbed for transportation, particularly railroads creates functional dikes, and isolates much more floodplain from the river than the size of the footprint would make obvious. It is the length of the roadbed and its specific location, rather than the size in acres that creates the effect. The isolation of floodplain is discussed at length in Technical Appendix 4 Geomorphology (Channel Pattern and Channel Migration).

2.2.5 Region D – Agriculture

Region D begins with the juncture of Powder River and the Yellowstone, and ends at the confluence of the Yellowstone and Missouri Rivers. Geologically and geomorphologically the final region on the Yellowstone River differs significantly from top to bottom, but at the same time it is socially and economically and unified by having two of the largest irrigation projects on the entire Yellowstone main stem, which directly influence all but two of the Region D reaches. These two irrigation projects, both sponsored and initially constructed by the Bureau of Reclamation, irrigate approximately 78,000 acres within the Yellowstone corridor, in Prairie, Dawson, and Richland Counties, Montana, and McKenzie

County, North Dakota. With good soils, a wide floodplain, and for the most part, no need for major lifting of irrigation water to access the floodplain, this region is well suited for agriculture.

So, for the 60-year study period, the story of Region D is agriculture. In 1950, many reaches already had an agricultural land-use footprint nearing 100 percent of the inundation area. By 2011, all reaches except D6 (the location of the community of Glendive) had reached an agricultural footprint over 95 percent. For the study period, Region D had growth in agricultural land use of almost 5,600 acres. Irrigated agricultural growth was even greater, over 11,000 acres With the exception of two reaches, D4 and D6, the agricultural growth of the 60-year period was downstream of Reach D9, meaning that it was all within the big Bureau of Reclamation irrigation project (i.e., the Lower Yellowstone Irrigation District).

The region is divided into 16 reaches, covering a variety of physiographic areas. Reaches D1 through D3 in Prairie County, the upper most part of river is moderately incised into the landscape, and the floodplain is narrow. High terraces impinge on the river channel. Thus, irrigated agricultural land use is limited. The CMZ and 100-year inundation zone are very narrow.

Reaches D4 though D9, through Glendive to the Intake diversion dam for the Lower Yellowstone Irrigation District present a widening river bottom similar to Region C. While the inundation area remains similar to the uppermost D reaches, the CMZ reaches four digit acreage numbers for the first time in Region D.

After Intake (Reach D9) the river makes a major change. With one exception, the reaches are much larger in acreage by 1,000 to 4,000 acres for the inundation area, and the CMZ from 1,200 to 2,000 acres. A few reaches have massive meander belts with extensive riparian forest, and two large Montana Wildlife Management Areas are located along the river in Reaches D11 and D12. The final reach, D16 in McKenzie County, North Dakota, is unconfined by topographic features as it enters the joint Yellowstone-Missouri River floodplain. The inundation area for this reach is by far larger than any other on the Yellowstone—12,050 acres.

2.2.5.1 *Inundation Area Discussion*

Agricultural land use in the Region is straightforward. In the upper nine reaches to Intake Diversion in D9, overall land use, and agricultural land-use acreages are consistent and lower in size than the valley from D10 through the end of Region D. These upper reaches show substantial growth only in Reaches D4 and D6. In both cases, the acreage taken by river channel is reduced and apparently taken advantage of by increases in agricultural use, and in the case of D6 an expansion of urban development into the inundation area. In D6, the construction of Interstate Highway 94 across the floodplain and bridging the Yellowstone caused the abandonment of a major side channel by the river. That and the construction of a levee allowed urban development and increased farming in previously high-risk flood areas. Absent that development, Glendive’s urban development would not affect the inundated area as most of Glendive is located on a high terrace to the east.

From Reach D10 to the end of the Yellowstone in D6 the river is characterized by an ever-widening floodplain. For the most part, agricultural land use was nearly at 100 percent in 1950 and that did not change. The only exceptions are in Reaches D13 and D14 where exurban development and agricultural infrastructure make up 5 and 3 percent of the land use in the two reaches.

Acreage sizes and percentage of land use are depicted in Figure 2-38 and Figure 2-39. These two figures bear some discussion of the data presentation in them. They show apparent new land-use acreage through the years of the study period and some apparently aberrant percentage figures in seven different reaches. The acreage figures are real, in that the river channel made major changes in these reaches during the study period, in most cases simplifying its channel, and creating more land surface at various time points when measurements were calculated. Figure 2-38 records the acreage at four time periods and shows growth or loss. Figure 2-39 percentages are based on a reach mean channel acreage for all four time points, and thus may understate or overstate the percentages of land use relative to the inundation area in any one time period for that reach.

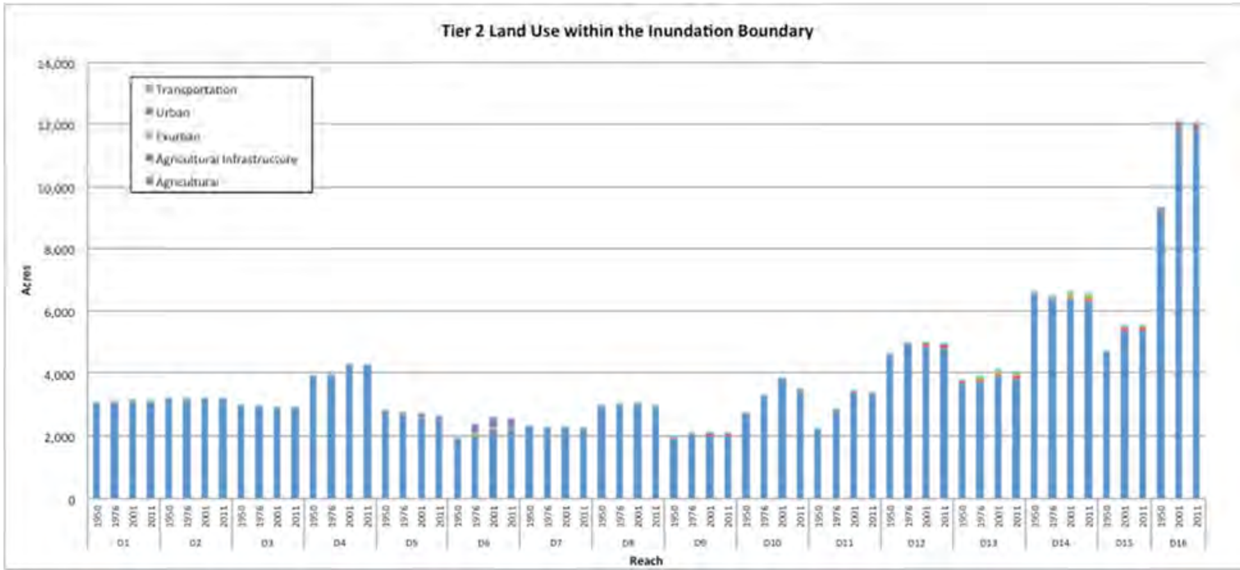

Figure 2-38 All Major Land Uses within the Inundation Area of Region D, 1950-2011.

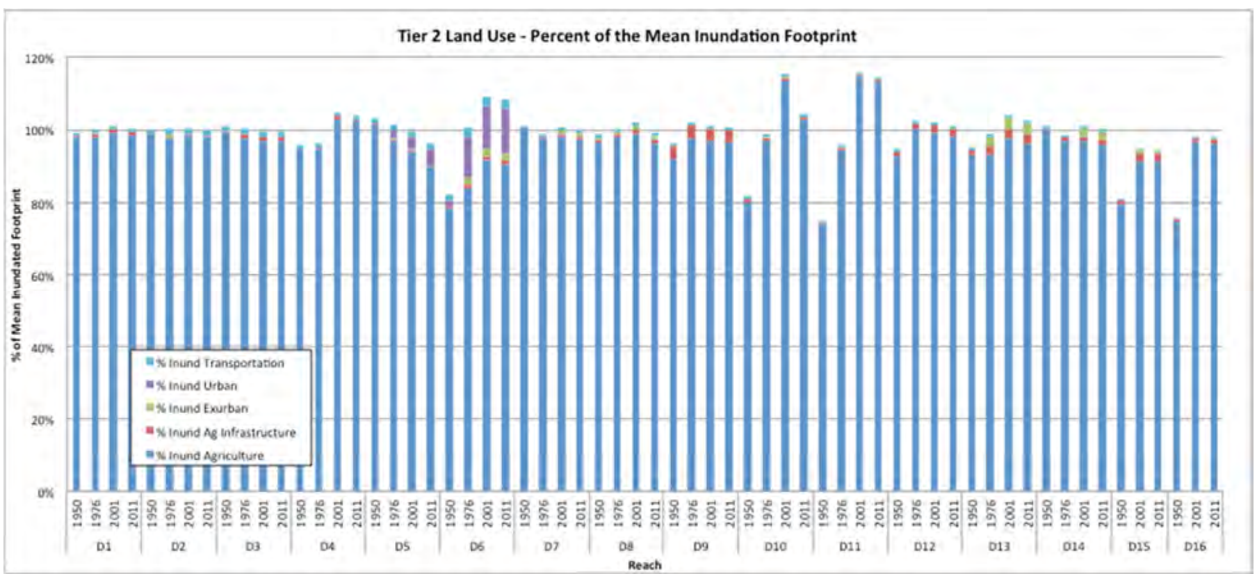

Figure 2-39 Percentage of Each Major Land Use in the Inundation Area of Region D Reaches, 1950-2011.

Turning to irrigated and non-irrigated agricultural land use, D1 and D2 are typical of the narrow area available to irrigation in the uppermost Region D. In D1, the irrigated agriculture acres in the CMZ and the inundation area for 2011 are 24 and 742 acres, respectively, out of 3,057 acres available for general agricultural purposes in the inundation area. In D2, those same three acreage figures are 3 and 881, out of 3,153 inundation area agricultural acres. For comparison purposes in a wider river reach in the D region (Reach D12), the acreage figures for irrigated agriculture in the CMZ and floodplain are 1140 and

2,532, out of 4,814 general floodplain agricultural acres. Figure 2-40 details the type of agricultural land-use acreages by reach and shows the inundation area side of this equation. CMZ acreages will be discussed further in the next section.

Comparing the first six reaches in the inundation area for the region reveals some subtle changes in irrigated agriculture. There were real increases in irrigation, particularly between 1950 and 1976 (Figure 2-40). The Buffalo Rapids Irrigation District, a Bureau of Reclamation sponsored irrigation program, is dependent on a series of large-scale pumps to provide water to its floodplain acres. The total acreage increase for these six reaches within the inundation area is from 2,558 acres in 1950 to 5,794 acres in 2011, more than doubling the total acres in irrigation. Buffalo Rapids irrigation project was conceived

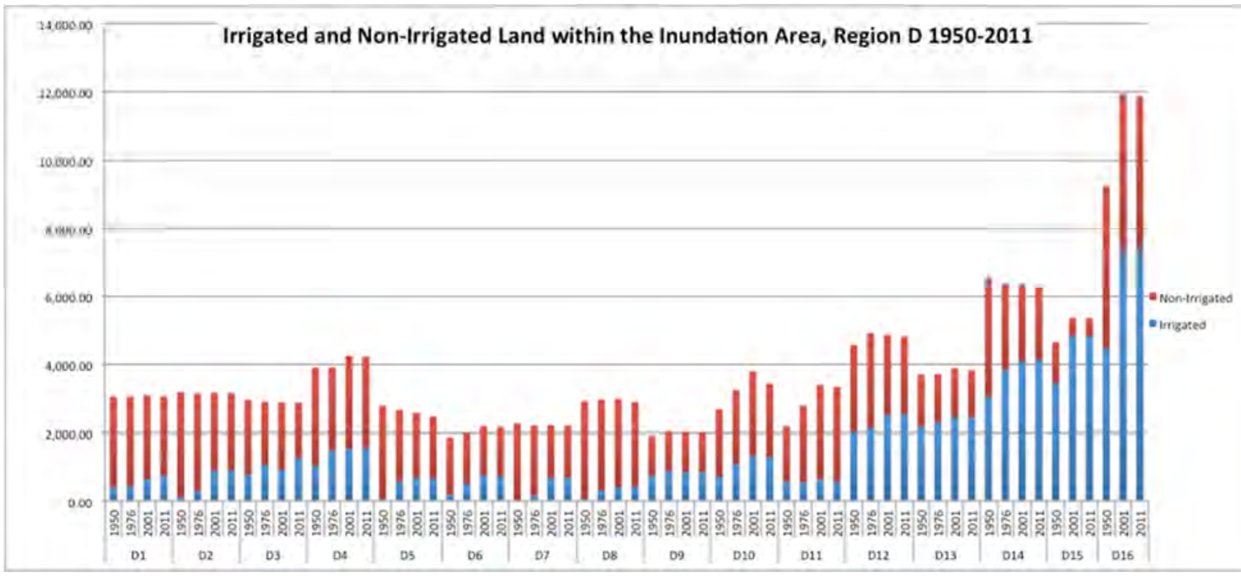

Figure 2-40 Irrigated and Non-Irrigated Land within the Inundation Area, Region D 1950-2011.

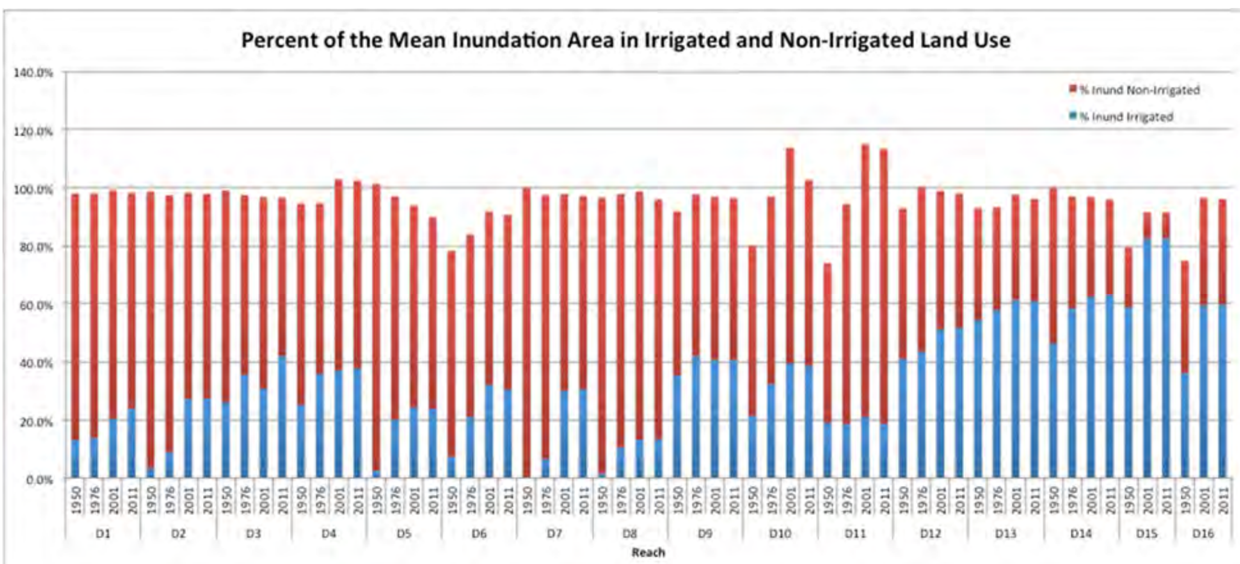

Figure 2-41 Percent of the Inundation Area, Region D, in Irrigated and Non-irrigated Land Use 1950-2011.

during the 1930s depression and built by the Bureau of Reclamation in cooperation with the Works Progress Administration, starting in 1937.Although construction was halted during the latter portions of World War II, it restarted in 1946 and the pumping plants, main canals and major laterals were completed by 1948. The build out of this system largely occurred after the 1950 aerial photography utilized as the baseline for this study, thus accounting for one portion of the irrigated agriculture land-use growth in Region D.

Even with conversion to irrigated agriculture increasing significantly over the last 60 years in upper Region D, there remains a solid percentage (60 percent or more) of open, non-irrigated agricultural lands in these six reaches. Except for Reaches D1 and D2 where irrigated lands accounted for between 20 and 30 percent of the inundated area in 2011, the non-irrigated lands in the inundation area hover in the 30 to 40 percent range for the same time period (Figure 2-41).

After Reach D9 the region is primarily defined by the second major irrigation district in Region D. The Lower Yellowstone Irrigation District begins in Reach D9 and carries through on the west/north side of the Yellowstone to the end of the river. Intake Diversion extends across the entire river in Reach D9 and withdraws approximately 1,250 cubic feet per second from the river to serve irrigation water to the remainder of the Yellowstone floodplain on the west side of the river. This is a Bureau of Reclamation project begun in 1905, with dam and main canal put into operation in 1910. The project presently irrigates about 55,000 acres throughout the remainder of the valley to the confluence with the Missouri.

This part of the valley is within the area of Pleistocene glaciation and glacial deposits are characteristic of the river valley margins on the west side of the river. The gradient here is the lowest of the river, and the river valley has carved out a wide meander belt can extend laterally nearly two miles in places.

Riparian forest is extensive, most often on the west side of the river, as the east bank is against the bluffs for long stretches on the east/southeast side of the valley until reach D16 where the river flows through the shared Yellowstone—Missouri River floodplain. The largest pieces of riparian forest are associated with two wildlife management areas (under Montana Fish Wildlife and Parks jurisdiction—Elk Island near Savage and Seven Sisters near Crane) in reaches D11 and D12.

In the upper portion as well as the lower portion of reach D12 (separated by Seven Sisters Wildlife Management Area (WMA)) the inundation area assumes its final configuration, which is accompanied by the most extensive irrigated agricultural acreage along the entire river valley. From the downstream end of Seven Sisters WMA, past Sidney opposite the middle of reach D13, the amount of cottonwood forest drops off and the floodplain has nearly all been converted to irrigated agriculture. The same situation persists to the confluence with the Missouri River in reach D16. The river flows into North Dakota briefly in D14, back into MT in a wide meander bend, and then permanently into North Dakota at the beginning of D15.

Reach D16 marks the end of the Yellowstone Valley and the final almost 7 river miles flow through the joint Yellowstone/Missouri floodplain. A few remnant pieces of river meanders and associated forest exist to nearly a mile distant, west of the present course of the Yellowstone channel. However most land in the floodplain south of the Missouri channel has been converted to irrigated agricultural land use.

The Lower Yellowstone Irrigation District reaches show two distinct characters in the inundation area. At the upper end of the district (Reaches D10 through D12), in 2011 stretches of reach D10 still contained undeveloped land. After irrigated agricultural land use grew between 1950 and 1976, and again between 1976 and 2001 to a total irrigation footprint of just under 40 percent of the inundation area, it appears to have leveled off in the final 10 years of the study period with approximately 30 acres less in irrigation by 2011(Figure 2-41).

Reach D11 shows the effect of the extensive bottom lands in riparian forest within and adjacent to Elk Island WMA. The reach only had about 19 percent of the inundation in irrigated land use through all time periods of the study (Figure 2-41). Reach D12, which contains Seven Sisters WMA, is also affected by the WMA jurisdiction, but not to the extent of D11. With considerable irrigated agriculture already present on either side of the WMA in 1950 (41 percent of the inundation area), irrigated agricultural land use steadily grew through all four time periods to 52 percent of the inundation area in Reach D12 (Figure 2-41).

Reach D12 is a long reach at over 11 valley miles. The final three miles of the reach begins the most intensively cultivated area of the inundation area. By 2011, the remaining reaches in the Yellowstone Valley all had over 60 percent in irrigated agriculture, with one reach (D15) exceeding 80 percent (Figure 2-41). These final reaches have increased risk of not maintaining sustainable native vegetation and wildlife habitat.

2.2.5.2 *CMZ Discussion*

Looking at relationships among the various components of the river valley in Region D for the CMZ, the channel area dominated this part of the rural landscape with extensive riparian forests, although its presence has shrunk in the 60 years of the study. Particularly from Reach D9 through Reach D11, the channel occupied 45 to 58 percent of the CMZ, but has lost from 13 to 39 percent of its area in these reaches. This has created new land surfaces, a substantial amount some of which have gone into agricultural land use.

In general the CMZ in Region D has followed the pattern of the inundation area. Figure 2-42 shows that only a small amount of acreage has been converted to high intensity irrigated agriculture in the CMZ from Reach D1 though D9. Once the river valley widens after D9 and the river reaches the area encompassed by the Lower Yellowstone Irrigation District, there is a steep increase in irrigated agriculture in the CMZ. The contrast is startling from D1 with 24 acres of irrigation land in 2011 (albeit in a very constricted portion of the valley) to D14 with 1678 acres of CMZ under irrigated cultivation. The percentage of CMZ in irrigation tells a similar story (Figure 2-43). Of the first nine reaches in the region four hardly exceed 5 percent of the CMZ in conversion to irrigated agriculture. No reach in this area reaches the 25-percent level of conversion to agriculture. For the final seven reaches (D10 – D16), all but one reach had a conversion to irrigated agriculture level of over 20 percent. One sequence of reaches, D12 through D14 have had increasing conversion rates, with D14 having converted over 45 percent of its CMZ lands to irrigated agriculture by 2011.

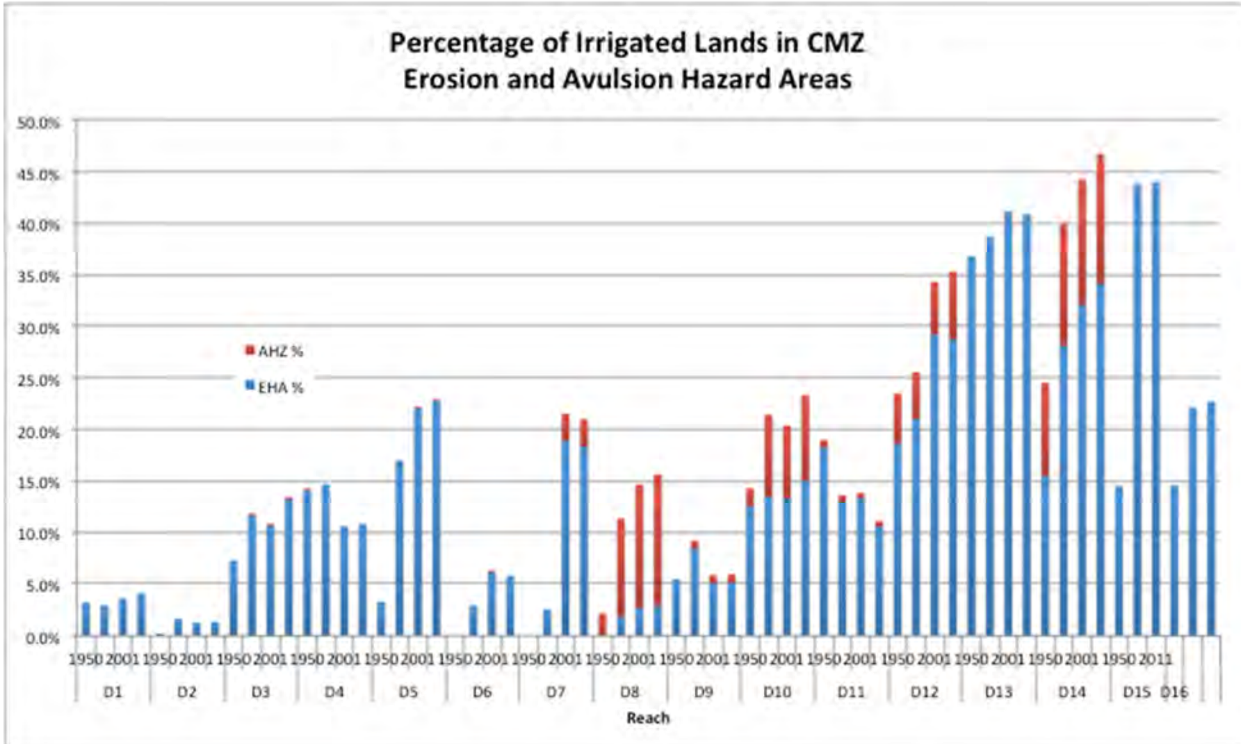

Figure 2-42 Acres of Irrigation in the CMZ, Region D 1950-2011.

Reach D8 is of interest in the relationship between non-irrigated open agricultural land and that which has been converted to irrigation. A very visible feature of Reach D8 is a series of three peninsula-like land features created by extensive lateral migration of the river. The two of these features on the east side of the river have been extensively converted to irrigated agriculture (Figure 2-43). This offers a view of the alternative effects of two land management applications. While this area in D8 shows an increasing amount of CMZ devoted to irrigated agriculture, similar areas in Reach D11, either at present or in remnant form from earlier channel configurations, support extensive native vegetation and wildlife habitat in a WMZ management setting.

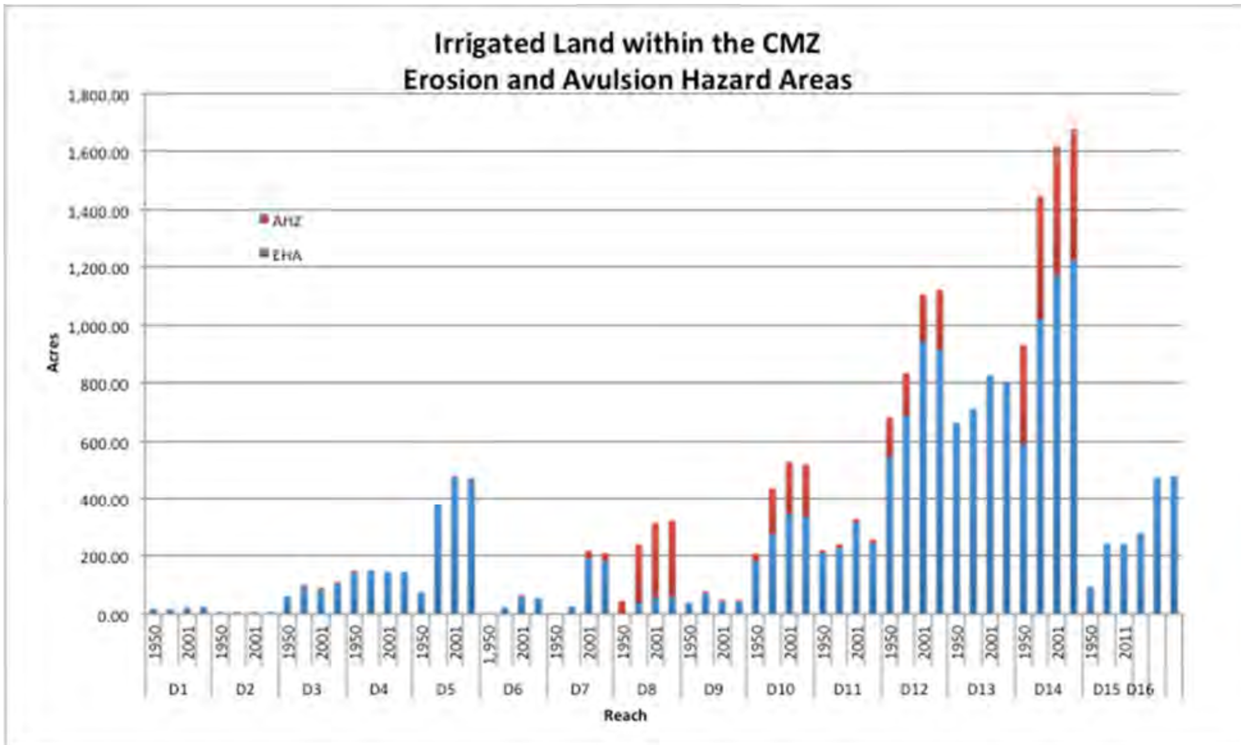

Figure 2-43 **Percentage of Irrigated Lands in the CMZ, Erosion and Avulsion Hazard Areas, Region D 1950-2011.**

One area of potential concern is the conversion of flood irrigation to pivot in the CMZ. The impetus to protect investment in pivot irrigation can potentially increase the bank armor projects where pivot irrigation has been installed in proximity to the channel. In early years of the study period, no pivot irrigation was installed in the CMZ. It began appearing by 2001, and by 2011 had increased in most reaches in which it was being used. In 2011, only two reaches had as much as 200 acres in pivot irrigation, but it could be a risk to a sustainable CMZ if present indicators continue to increase into the future (Figure 2-44).

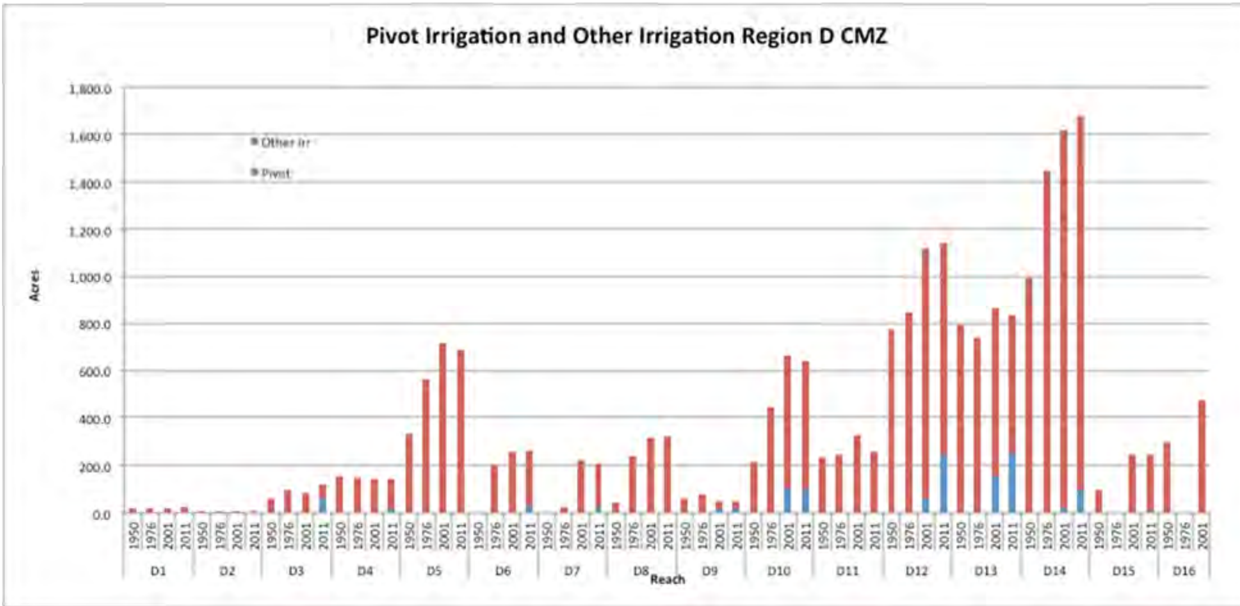

Figure 2-44 Pivot Irrigation Relative to Other Irrigation Methods in the CMZ, 1950-2011.

In total about 846 acres had been converted to pivots in the Region D CMZ by 2011, with Region D being the highest of any region. Comparison to other regions is shown in Figure 2-45.

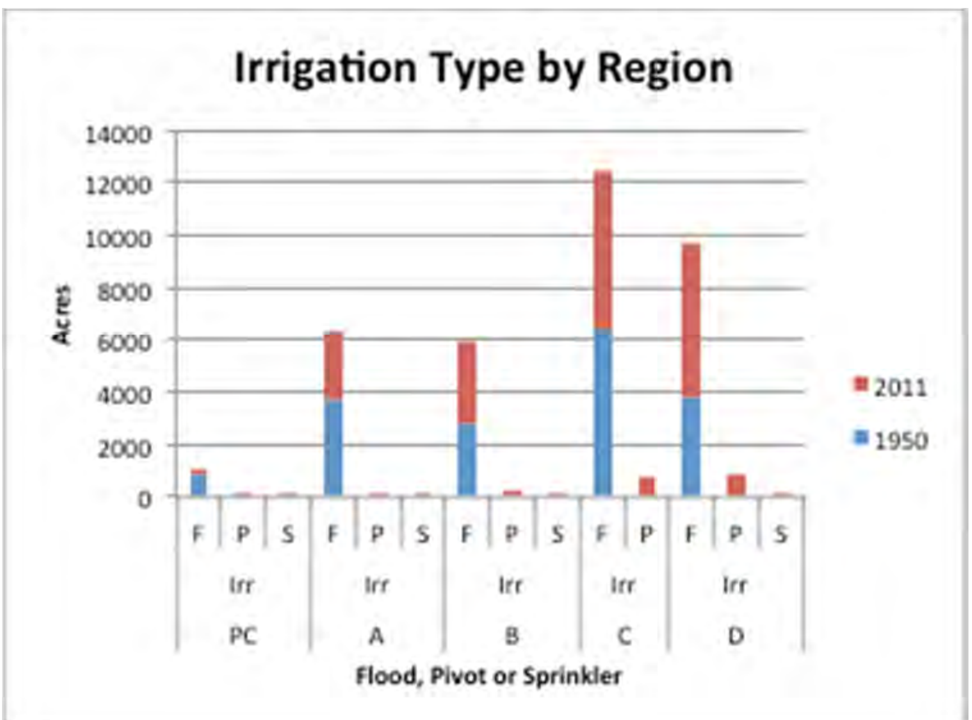

Figure 2-45 Irrigation Land Use by Irrigation Method, All Regions, 1950 and 2011.

2.3 Urban and Exurban Land Use Change

Urban land-use conversion, the land within incorporated city limits, and exurban land-use conversion, or rural subdivisions, are limited on the Yellowstone River main stem. Aside from communities like Livingston, Laurel, Billings, Miles City, Glendive and Sidney, towns were very small in 1950. The 1950s were a time when suburban communities and exurban developments were in their development stages country-wide, and given Montana's small population, nearly non-existent along the Yellowstone. In 1950, only 425 acres were classified as exurban land use within the over 560-mile long Yellowstone River floodplain, about the acreage of a town like Columbus, in Stillwater County.

By 2011, the situation had changed moderately. Billings had grown into a mid-sized city. There had been noticeable rural exurban development upstream from Billings, particularly in Park County/Region PC and its Paradise Valley.

For the most part urban development affected only the immediate area of a specific city or town. However there were two exceptions. First, the Billings/Laurel area was large enough that it economically drew people as commuters for some distance in either direction along the Yellowstone River. This has contributed to an extensive although discontinuous exurban presence for a short distance to the east and to perhaps 60 miles west along the river. Much of that exurban presence is away from the Yellowstone River valley and does not appear in the footprint this study addresses.

In addition to urban growth and exurban development due to the presence of medium and small urban communities, proximity to the mountains, trout streams and Yellowstone National Park has drawn permanent and part-time residents attracted to the amenity values of four upper river counties: Park, Sweet Grass, Stillwater, and Carbon. Some of that exurban development occurred along the Yellowstone River and is described in this study, particularly in Regions PC and A.

Below Billings, the population has stayed much more rural, and compared to the four upper river counties and Billings vicinity, exurban developments have been almost always associated closely with the location of the larger towns and cities, including Forsyth, Miles City, Glendive and Sidney. There is some attraction to living outside the city limits of these downstream communities, but normally that development is within the reach or reaches of the river that touch the related city/town boundary.

On a regional basis, only Region PC and Region B have experienced enough growth that they exert influence at greater than a reach scale. Looking at the regional distribution of land uses, the collection of land uses related to development approached 20 percent of Region PC by 2011, and just over 16 percent in Region B. Region A also experienced steady growth in exurban development, but it remains scattered through the region and had reached only 3 percent of the region by 2011 (see Figure 2-45 for details).

In a regional view of urban/exurban development in the CMZ, an examination of Figure 2-46 shows that encroachment of urban and housing growth into the CMZ barely registers from this high level viewpoint. Compared to the extent to which the inundation area has been converted in Region PC and Region A, acreage in the CMZ is miniscule. However, the CMZ itself is small relative to the inundation at the regional scale. Looking at the percentage of the CMZ that has been converted at least shows that the trend of development has begun to present a risk factor for CMZ sustainability (Figure 2-47). The effect on CMZ is mostly localized however, and will be explored further in sections below.

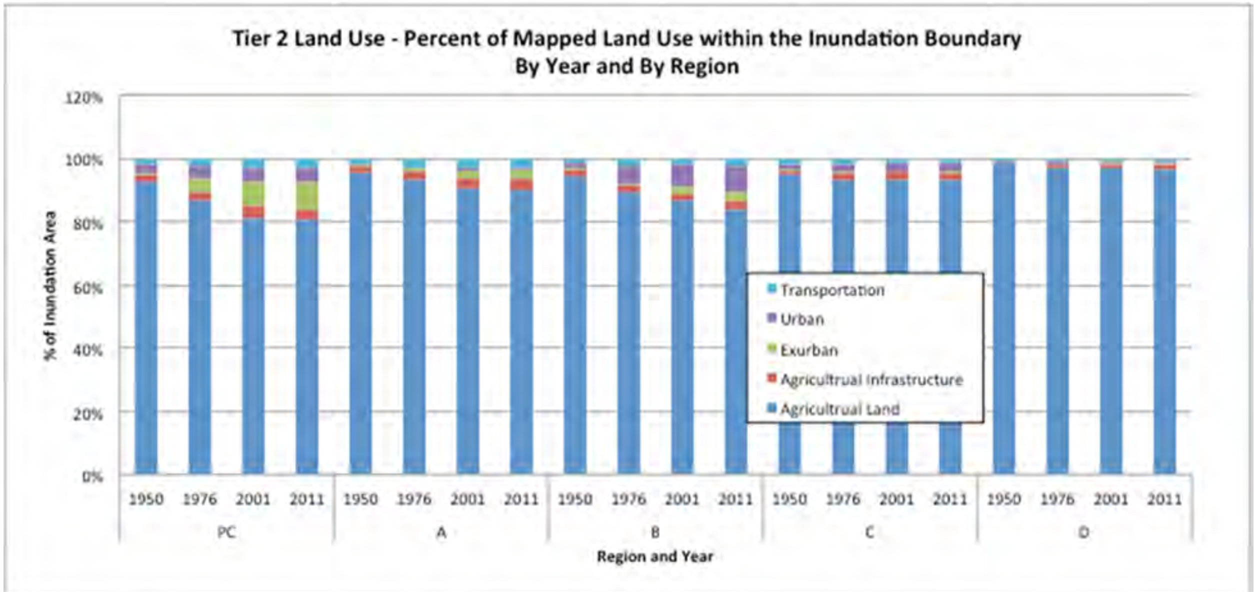

Figure 2-46 **Regional Chart of Land Use Distribution throughout the Yellowstone River Valley Corridor, 1950-2011.**

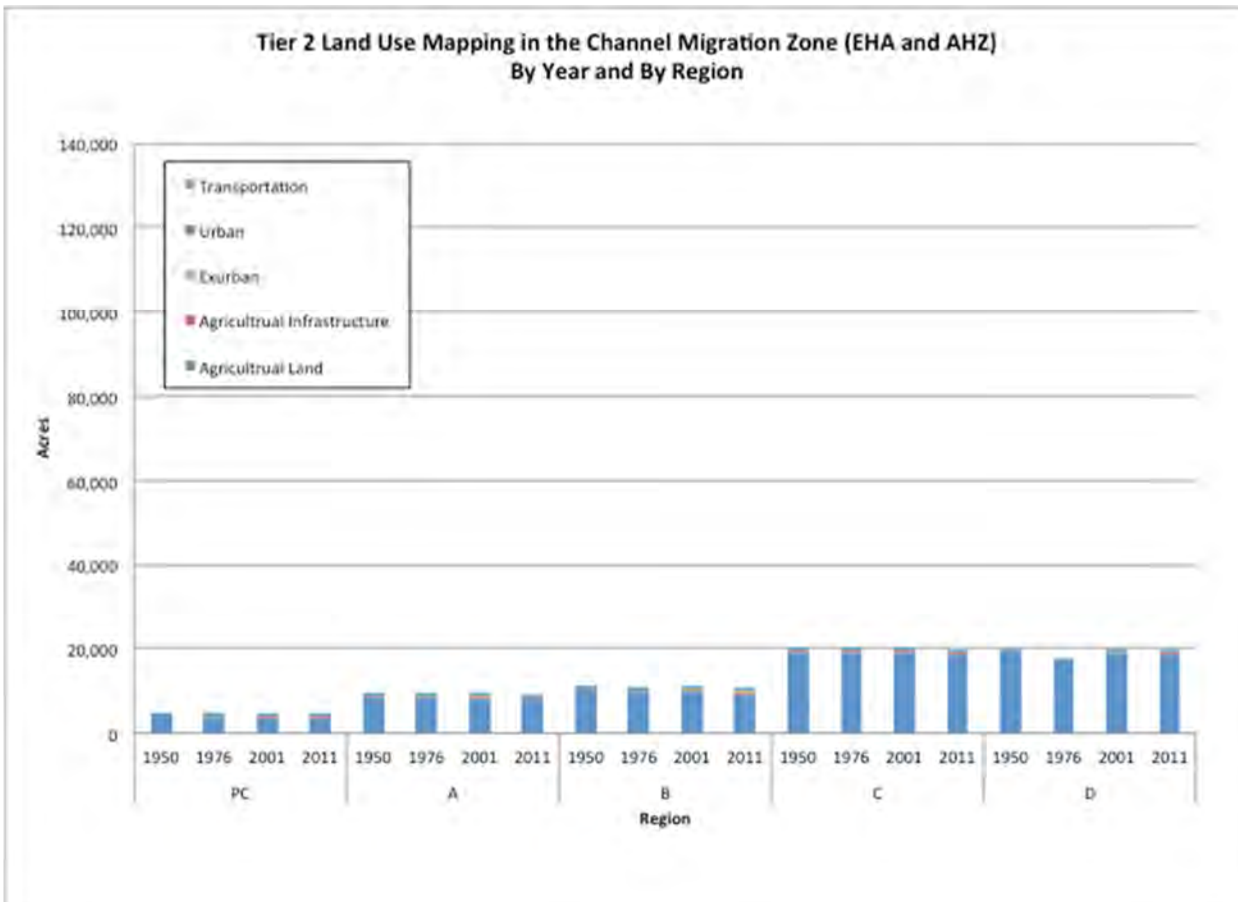

Figure 2-47 **Acreage Devoted to Major Land Uses on a Regional Basis.**

2.3.1 Urban and Exurban Land Use Change in the Upper River Regions – Region PC and Region A

The Yellowstone Cumulative Effects Analysis is intended to be “river centric”, in that its principal aim is to assess what the effects of human activity have had on the river, not necessarily the role of the entire valley and its effects. Urban and exurban development is easily observed by the casual observer because housing clusters, new businesses and roads and streets provide a contrast to the agricultural or natural areas which become converted to urban or exurban land use. However, the point at which such development might have impacts on the river is more difficult to discern, because the floodplain where interactions begin between the river and surrounding land is not marked by a visible boundary. The urban and exurban land use is built on data sets that were collected with the river as the target, rather than being focused on the towns and cities that make up urban areas or the settings that attract exurban development. The analysis that follows was built on the remote sensing data collected for all of the Yellowstone studies, and as such only covers the river channel, floodplain and a small buffer area. The reader is encouraged to keep in mind that entire urban areas and entire exurban developments are not part of the study. Rather this analysis concentrates on encroachment into the floodplain, the CMZ, and the banks of the river itself.

The most extensive exurban developments have occurred in Park County/Region PC. Overwhelmingly that change in land use has occurred since the beginning date of the study of 1950. In 1950 there were only 39 acres of inundation area exurban development in the entire PC region, and that acreage barely registers as a fraction of the total PC Region inundation area (i.e., 0.3 percent). By 1976, the trend of change in land use was well underway, having grown by a factor of 10, with 379 acres of exurban land-use conversion. That acreage had almost doubled again by 2001 at 652 acres and in the ten years to 2011s grew another 18 percent to 768 acres. Those acreages represented a range of 0.7 percent of Reach PC4 to 39.3 percent of PC13 (inundation area) (see Figure 2-48 to view the percentage growth in the inundation area).

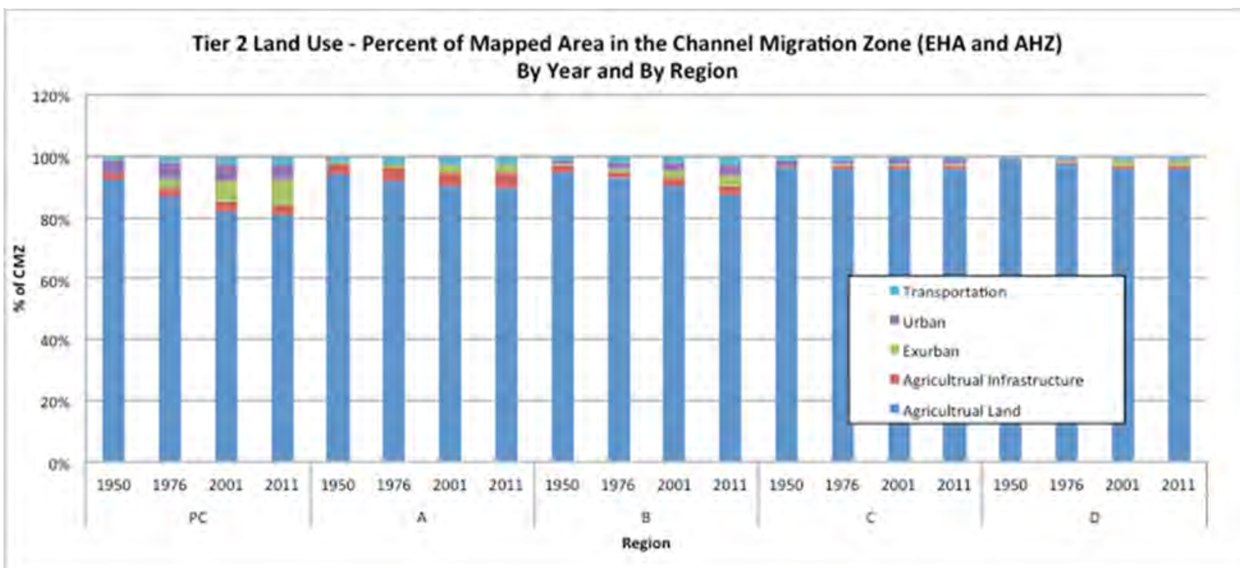

Figure 2-48 Percent of Major Land Uses on a Regional Scale.

Development of exurban properties has also occurred within the CMZ. This growth has been localized to a large extent, although there is a presence of exurban growth in all but five PC reaches. The greatest exurban growth in the CMZ has been in three reaches in the Paradise Valley (PC5, PC6, and PC8) with one reach over 25 percent of its reach and two over 30 percent. There has also been exurban growth in the Livingston area with reaches PC13 and PC14 both over 20 percent of their reaches (Figure 2-49).

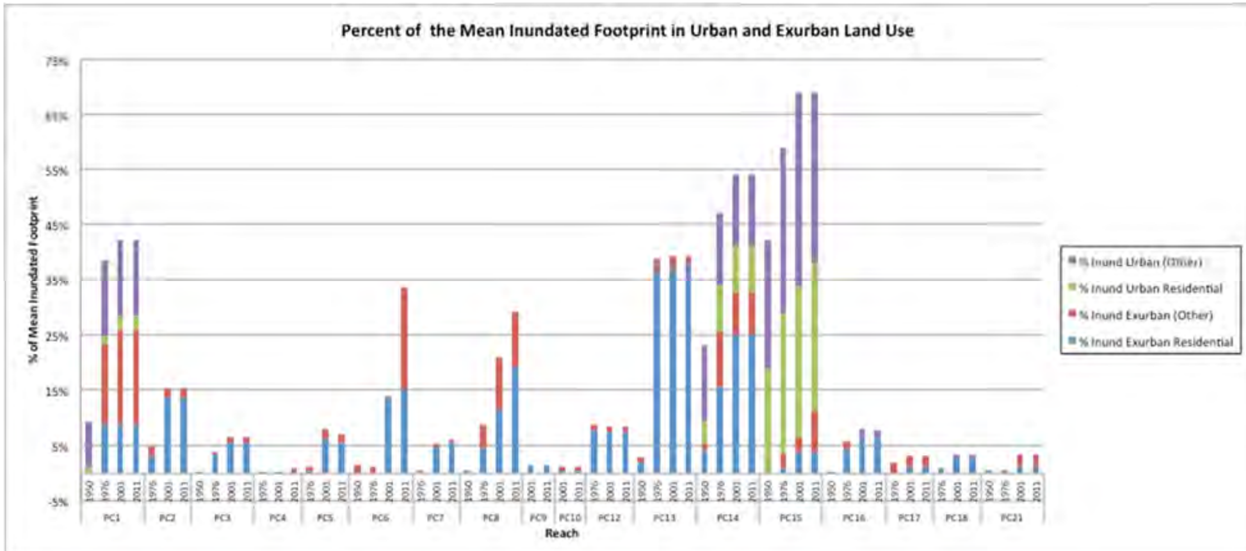

Figure 2-49 Percent of the Inundation Area in Exurban and Urban Land Use.

In 1950 the Livingston urban/exurban inundation area share was 23 percent of the Reach PC14 and 33 percent of Reach PC15. By 2011, the two reaches were at 54 and 69 percent, a trend that increased through 2001 but stayed level through 2011. At the same time, open land (non-irrigated agricultural land) decreased from 79 and 57 percent to 37 and 23 percent of the same two-reach area.

Two towns lie within Region A, Big Timber and Columbus. Big Timber proper is on a high terrace to the south of the river and only 7 to 8 acres of urban area fall within the floodplain, either in 1950 or 2011. Exurban growth is small throughout the time period of the study. Zero acres of exurban land were mapped for 1950, but by 2011 Reach A6, close to Big Timber had gone from zero to 110 acres of exurban development, the only exurban development of note in the inundation area. Other Region A reaches upstream and downstream of Big Timber had either no exurban development or very minor acreages (i.e. less than 10 acres, even by 2011).

In Stillwater County the Columbus area is somewhat different than Big Timber although similar in population size. The town limits lie within the inundation area in Reach A13 creating a bigger footprint than for Big Timber. Growth is relatively steady throughout the study period, thus making a different pattern from upstream, and reflecting the gradual assumption of commuter status for the Columbus area, with many residents driving to employment in the Billings/Laurel area. In addition Columbus possesses a small industrial base which adds to the dynamics of its population.

While in the higher Region A reaches there is some exurban development, it has only risen into the 100- to 200-acre range close to the towns of Big Timber and Columbus. Otherwise, it is scattered, never rising above 10 acres.

The widened agricultural area approaching Laurel in reach A remained largely agricultural in the 100-year floodplain, with small acreages in reaches A16 and A17 not reaching 5 percent of the acreage in either of those two reaches by 2011. Only immediately downstream of Laurel, at the end of the Region in reach A18 was there a significant amount of exurban development, even in 2011. In this reach the 1950 acreage in exurban development was 27 acres, but jumped 10-fold to 239 acres in 2011, or 16.4 percent of the reach.

Figure 2-50 shows the percentage of the inundation area converted to urban or exurban land use by 2011 throughout Region A (reaches with negligible or no urban/exurban growth are not shown). No reach has been encroached upon by urban and exurban development combined to more than 21v of its area, and that only in Reach A13, the Columbus area.

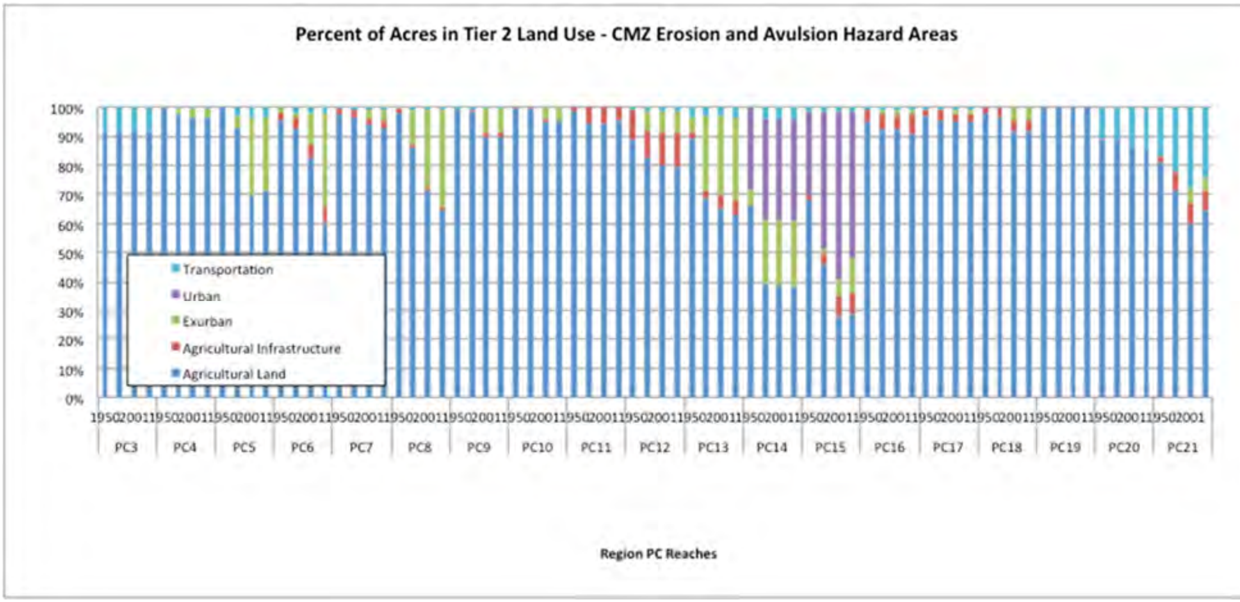

Figure 2-50 Percent of the CMZ in Region PC in Urban/Exurban and other Major Land Uses.

Urban and exurban development is not described in detail as few Region A reaches have such land use in amounts large enough to register. Of those inundation areas noted above only Columbus and Reach 18 just downstream from Laurel exceed 10 percent of a CMZ reach. At Columbus, the 2011 statistic is 16.6 percent of Reach A13 in combined urban and exurban development. Reach A18, however, shows the beginning of the outer reaches of Billings' exurban development as the eastern boundary of A18 is only 11 valley miles from the edge of the city. A18 exurban development occupied 26 percent of its reach, an increase of over 13 times the 1950 percentage (1.6 percent).

2.3.2 Urban and Exurban Land Use Change in Region B

The only urban or exurban reaches in Region B are those including and immediately upstream and downstream from Billings. Reach B1 is between 13 and 14 valley miles in length and begins just downstream of Laurel. It is largely exurban, but encounters the urban boundaries of Billings just under 2 miles from its terminus at valley mile 300. Urban Billings runs from that point through reach B2 until terminating between valley miles 293 and 294 in reach B3. Reach B3 is a combination of exurban and urban development. Urban Billings abuts the river on the north bank for approximately 9 miles.

All three of the Billings reaches have shown tremendous growth over the length of the study period within the inundation area. In 1950, both Reaches B1 and B3 urban and exurban areas occupied well less than 5 percent of their reaches. By 2011, those same reaches had urban/exurban occupation of 20 and 32 percent, respectively, and both showed a continued steep upward growth curve. In Billings itself, the urban growth curve was even steeper, and urban/exurban development had grown from 25 percent of the inundation area in 1950 to 74 percent in 2011. These three reaches are a definite risk to sustainability of a 22-mile stretch of the river Valley by converting native vegetation and wildlife habitat to urban uses, plus other factors isolating the river floodplain and modifying the immediate riverbank environment.

Huntley diversion dam is located downstream of Billings in Reach B4, a reach that is confined to the south by high hills and on the north bank, a narrow floodplain is dominated by agriculture below a high terrace. Any urban or exurban development near this reach is outside the boundaries of this study.

Below Reach B4, the valley rapidly becomes largely agricultural because of the presence of the Bureau of Reclamation Huntley Irrigation Project. However, there are three communities associated with the project as well as some small exurban carve-outs within the irrigation project. By the east end of Huntley, just six miles east of Reach B3, urban and exurban development has nearly disappeared. Figure 2-51 shows the growth of urban and exurban acreages in the floodplain between 1950 and 2011 from reach B1 through B11, well past the exurban and urban growth zone.

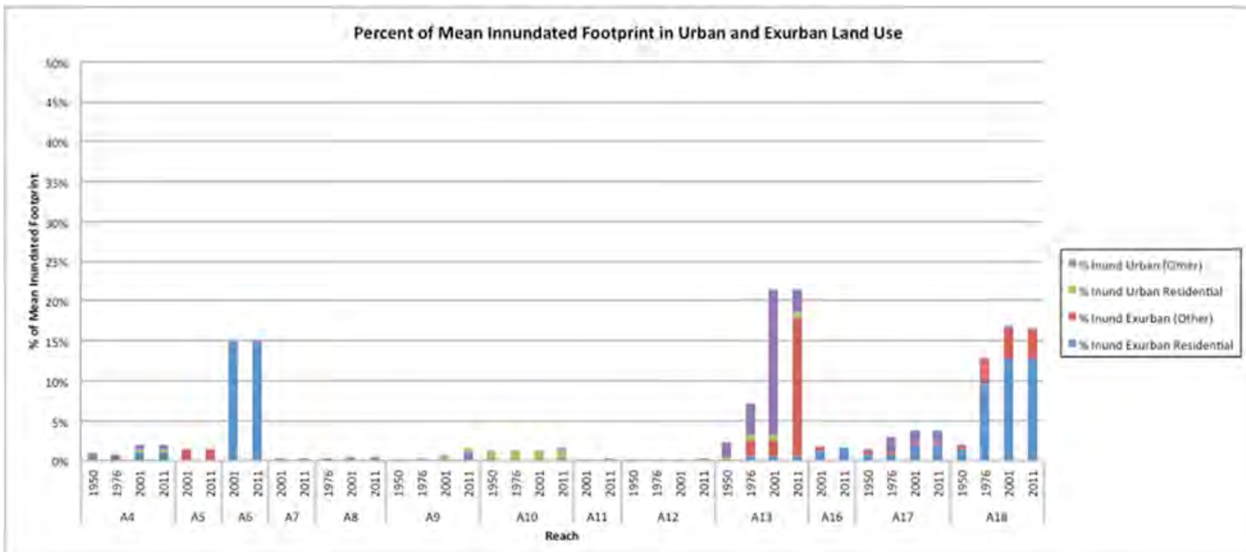

Figure 2-51 Urban and Exurban Land Use in Region A.

In the CMZ near Billings, there has been an extraordinary amount of incursion into near vicinity of the Yellowstone River in Reaches B1, B2 and B3. The three reaches show a similar growth curve to the same three reaches in the inundation area. To 2011, Reach B1 had moved from exurban occupation of about 1 percent of the reach to about 9 percent 2011. However, transportation land use and agricultural infrastructure bring that total up to about 16 percent in 2011.

Reach B2 shows the greatest growth rate and incursion into the CMZ. Urban and exurban conversion of CMZ acres was about 12 percent in 1950. That total rose to 44 percent in 1976, with most of the conversion moving from exurban to urban, and also saw associated transportation land use of 2.5 percent in that total. By 2001, all development was either urban or transportation in Reach B2 and the incursion into the CMZ had grown to 40 percent of the reach. Change occurred even more quickly in the ten years between 2001 and 2011 and occupation of the CMZ increased to 88.5 percent. Very little native vegetation or habitat remains by the year 2011 in Reach B2.

Reach B3 also saw growth of land-use conversion into the CMZ, but it more nearly paralleled the growth B3 had seen in the inundation area, beginning in 1950 at 6 percent of the reach and climbing to occupy about 34 percent by 2011.

After this reach, no reach has converted more than 10 percent of the CMZ in the downstream reaches of Region B. CMZ changes are shown in Figure 2-52.

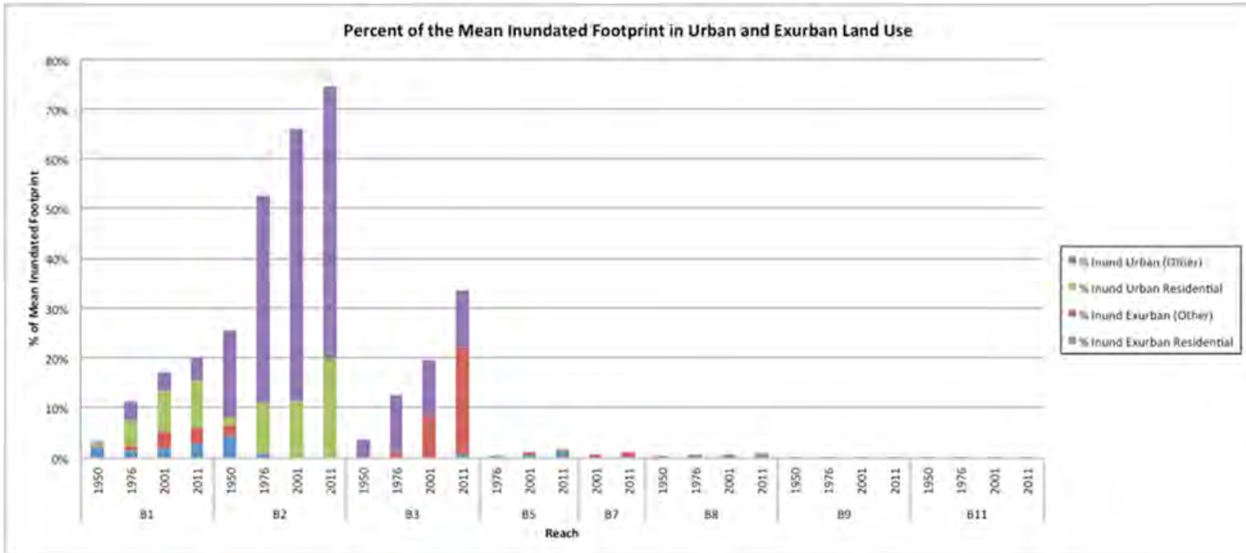

Figure 2-52 Change in Urban and Exurban land use, 1950-2011 in Region B near Billings, Montana.

2.3.3 Urban and Exurban Land Use Change in Regions C and D

Urban development falls dramatically after the Billings vicinity. The first community with a population greater than 1000 is Forsyth, in Region C some 105 miles from the center of Billings. In contrast, two communities upstream of Billings, Laurel 14 miles west of Billings and Columbus 40 miles west of Billings had populations greater than 1000 in 2012. To the east and north, after Forsyth, only Miles City (45 valley miles east of Forsyth), Glendive (57 valley miles northeast of Miles City) and Sidney (36 valley miles north-northeast of Glendive) have populations exceeding 1,000 (source, Wikipedia, 2012 population estimates).

Forsyth, MT. Most of the small city of Forsyth is in Reach C10. At the beginning point of the study, 1950, Forsyth occupied 469 acres of area classified as urban land use within the 100-year floodplain, and zero acres of exurban expansion land use. By 2011, the urban area had expanded to 623 acres and exurban land use was at 17 acres. During the period of study, 1950-2011, the change in urban acres was 154 acres, a 33-percent gain, but in terms of the C10 reach, only a small portion. The 2011 figure of 623 acres is just 14 percent of the 4,432 acres of 100- year floodplain.

Less than 10 percent of the urban land-use area extends into the CMZ. Open non-irrigated agricultural land use occupied 1013 acres (55 percent) of the CMZ area in 2011, the same percentage as in 1950. The river channel accounts for 758 acres (41 percent) of the CMZ around Forsyth, leaving only 4 percent of the acreage in the CMZ in any kind of developed land use in reach C10.

On the other hand, the floodplain acres capture nearly all of the urban development at Forsyth. Only 15 acres of urban development were outside the floodplain in 1950, increasing to 105 acres in 2011. Forsyth has constructed a levee which protects the urban floodplain acres, so outside of the CMZ, Forsyth has isolated all of its floodplain.

Miles City, MT. At a 2012 population of 8,569, Miles City is the largest city downstream of Billings on the Yellowstone River. It is located in reach C17 at the Yellowstone's confluence with the Tongue River. Miles

City has two levees, one on the west side of the city to protect the urban area from the Tongue River and on the north side of the city and Yellowstone River south bank. The levees at Miles City isolate considerable floodplain acreage [see Technical Appendix 3 Floodplain Connectivity (Hydraulic Assessment)].

Most of the urban growth in Miles City came before the zero year of the present study, 1950. The amount of urban land-use conversion in 1950 was 1,042 acres. That number dropped slightly by 1976 to 1,028 acres, but exceeded the 1950 acreage figure by 2001 at 1,075 acres. The figure remained stable in 2011.

There was some exurban growth in reach C17 from 1950 to 2011 but the growth was moderate, from 28 acres in 1950, to 171 acres in 1976, to 272 acres in 2011. To the west of the Tongue River in Reach C16 the same growth pattern obtained. Urban/exurban acreage in 1950 was 183 acres, in 1976 196 acres, and in 2011 262 acres. To the east of Miles City, Reach C18 begins about a mile from the Miles City urban boundary. A small amount of exurban growth occurred between 1950 and 1976 (from 3 to 32 acres), but after that only an additional 5 acres of exurban growth occurred through 2011.

For the three reaches around Miles City, open land (non-irrigated agricultural land) in both floodplain and CMZ was established by 1950 at levels ranging from 47 to 59 percent of reach C16, 17 to 24 percent of reach C17, and 23 to 34 percent of reach C18, and have stayed consistent in the 61 years to 2011. In all cases, both floodplain and CMZ there has been some loss of acreage but has averaged about 3 percent. Figure 2-53 shows the acreage and percentage of reach from 1950 to 2011 for selected reaches containing urban population.

The two communities having urban or exurban growth in Region C can be clearly seen in Figure 2-53. As both Forsyth (Reach C10) and Miles City (reaches C16 through C18) have relatively stable populations, and both have neighborhoods hard against the levees protecting them from the river, it is unlikely that either growth will occur further into the inundation area or CMZ, or that change will occur to reduce either community's footprint in the river environment. No other reach in Region C beyond the four discussed above has significant amounts of urban or exurban land-use conversion.

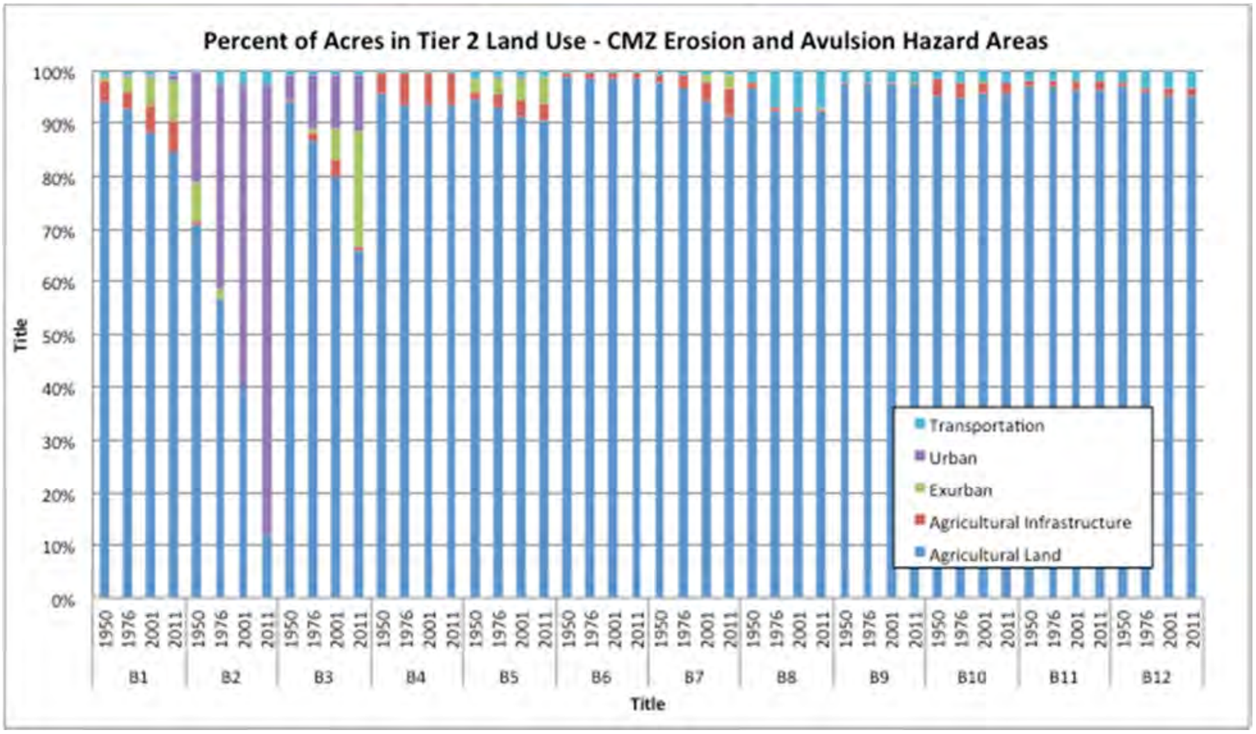

Figure 2-53 Percentage of Urban, Exurban and other Major Land Uses in Region B, 1950-2011.

<u>Glendive, MT.</u> Glendive in Reaches D5 through D7 has considerable acreage inside the CMZ boundary, although much of it has been isolated by several features complicating the Glendive urban landscape. These include a railroad bridge at the south end of the city, an interstate highway bridge at the north end of the city, an additional two highway bridges at the center of the city, and a levee on the west side of the river connecting to a railroad grade to the west. The bulk of the city center and public buildings are on the east bank of the Yellowstone which is located on a high terrace adjacent to the river, and well away from the ice and flooding problems within the CMZ. In recent years, the Federal Emergency Management Agency has withheld flood insurance certification from the CMZ/floodplain area which has caused several businesses to close or relocate.

Urban land use has been mapped for 105 acres of CMZ in reach D6, in place at the point in time this study commences, and in 2011 still has 90 percent of those urban acres. In the inundation area the picture is more complicated. Reach D5 had no urban land-use conversion in 1950, but had grown to 124 acres by 2011, Reach D6 had 39 acres of urban land-use conversion in 1950, which had grown to 290 acres in 2011. In 1950, there were no exurban acres developed in the floodplain or CMZ in the reaches around Glendive (D5, D6 and D7). In the CMZ very few acres had been developed into exurban land use in 2011, from 4 acres upstream in D5 to zero acres in D6 to 21 acres in D7. In the inundation area, these same three reaches all saw minimal growth of exurban acres from a base of zero in 1950 to no more than 47 acres in any one reach by 2011.

Scattered exurban expansion has occurred downstream of Glendive in the floodplain of reach D8. Small pieces of exurban development from there downstream to Sidney appear to be associated with small unincorporated communities like Intake, Savage, and Crane.

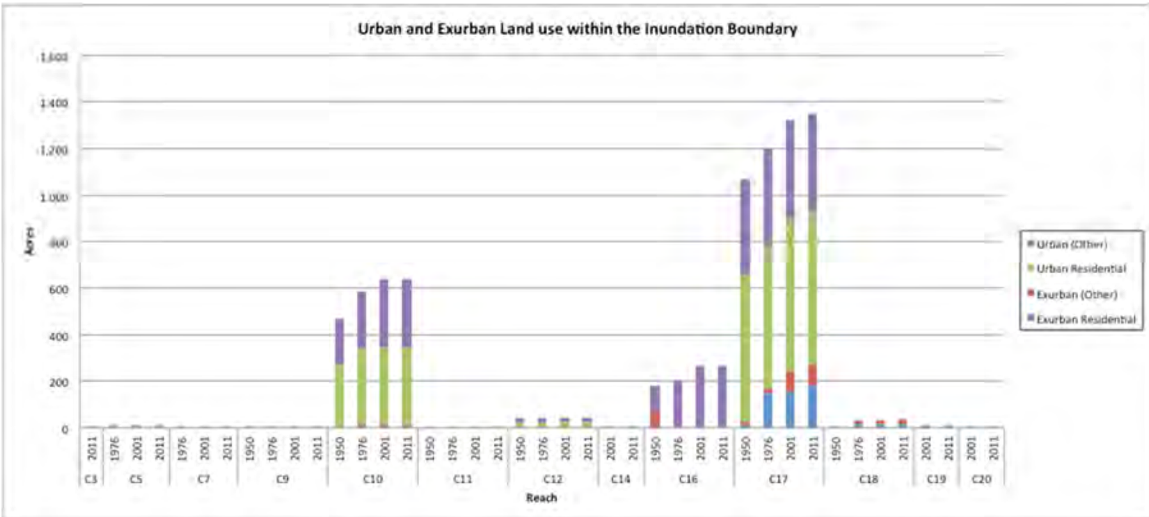

Figure 2-54 Change in Urban and Exurban Land Use, 1950-2011 in selected reaches, Region C.

<u>Sidney, MT.</u> Sidney sits on a plain at a distance from the Yellowstone River, ranging between one and two miles as the river passes to the east of the urban area. Land-use conversion does show up as exurban development in the reaches near Sidney (D13 and D14). Most of the development is in reach D13, where exurban development jumped from zero acres in 1950 to 108 acres in 1976. That acreage had grown slowly to 122 acres in 2011. Only 0.4 percent of the exurban development is residential, with rest mapped as industrial, presumably the sugar beet factory and petroleum refinery located at Sidney, and both dependent on water for processing their products. Exurban development, however, is very small compared with the floodplain and CMZ acreage of 5,467 in reach D13.

At this writing (2014), the community of Sidney is changing rapidly due to oil and gas development in the Bakken oil field of Montana and North Dakota. Almost none of that development had occurred by the end of the study period, and latest data capture for the area which was the year 2011. Region D urban and exurban land use is shown in Figure 2-55.

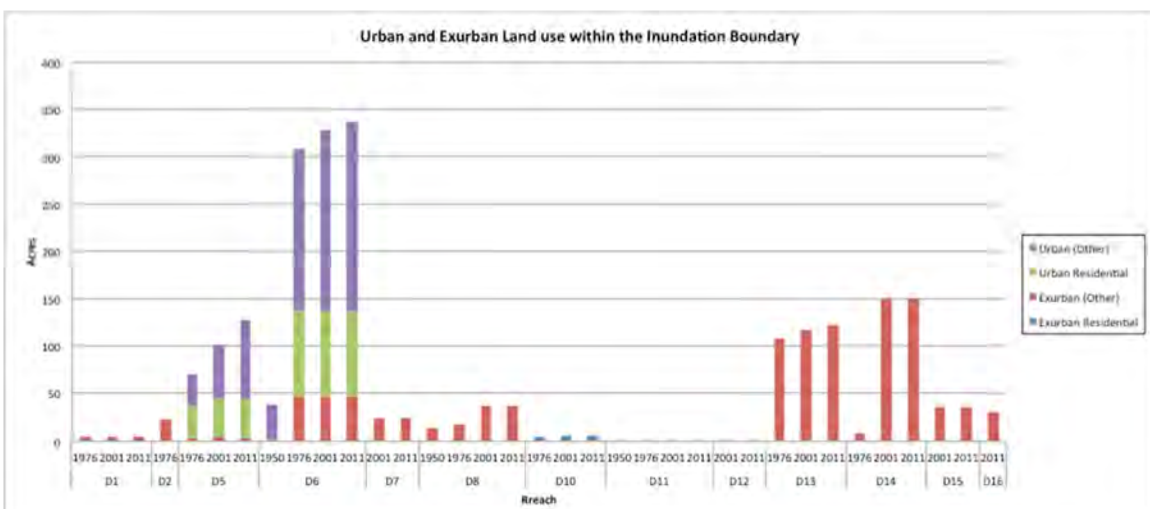

Figure 2-55 Change in Urban and Ex-urban land use, 1950-2011, in selected reaches, Region D.

For smaller communities along the lower river, few acres have been converted to urban land uses. Reach C5 where the county seat of Treasure County is located (Hysham) and Reach C12, with the town of

Rosebud located close to the Yellowstone River south bank are good examples of the scale of these small communities. In reach C5, Hysham represented only 12 acres of urban land use as it is nearly 1.5 miles from the river channel, and barely intersects the floodplain area. The study area buffer mapping only adds 17 acres to Hysham’s urban footprint, plus 15 acres of exurban development. In reach C12, Rosebud consisted of 42 acres of urban land use and zero acres of exurban development in the inundation area in 1950. There was no net change by 2011 as Rosebud represented 40 acres of urban area and 2 acres of exurban development. The landform (terrace) where Rosebud is located is close enough to the river that the CMZ extends laterally beyond the floodplain. This adds an additional urban development of 17 acres to Rosebud’s footprint. Total floodplain acreage in reach C12 in 2011 was 6946, demonstrating the small impact of urban land-use conversion in the smaller communities on the Yellowstone and its immediate environment.

2.4 Transportation Land Use Change

Transportation features do not represent a significant area of land-use conversion in and of themselves. Where railroad and older two-lane highways are the only transportation features located within the floodplain, a typical reach will have 10 to 25 acres of transportation land use mapped. That area represents from 0.5 to 2 percent of a typical reach, and thus does not disturb much native habitat.

Even where the construction of the interstate highway system appears with the 1976 data point, it adds another 60 to 125 acres of footprint, or up to 5 percent of a reach acreage and those larger numbers are rare.

Most of the interstate highway system runs on the periphery of the river valley, so many reach boundaries do not intersect the interstate highway system. For example in Region C, which covers 122 valley miles, the interstate has acreage within the study area floodplain only in 5 reaches for a total of 215 acres, barely registering against the total acreage of the entire Region C study area of 147,286.

The railroad impact is much more complicated. First, it follows the river channel as closely as possible, very different than either the interstate or secondary road systems, as the railroad companies have endeavored to minimize the grade changes, presumably to reduce construction costs and to minimize energy use (discussed in White, 2011). The same Region C that has only 5 reaches with interstate highway grade within the study area inundation area, has only one reach without railroad acreage. And Region C is further complicated because from reach C10 through the final reach (C21) trackage was roughly double the 2001 and 2011 totals, as the Milwaukee Road railroad right-of-way was not abandoned until after the 1976 photography.

Even including the abandoned Milwaukee railroad, the acreage of land conversion was small, but the totality of the railroad land-use impact includes at least three further effects to the corridor.

1. Much of the railroad grade isolated the floodplain behind it. See the Floodplain Isolation, Geomorphology, and Riparian technical appendices for details of floodplain isolation extent and effects on riparian ecological processes.

2. Extensive sections of the railroad grade were accompanied by modifications to the river banks, such as bank armoring, to preserve the railroad when it is located well within the CMZ (see the hydrology and the geomorphology technical appendices for more information on these impacts).

3. Finally the railroad grade serves as a barrier to some animal and plant migration movements.

The relationship among the various ways that the transportation affects the river corridor is further complicated. For example, a substantial amount of irrigated agricultural land in Regions B, C, and D can be found behind the protection offered by transportation infrastructure.   Analysis of the complicated relationships among various land uses and their effect on the system can be found in the Appendices on Hydrology, Floodplain Isolation, Geomorphology, and Terrestrial and Wetland Biology.

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 2

Hydrology

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1.0 INTRODUCTION

The following Appendix summarizes the hydrologic data and analyses used in support of the Yellowstone River Cumulative Effects Assessment (CEA). Much of the information presented here consists of existing data that have been re-plotted for interpretive purposes, as well as materials retrieved directly from supporting documents. Flow depletion data have also been re-analyzed to estimate the relative influences of Yellowtail Dam operations and irrigation land uses on system hydrology. The overall goal is to provide a general summary of hydrologic trends in the basin that can be used to help interpret results that are developed in other components of the CEA. The summaries in some cases only present a fraction of the data available; however the supporting data sources are all publicly available for further investigation. The primary data sources used include the following:

1. **Yellowstone River Corridor Hydrology Study: Upper Yellowstone River Hydrology (USACE, 2011).** United States Army Corps of Engineers (2011). This report includes hydrologic data developed for historic, unregulated, and regulated flow conditions on the Yellowstone River upstream of Billings Montana. The report includes discharge probabilities, volume probabilities, and flow duration relationships for the upper river.

2. **Streamflow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Yellowstone, Tongue, and Powder Rivers, Montana, 1928-2002 (Chase, 2013)**. This report provides streamflow statistics such as flow frequency and flow duration data calculated for unregulated and regulated streamflow conditions for selected gaging stations on the Tongue and Powder Rivers and for the Yellowstone River downstream from Billings, Montana. Statistics also were also interpolated between gaging stations on a reach scale.

3. **Streamflow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Upper Yellowstone and Bighorn Rivers, Montana and Wyoming, 1928–2002 (Chase, 2014)**. The 2014 report was developed to supplement the USACE (2011) and the Chase (2013) reports by presenting low flow frequency data as well as monthly and annual streamflow characteristics for the Bighorn River and for four streamflow gaging stations upstream from the mouth of the Bighorn River. The low flow frequency data were interpolated at a reach scale.

4. **Yellowstone Corridor Study, Lower Bighorn River Hydrology (USACE, 2011)**: The 2011 Bighorn River Hydrology Report includes hydrologic data developed for regulated and unregulated flow conditions on the lower Bighorn River.

5. **Yellowstone River Hydrograph Trends, Water Rights, and Usage (Watson, 2014)**. Trevor Watson's Master's thesis was completed in June 2014 at the University of Idaho. The thesis includes evaluations of the volume and timing of discharge in the Yellowstone River and its tributaries for long term (1898-2007) and more recent trends (1970-2007). Additionally, Watson (2014) conducted a physical inventory of surface water withdrawals and assessed water management needs based on the hydrologic analysis.

6. **Impacts of Climate Change on August Stream Discharge in the Central-Rocky Mountains (Leppi et al., 2012)**. This paper describes the results of an analysis of mean August discharge at 153 stream throughout the central Rocky Mountains of North America for changes in discharge from 1950-2008.

7. **Indicators of Hydrologic Alterations (The Nature Conservancy, 2009)**. The Index of Hydrologic Alterations (IHA) is a software program designed specifically to evaluate the impacts

of human activities on flow regimes. The software is commonly used to evaluate the impact of dams on river hydrology. This tool was used herein to evaluate Yellowstone River and Bighorn River gage records to allow further consideration of the impacts of Yellowtail Dam on Yellowstone River hydrology.

8. **Estimated Water Use in Montana in 2000 (Cannon and Johnson, 2004).** This Scientific Investigation Report summarizes the quantities of water withdrawn and consumed across the state of Montana in 2000. Withdrawals are summarized for irrigation, public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock.

9. **Tree-Ring Reconstructions Depicting Streamflow and Drought History for the Bighorn Basin, Wyoming (Swindell, 2011).** In his Master's Thesis, Bryan Swindell used tree-ring data to reconstruct streamflow records or six gages in the Bighorn River Basin. The reconstructions are between 500 and 800 years long, and calibration models between the tree-ring data and the available gage record explain up to 60 percent of the variation in gaged streamflow.

1.1 Major Findings in Support of Cumulative Effects Analysis

The primary findings of the hydrologic analysis that may support multiple aspects of the CEA include the following:

1. A comparison of unregulated (undeveloped) and regulated (developed) flows shows the following:

   - The most pronounced shifts in hydrology are downstream of the mouth of the Bighorn River, indicating that Bighorn River flow alterations have exerted a major influence on the hydrology of the lower Yellowstone River.

   - Upstream of the Bighorn River confluence, changes in hydrology are less pronounced yet still potentially important with respect to river process.

   - At both the Billings and Forsyth stream gages, mean monthly flows have increased from October to February and decreased during the months of April through September. From both a magnitude and percent change perspective, the Forsyth gage, which is downstream of the mouth of the Bighorn River, shows a larger response (Section 2.2). At Forsyth, May-June mean monthly flows have dropped approximately 30 percent, which has a strong potential influence on channel form.

   - Peak flows have decreased for the 2-, 10- and 100-year floods, with the observed reduction beginning upstream of Billings and increasing in the downstream direction (Section 2.3).

   - The magnitude of the 2-year flood has dropped by approximately 23 percent downstream of the mouth of the Bighorn River (Section 2.3).

   - For the 1-percent exceedance probability event (100-year discharge), peak discharge has dropped by approximately 20,000 cfs below the mouth of the Bighorn River, a 16-percent reduction in total flow (Section 2.3).

   - Powder River inputs appear to partially mitigate the upstream reductions in annual peak discharge (Section 2.3).

- Flow-duration data show a 25-percent reduction in channel forming flows downstream of the Bighorn River (Section 2.4). The estimated number of days that historic channel forming flows persisted dropped from about 2½ weeks per year under undeveloped conditions, to less than a week for developed conditions.
- Although flow duration data indicate that base flows during the fall and winter have increased up to 60 percent downstream of the Bighorn River confluence, gage records indicate that since 2000, winter releases from Yellowtail Dam have dropped.
- Spring and summer baseflows have been reduced by over 20 percent under regulated conditions (Section 2.4).
- The lowest flows experienced in the summertime (Summer 7Q10) have dropped throughout the system, and the relative reduction of those flows increases in the downstream direction (Section 2.5). These low flows have dropped by approximately 1,000 cfs (30 percent) at Billings and 1,800cfs (40 percent) at Miles City.

2. Previously published literature (Leppi and others, 2012), show reduced late August streamflow associated with climatic trends (Section 3.1). Low-flow analysis from a largely pristine gage at the Yellowstone Lake outlet indicates low August flows are associated with increased air temperature (Section 3.1).

3. The results of an “Indicators of Hydrologic Alteration” assessment (TNC, 2009) indicate the following:

   - Flow management at Yellowtail Dam on the Bighorn River has resulted in a reduction of flood magnitudes on the Yellowstone River below the Bighorn confluence (Section 3.2.1).
   - The impacts of Yellowtail Dam on low flows are substantially less on the Yellowstone relative to the Bighorn River (Section 3.2.1).
   - Yellowtail Dam release patterns have “dampened” the hydrograph on the Yellowstone River by reducing daily rates of discharge rise and fall (Section 3.2.1).
   - Winter flow releases have continuously dropped since the dam was constructed; since 2000, median December flows at St Xavier have been about 1200 cfs lower than those of the 1968-1999 timeframe. This change in winter flow release volumes at the dam is discernable on the Yellowstone River at the Miles City gage.

4. An evaluation of gaging records at Sidney indicate that hydrologic alterations on the Yellowstone River include both a reduction in peak spring runoff magnitudes, and a dampening of the early spring pulse runoff which tends to occur in late March to early April. The majority of this change in the lower river appears to be due to reduced early spring pulse flows from the Powder River.

5. Previously published estimates of water use (USGS, 2004) indicate that irrigation is the dominant water use in the basin, although the water use for cooling as part of thermoelectric power generation is the most substantial in the state of Montana.

6. Mean monthly flow patterns at Billings are consistent with hydrologic influences of irrigation; analysis of depletions below the Bighorn River indicate that during the winter months, over 80

percent of the increase in low flows is estimated to be due to Yellowtail Dam operations, whereas the period of most strongly reduced flows (May to July) shows a much stronger influence of irrigation on streamflow patterns. Based on the estimates, the primary influence on flow reductions in August and September is irrigation.

7. Tree-ring analyses of the basin show that the 20th century was a wet period relative to the several centuries prior, and droughts have historically been substantially longer and more intense than those recently experienced in the basin.

2.0 COMPARISON OF “REGULATED AND “UNREGULATED” CONDITIONS

The methodologies used in the USGS and USACE hydrologic analyses are described in detail in the original reports (USACE 2011; Chase, 2013 and, 2014). The approach basically used depletion data to develop two flow records: (1) no depletions (unregulated), and (2) with modern depletions (regulated). These constructed flow records were then analyzed to develop flow statistics for each condition, to help define the impacts of human development on Yellowstone River hydrology.

The main analysis is a comparison of the hydrology of the river under “unregulated” and “regulated” flow conditions, defined as the following:

- ***Unregulated:*** Flow statistics for a hydrologic record for which the effects of streamflow regulation have been removed; and,

- ***Regulated:*** Flow statistics for a hydrologic record that has been adjusted to represent near-present day (based on 2002) levels of development.

For the purposes of the Cumulative Effects Study, ***Unregulated flows can be considered to represent an undeveloped condition, whereas Regulated flows reflect the modern developed condition***.

This Appendix presents only a portion of the flow statistics developed for the regulated and unregulated hydrology of the Yellowstone River. The statistics used include peak discharges, seasonal flow duration, and low flow conditions. The intent is to provide a synopsis of the primary results of the analyses, and to help establish a series of hydrologic reference points for use by other disciplines in the evaluation of human impacts in the Yellowstone River corridor. The approach used is to directly compare the unregulated and regulated flow statistics to determine the influence of human activities on river hydrology. For this effort, the influences are not specifically identified; it is impossible, for example, to accurately quantify impacts of irrigation versus municipal and/or industrial water use.

These regulated/unregulated flow statistics were used by the Corps of Engineers in subsequent hydraulic modeling efforts to evaluate the influence of hydrologic change on floodplain access in the river corridor. That analysis is described in Appendix 3: Floodplain Connectivity (Hydraulic Assessment).

2.1 Unregulated/Regulated Flow Statistic Interpolation

The regulated/unregulated datasets were developed for gaging stations and then interpolated to a reach scale using drainage areas as the interpolation factor (USACE, 2011; Chase, 2013 and 2014). Because of abrupt changes in drainage area at major confluences, some of the interpolated trends show abrupt shifts in parameters at those confluences. These shifts may reflect more of a drainage area influence than actual hydrologic change; shifts at confluences should thus be considered approximate where interpolated.

The interpolation issue is described by Chase (2014):

> To be consistent with Chase (2013), streamflow statistics for ungaged reaches were linearly interpolated on the basis of approximate drainage area at the downstream end of each ungaged reach relative to the drainage areas of the bracketing streamflow-gaging stations. In many cases, such as downstream from a relatively large tributary, changes in streamflow statistics between different locations on a river channel do not vary linearly with proportional changes in drainage area. Therefore, the interpolated statistics for reaches A18 and B1, [Clarks Fork Yellowstone

River confluence to streamflow-gaging station 06214500 (Yellowstone River at Billings, Mont.)] and C1 through C9 [Bighorn River confluence to streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.)], might not be as representative of actual conditions as for the rest of the reaches.

Because of the limitations of interpolation, it is critical to note that the data presented are most accurate at gage stations, and that intermediated interpolated values should be considered approximate.

2.2 Mean Monthly Flows: Unregulated and Regulation Conditions

As the depletion data used to develop the unregulated condition dataset are monthly averages, comparison of the mean annual hydrographs for each condition can only be done on a monthly basis. The data do not support analysis on a daily basis. To show the overall temporal changes in mean monthly flows, results from the streamflow gage stations at Billings and Forsyth were summarized (Figure 2-1 through Figure 2-4). At both gages the coarse shape of the hydrograph is maintained under developed (regulated conditions), however at both gages, the mean monthly flows have decreased during the months of April through September, and increased from October to February. From both a magnitude and percent change perspective, the Forsyth gage, which is downstream of the mouth of the Bighorn River shows a larger response (Figure 2-3 and Figure 2-4). Mean monthly flows during spring runoff have dropped by about 30 percent at Forsyth, indicating a substantial change in river condition due to human activities below the mouth of the Bighorn River.

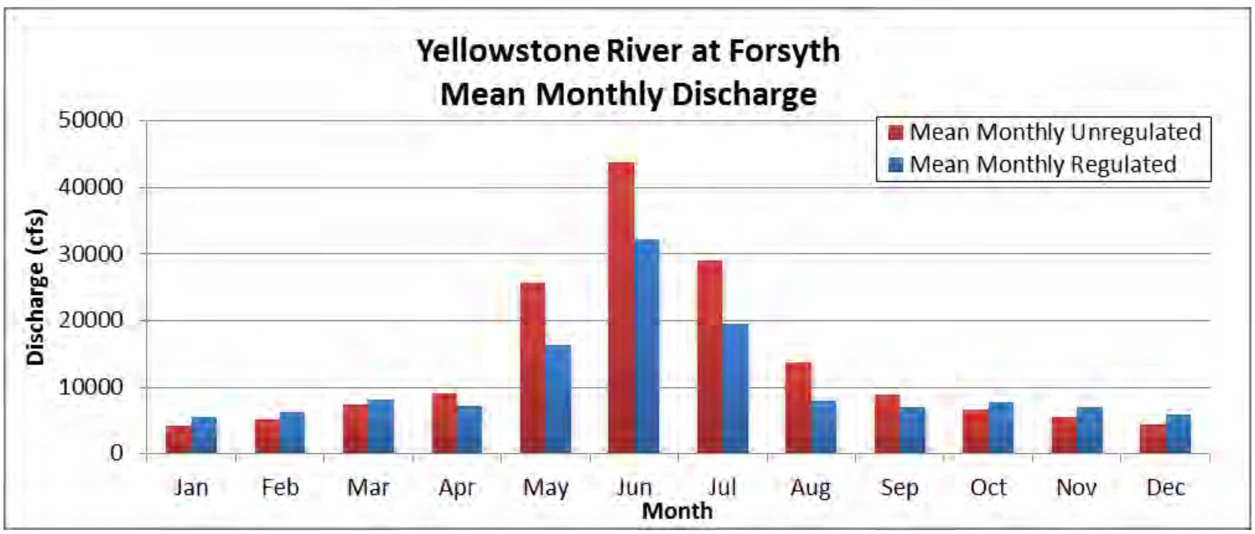

Figure 2-1 Mean monthly flows under Unregulated and Regulated Conditions, Yellowstone River at Billings (USGS 06214500).

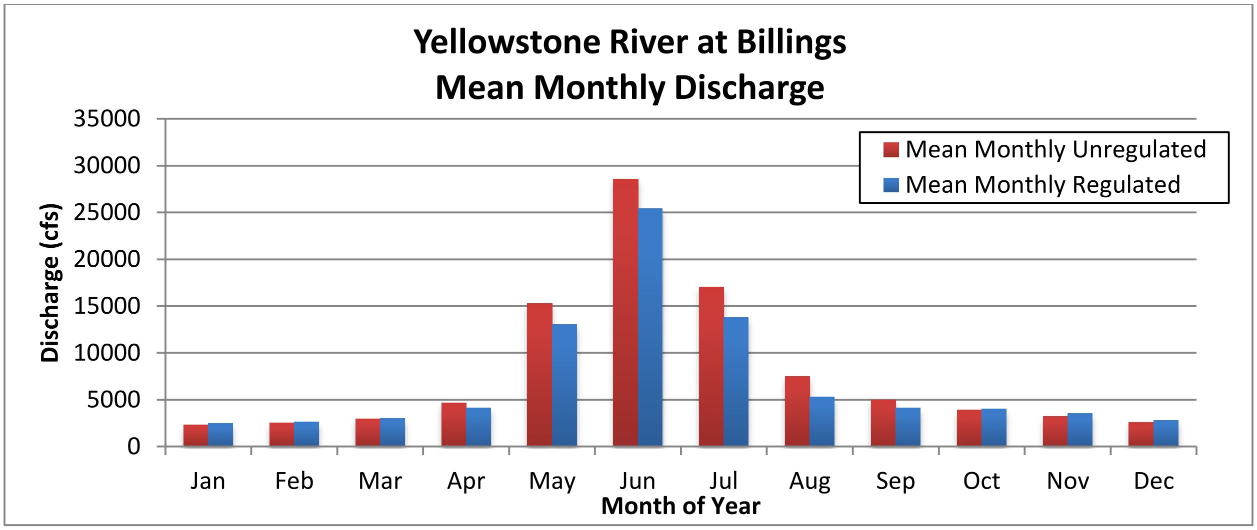

Figure 2-2 Mean monthly flows under Unregulated and Regulated Conditions, Yellowstone River at Forsyth (USGS 06295000).

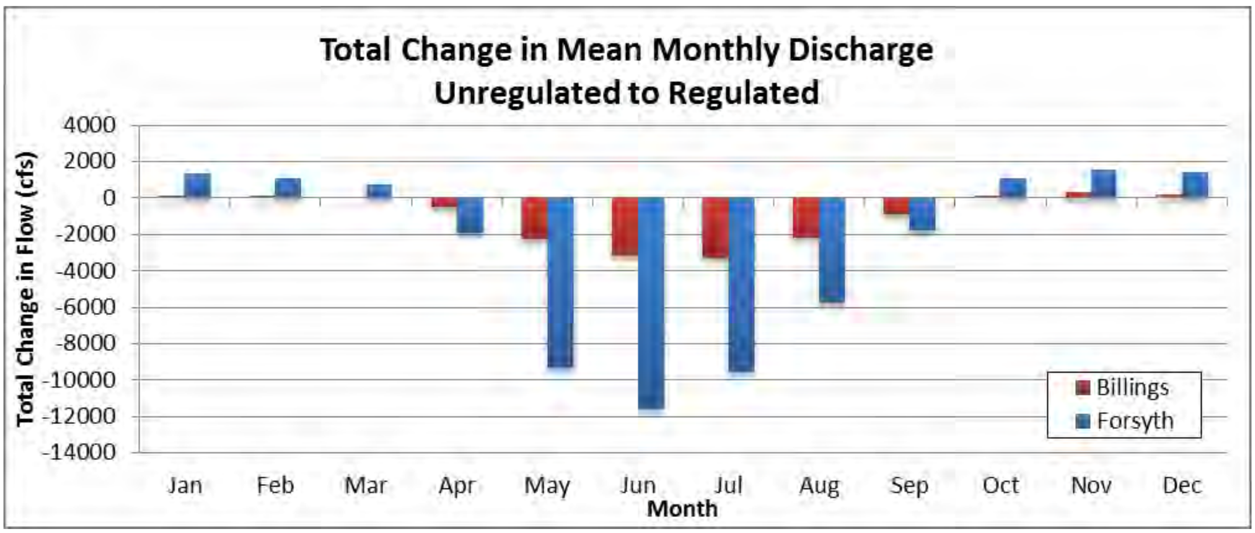

Figure 2-3 Total change in mean monthly discharge from Unregulated to Regulated Conditions, Billings and Forsyth.

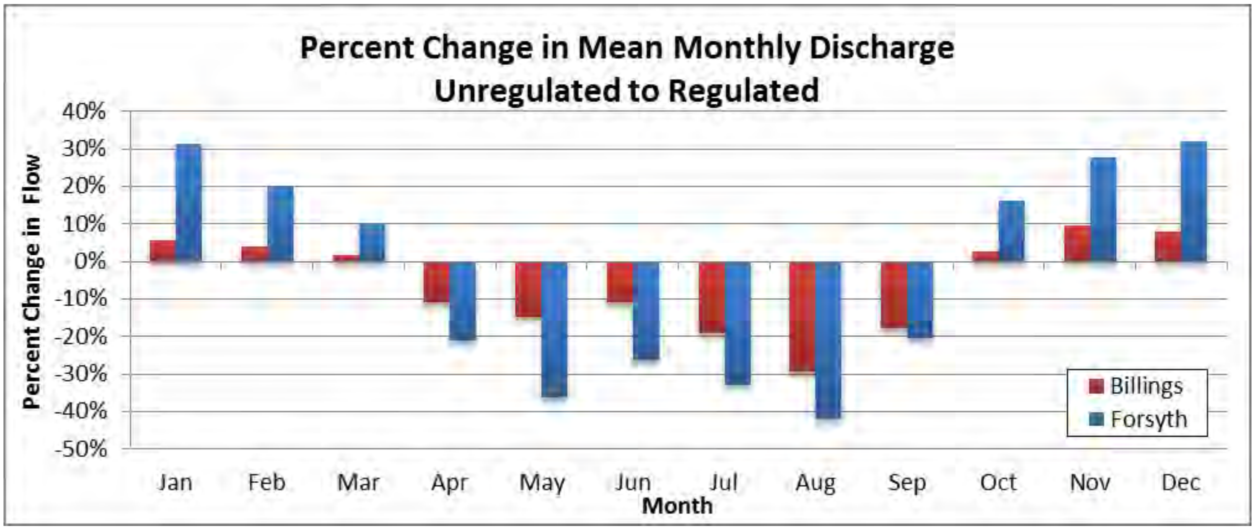

Figure 2-4 Percent change in mean monthly discharge from Unregulated to Regulated conditions, Billings and Forsyth.

2.3 Peak Flows: Unregulated and Regulation Conditions

The hydrologic data developed for flood frequencies under regulated and unregulated conditions were compared to quantify the change in those discharges with human influences and to display those results spatially. The flood frequencies evaluated include the 1, 10, 20, and 50 percent annual probability discharges. These events are commonly referred to as the 100-, 10-, 5- and 2-year floods, respectively.

Figure 2-5 through Figure 2-8 show the regulated and unregulated discharges plotted by River Mile for the 50-, 20-, 10- and 1-percent exceedance probability flood events. The results show that for the 50-percent exceedance probability (commonly referred to as the 2-year flood) begin to show divergence around the mouth of the Clarks Fork River (Figure 2-5). The divergence increases gradually to the mouth of the Bighorn River, where there is another abrupt change in the flood magnitudes. The 20- and 10-percent exceedance probability event (5- and 10-year flood) shows a similar pattern (Figure 2-7). For the 1-percent exceedance probability event (100-year flood), the change is most pronounced between the mouth of the Bighorn River and Glendive.

The percent change in flood magnitudes under regulated and unregulated conditions is shown in Figure 2-9. For each of the flood events, the shift from unregulated to regulated condition results in a ***reduced*** flood magnitude and the impact increases in the downstream direction. The relative impact increases for the more frequent flows (e.g., 2- and 5-year). The most significant reduction in flood discharges occurs downstream of the mouth of the Bighorn River, although a notable change also occurs between the Livingston and Billings gages.

Below the Powder River confluence, the difference between unregulated and regulated flow statistics is less than that of the reach just upstream. This suggests that for the regulated flow condition, the net effect of regulation decreases as the distance downstream from the Bighorn increases, and that Powder River inputs contribute to that trend.

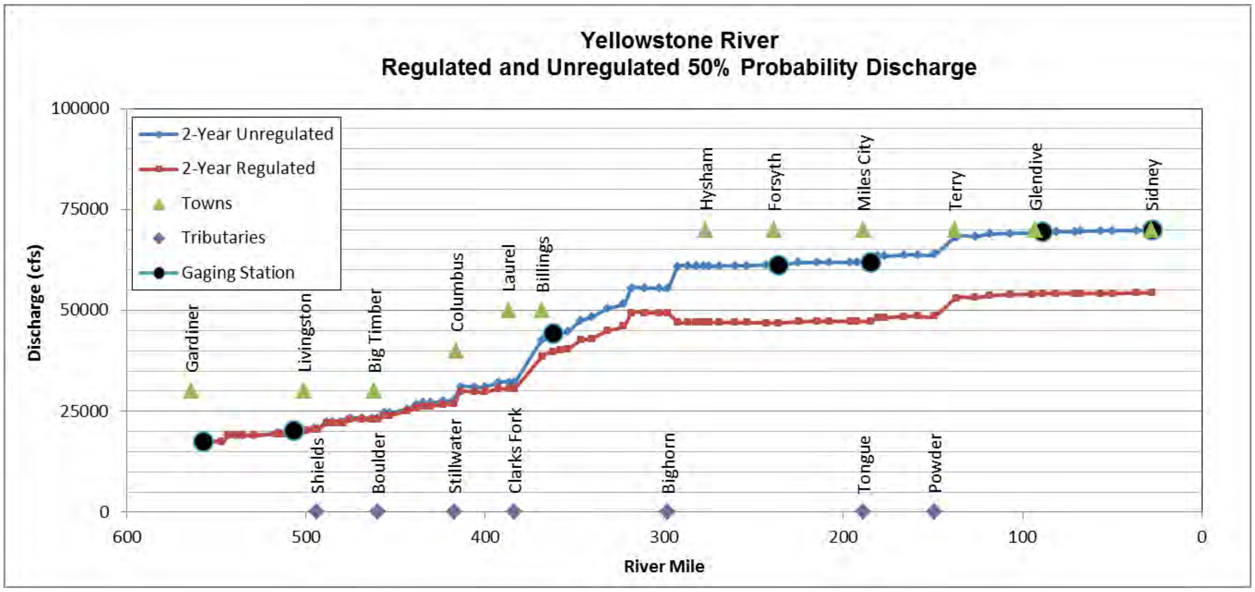

Figure 2-5 **Unregulated and Regulated 50-percent exceedance probability discharge plotted by River Mile. Note that values between gaging stations were interpolated on the basis of drainage area and might not be as representative of flow conditions as the values calculated at the gaging stations, especially for locations downstream from larger tributaries such as the Clarks Fork, Bighorn, Tongue, and Powder. See Chase (2013 and 2014) for more information.**

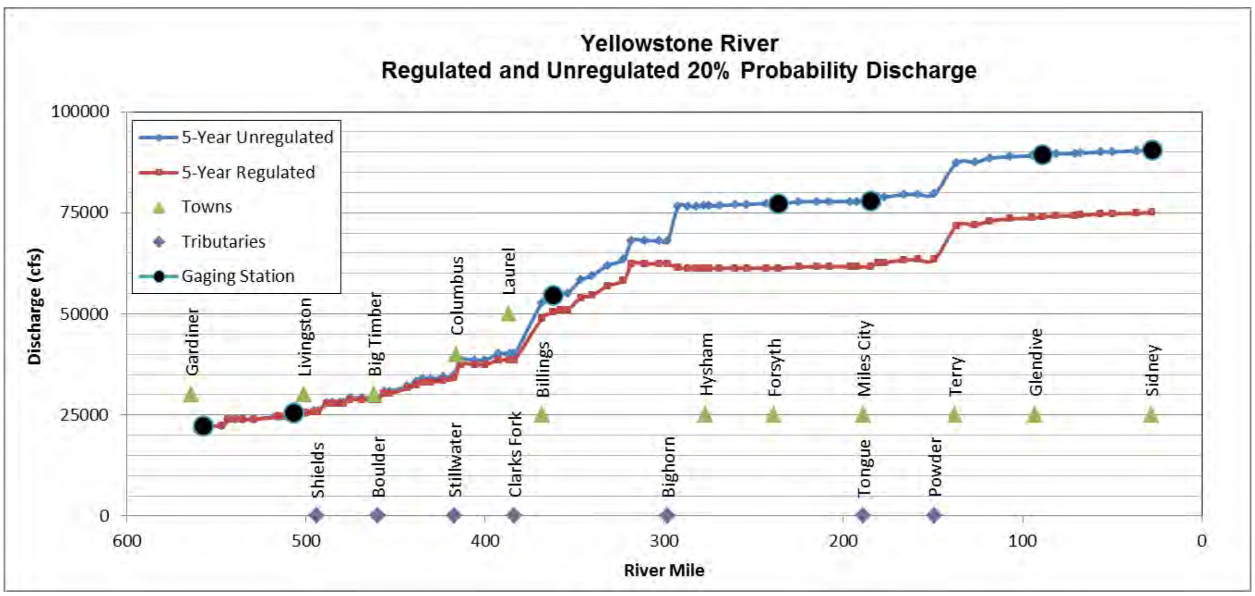

Figure 2-6 **Unregulated and Regulated 20-percent exceedance probability discharge plotted by River Mile.**

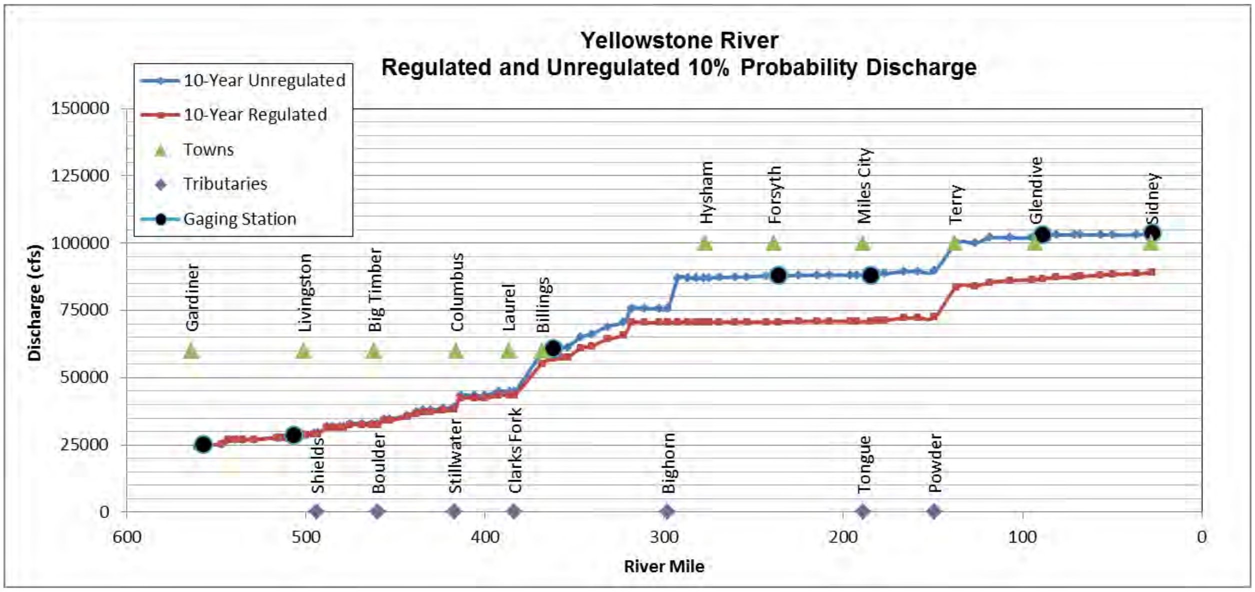

Figure 2-7 **Unregulated and Regulated 10-percent exceedance probability discharge plotted by River Mile.**

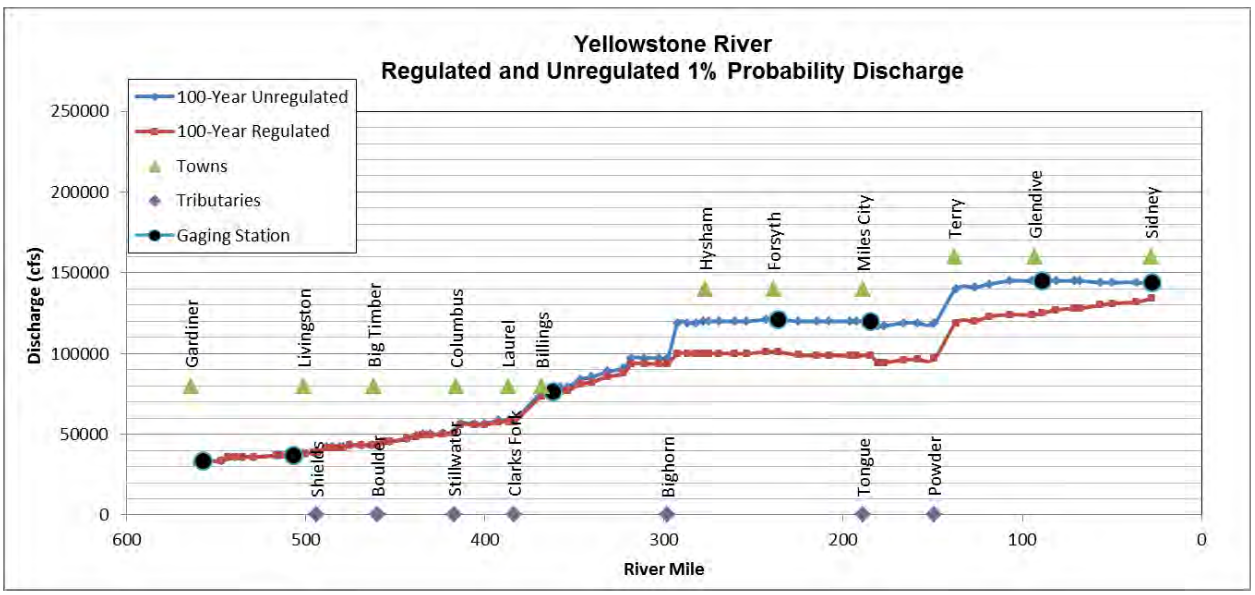

Figure 2-8 **Unregulated and Regulated 1-percent exceedance probability discharge plotted by River Mile.**

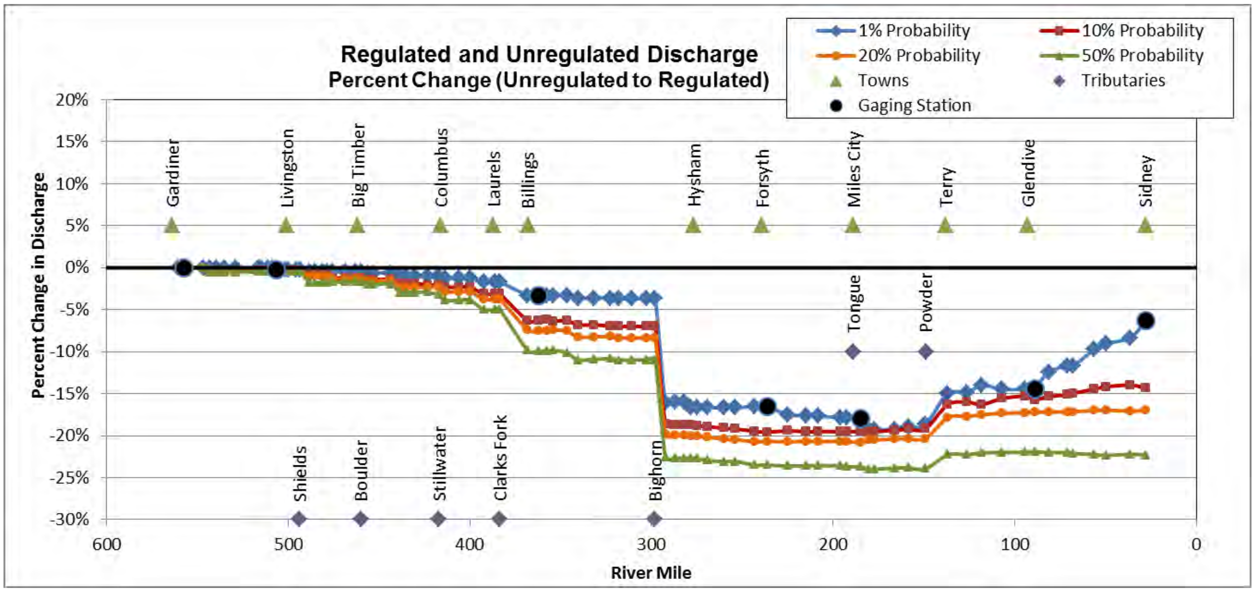

Figure 2-9 **Percent change in 1, 10, 20, and 50 percent annual exceedance probability discharge, regulated and unregulated conditions.**

Figure 2-10 through Figure 2-13 show the changes in flow magnitudes for each CEA study reach for the 50-, 20-, 10- and 1-percent exceedance probability events respectively. The plots both show the primary impact of the Clarks Fork and Bighorn River on flow alterations in the stream corridor. At the 2- and 5-year floods (50- and 20-percent exceedance), flows have been reduced by about 6,000 cfs between the mouths of the Clarks Fork and Bighorn Rivers, and by about 16,000 cfs between the mouths of the Bighorn and Tongue Rivers. Flows drop by almost 20,000 cfs below the mouth of the Bighorn River for the 100-year flood (1-percent exceedance). During larger flood events, the deviations in flow between developed and undeveloped conditions become smaller below the mouth of the Powder River (Region D).

The reductions in flow for the 2-, 5- and 10-year floods below the mouth of the Clarks Fork River, is on the order of 4,000 to 6,000 cfs, which is a 7 to 10 percent drop. That is a notable change since the Clarks Fork does not have any single major feature such as a flood control reservoir to drive such a reduction. Therefore, the flow reductions at the mouth of the Clarks Fork represent multiple spatial influences such as small storage structures such as stock ponds as well as net loss due to irrigation.

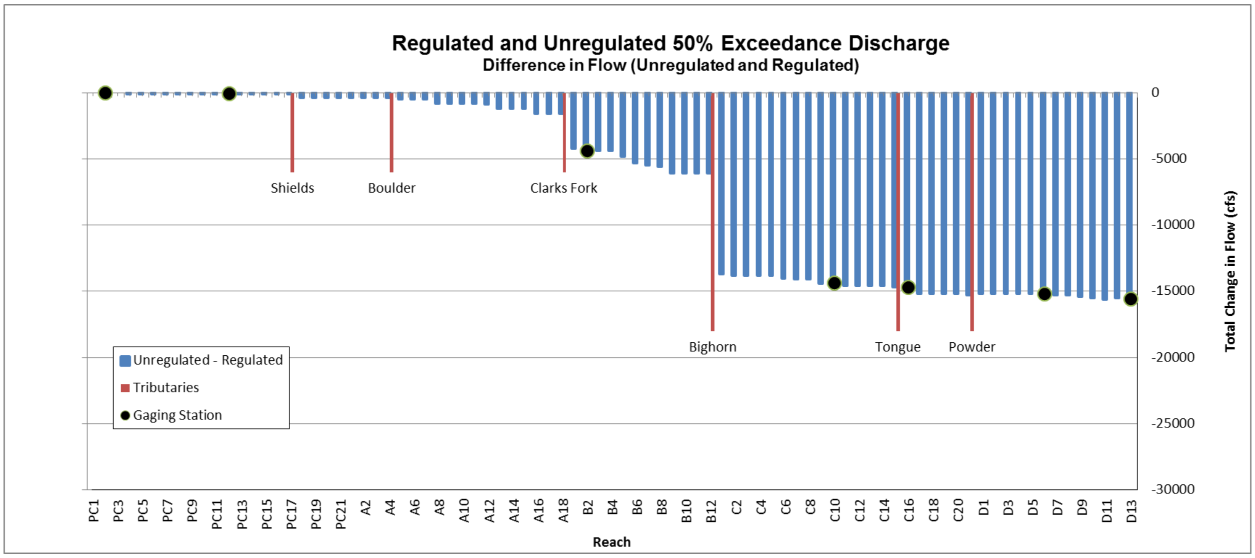

Figure 2-10 **Change in flow volume for the 50-percent exceedance flow plotted by reach (reach values interpolated by drainage area).**

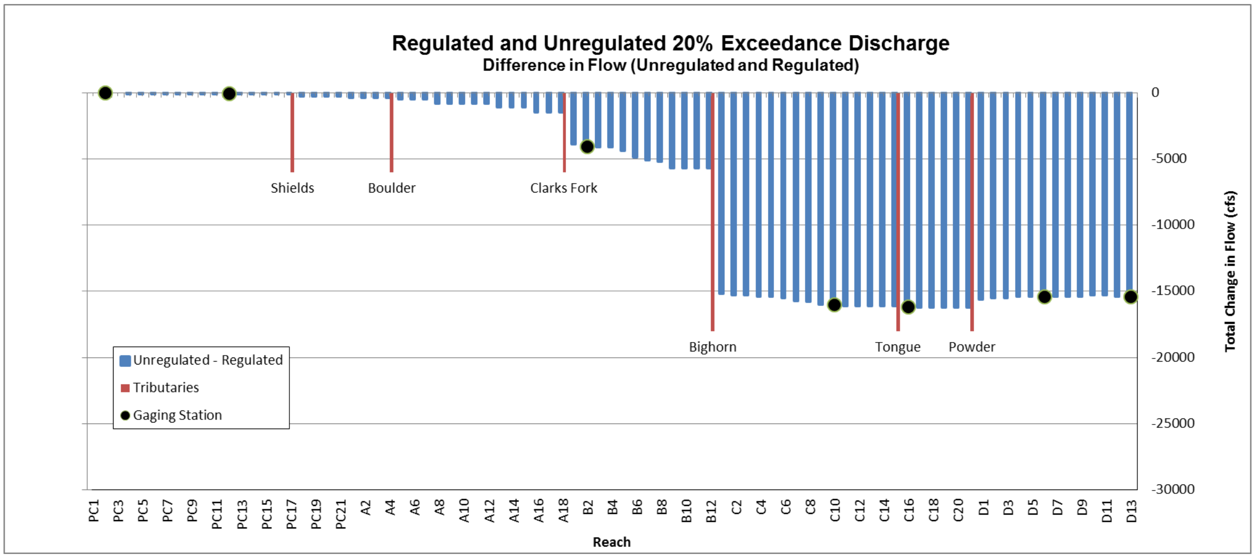

Figure 2-11 **Change in flow volume for the 20-percent exceedance flow plotted by reach (reach values interpolated by drainage area).**

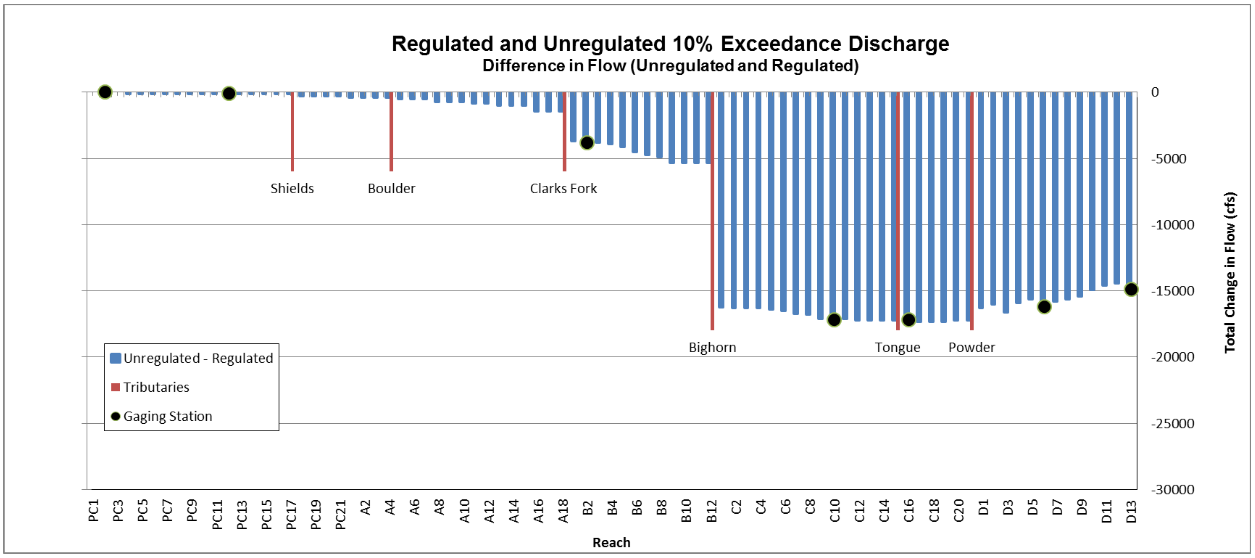

Figure 2-12 **Change in flow volume for the 10-percent exceedance flow plotted by reach (reach values interpolated by drainage area).**

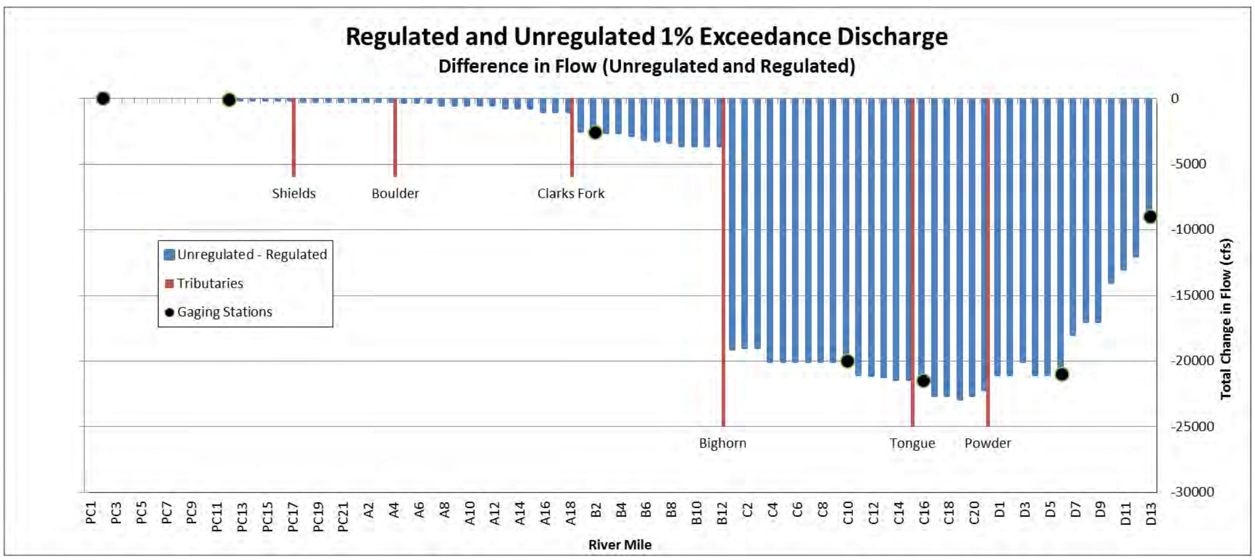

Figure 2-13 **Change in flow volume for the 1-percent exceedance flow plotted by reach (reach values interpolated by drainage area).**

2.4 Flow Duration: Unregulated and Regulated Conditions

The flow-duration computations provided by the USGS (2013 and 2014) and USACE for regulated and unregulated conditions have been summarized here to depict spatial trends in the data. The two flow duration conditions evaluated include the 95-percent duration, or the flow that is equaled or exceeded 95 percent of the time, and the 5-percent flow duration. The 95-percent duration flows were extracted to represent low flow conditions. The 5-percent duration flow is equaled or exceeded approximately 2½ weeks per year (18 days). For the Northern Rocky Mountain Region, the 3-percent duration flow has been shown to approximate the “channel-forming discharge”, or that flow that is largely responsible for developing and maintaining overall channel capacity and form (Andrews and Nankervis, 1995). For this effort, there were no data available for the 3-percent flow duration, so the 5-percent data were utilized to demonstrate potential impacts of human influences on the approximate channel-forming flow.

The flow-duration statistics are available for gaging station locations above Forsyth, and have been interpolated to a reach scale downstream of Forsyth. ***The data have not been interpolated above Forsyth, so influences of major confluences such as the Bighorn River on flow duration are not explicitly described by the dataset.***

2.4.1 Annual Flow Duration: Unregulated and Regulation Conditions

The annual flow duration data show that the divergence between the regulated and unregulated flow conditions increases in the downstream direction, with some divergence perceptible at Billings, and major divergence downstream of the Bighorn River confluence (Figure 2-14 through Figure 2-16). The 95-percent duration discharges (low flows) have increased by approximately 500 cfs or 30 percent below the Bighorn River (Figure 2-14). In contrast, the higher 5-percent duration flows (channel forming flows) have decreased by approximately 10,000 cfs or 25 percent below the Bighorn River (Figure 2-15). This further indicates that Bighorn River flow alterations have influenced the hydrology of the Yellowstone River by reducing high flows and increasing low flows downstream of the confluence at ~RM 300.

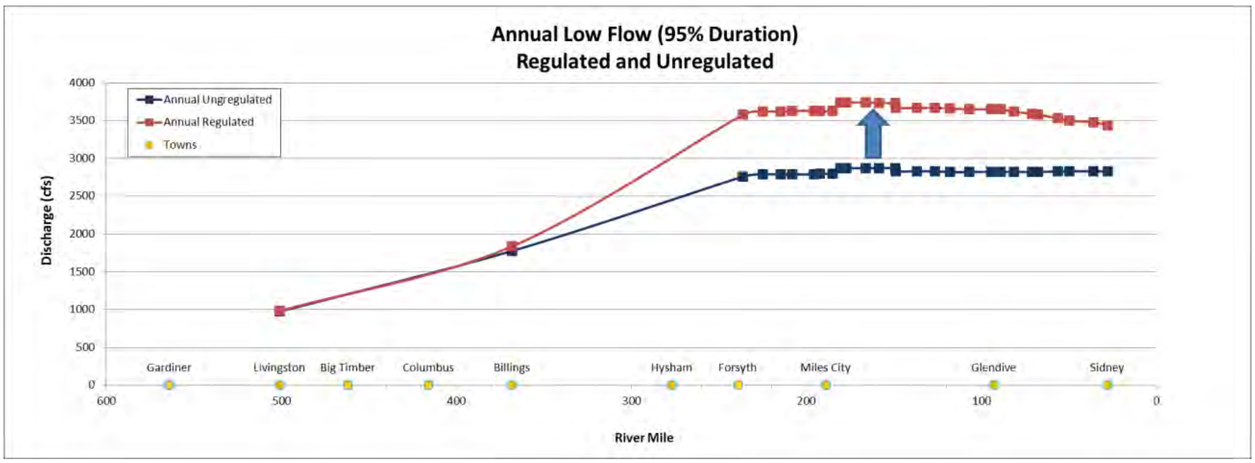

Figure 2-14 Total change in annual 95-percent duration flows for regulated and unregulated conditions.

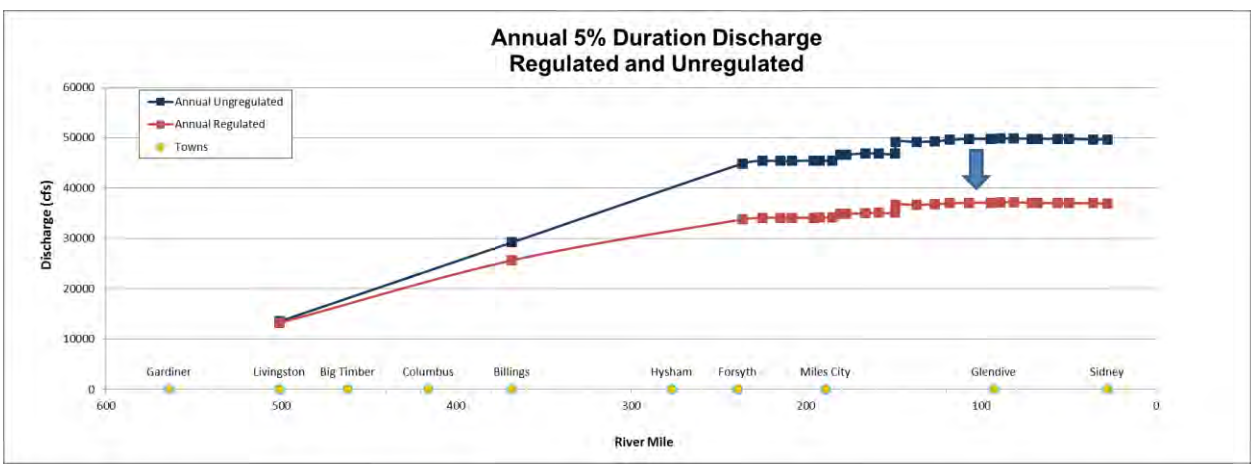

Figure 2-15 Total change in annual 5-percent duration flows for regulated and unregulated conditions.

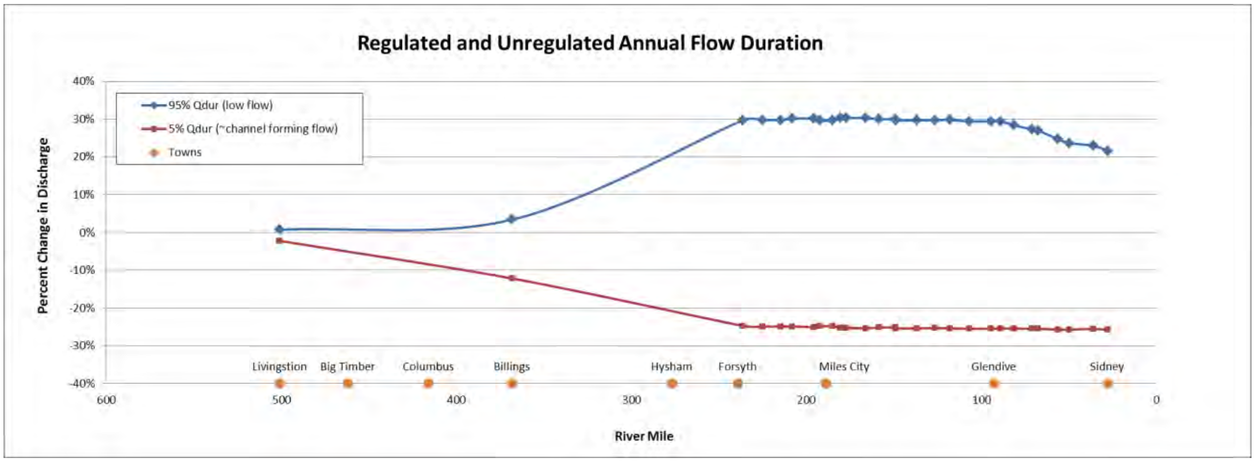

Figure 2-16 **Percent change in flows equaled or exceeded 5 and 95 percent of the time on an annual basis**

2.4.2 Channel Forming Discharge

The annual 5-percent duration flow, which represents that flow that is equaled or exceeded on the order of 18 days per year, typically represents spring runoff in snowmelt-driven systems. In many cases this flow statistic can be coarsely approximated as the "channel-forming discharge", which is that flow that is largely responsible for overall channel form. Figure 2-17 shows a comparison of the number of days that the unregulated 5-percent duration flow is exceeded under both regulated and unregulated conditions. Whereas under unregulated, undeveloped conditions the flow was equaled or exceeded 18.25 days per year by definition, that same flow has a much shorter duration under regulated conditions. Downstream of the Bighorn Confluence, the historic flow condition that lasted for 18 days per year now persists for less than a week, as demonstrated at Forsyth, the Powder River confluence, and Sidney (Figure 2-17). This indicates that the channel forming discharge downstream of the Bighorn River confluence is substantially less under regulated conditions. Such a reduction in channel forming flow will result in a response in channel morphology, including reduced floodplain connectivity and reduction in bankfull channel area.

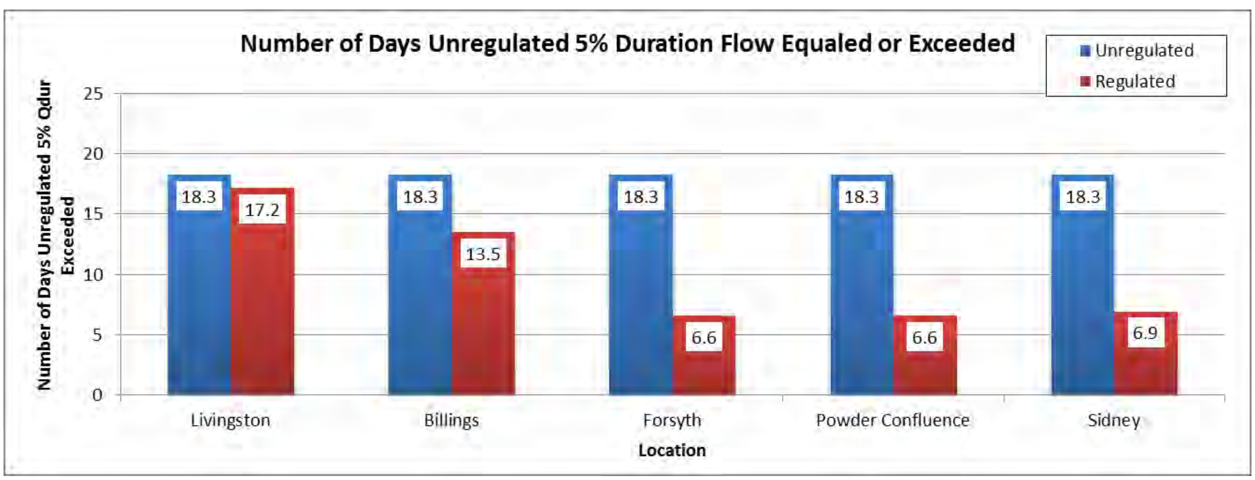

Figure 2-17 **Number of days the unregulated 5-percent duration flow is equaled or exceeded at selected sites under unregulated and regulated flow scenarios.**

2.4.3 Seasonal Flow Duration: Unregulated and Regulation Conditions

The annual flow-duration data (Section 2.4.1) show that, in general, the conversion from unregulated (undeveloped) to regulated (developed) flow conditions on the Yellowstone River includes a decrease in high flows and increase in low flows downstream of the mouth of the Bighorn River. These shifts are on an annual basis. The USGS work (Chase, 2013 and 2014) also compiled data on a seasonal basis. To estimate the impacts of human development on seasonal flows, the flow duration data were compiled to describe seasonal low flows (95-percent duration discharge) and seasonal moderately high flows (5-percent duration discharge).

2.4.3.1 *Low-flow Conditions: Seasonal 95-percent Flow Duration*

Summary plots showing the differences in seasonal low flow between unregulated and regulated conditions are shown in Figure 2-18 through Figure 2-24. The results indicate that spring (April-June) and summer (July-September) low flows have dropped under regulated conditions, especially below the Bighorn River confluence. The most significant impact has been to summer flows when unregulated discharges have been reduced by almost 60 percent below the mouth of the Powder River. Fall (October-December) and winter (January to March) low flows have increased, and these increases during periods of typically low flow have resulted in an overall increase in annual low flow duration (Figure 2-22). There is evidence, however, that over the past decade or so, flow operations at Yellowtail Dam have included a decrease in winter flow releases (see Section 3.2.1).

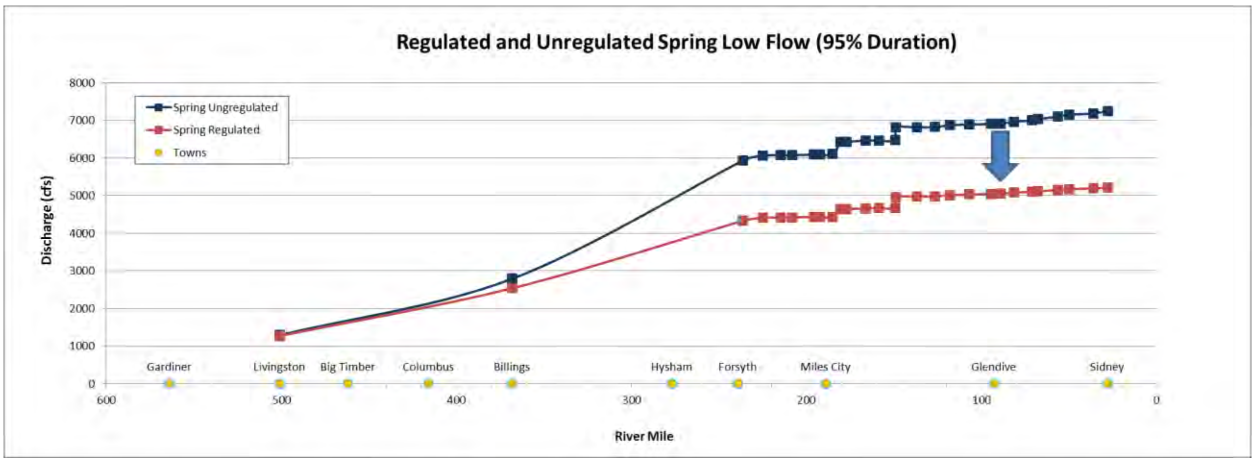

Figure 2-18 Regulated and unregulated spring (April-June) low flow discharges.

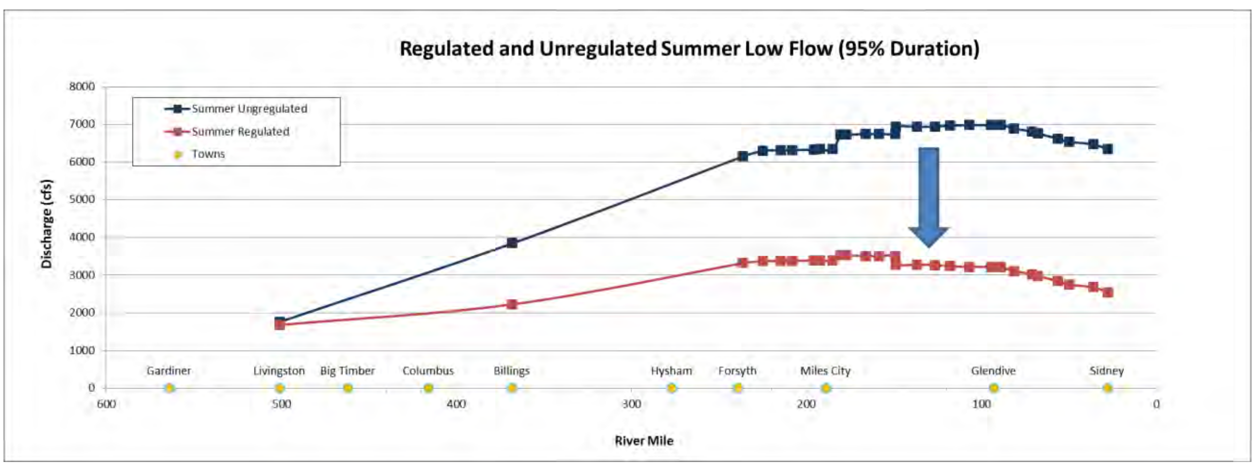

Figure 2-19 Regulated and unregulated summer (July-September) low flow discharges.

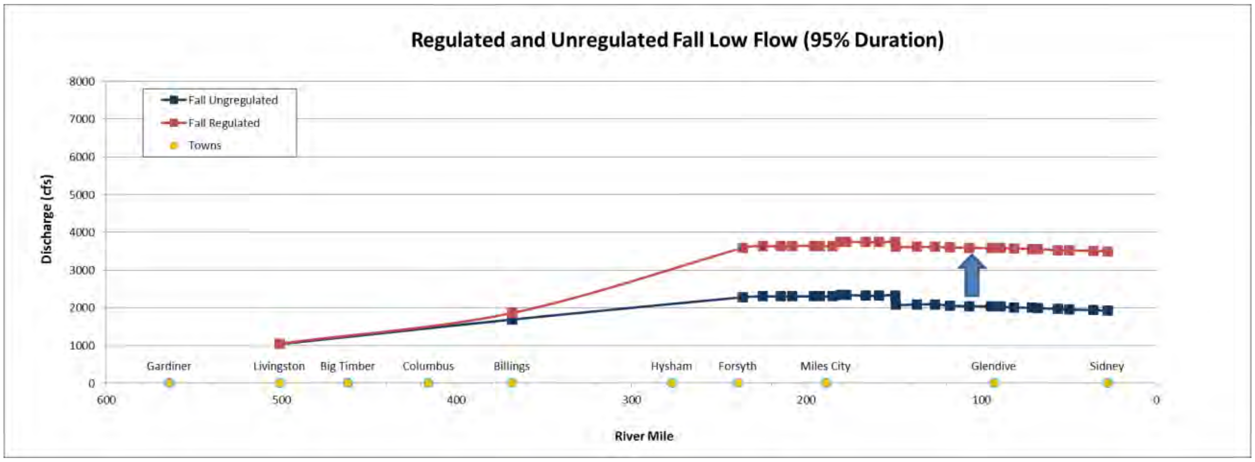

Figure 2-20 **Regulated and unregulated fall (October-December) low flow discharges.**

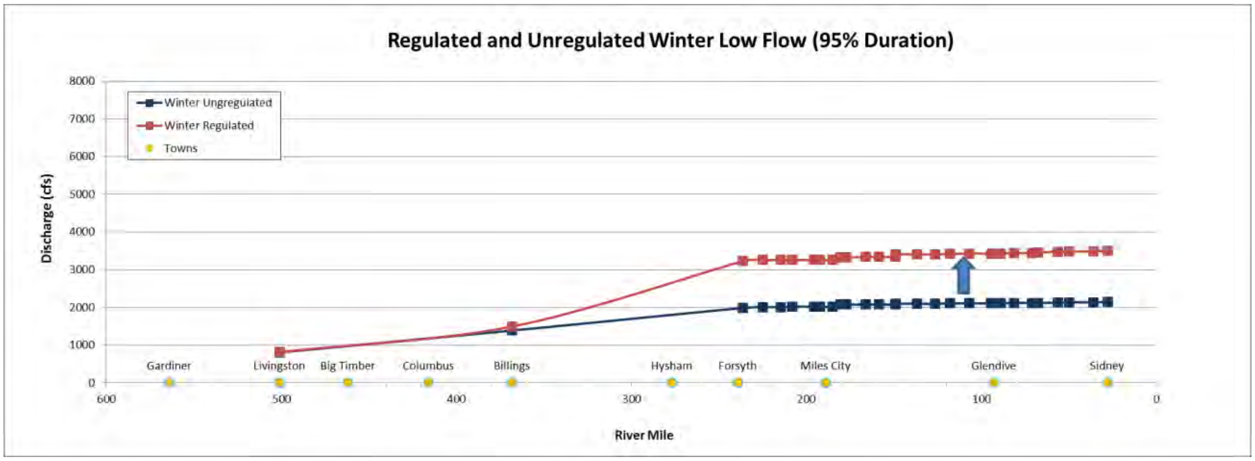

Figure 2-21 **Regulated and unregulated winter (January-March) low flow discharges.**

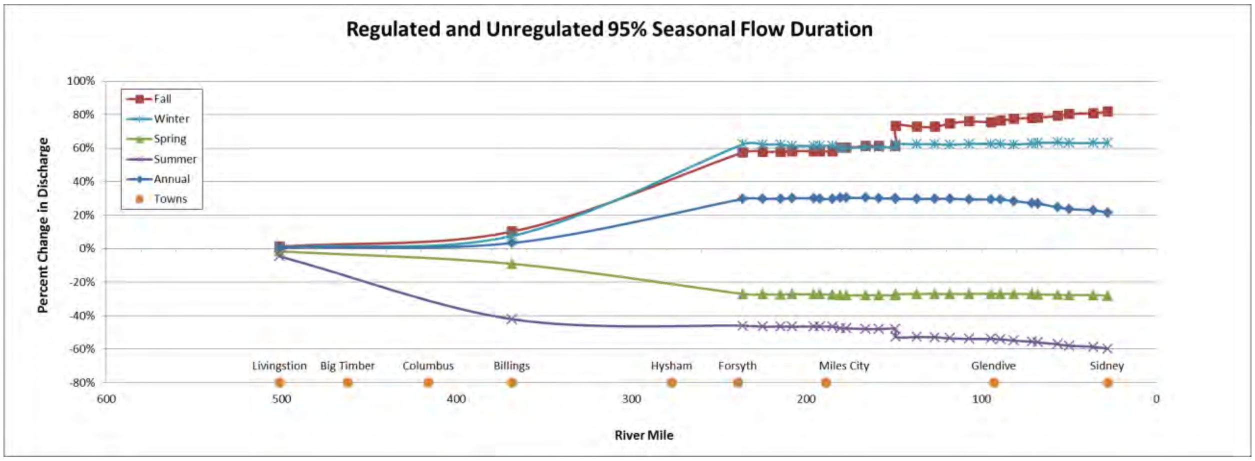

Figure 2-22 **Percent change from seasonal unregulated to regulated low flows.**

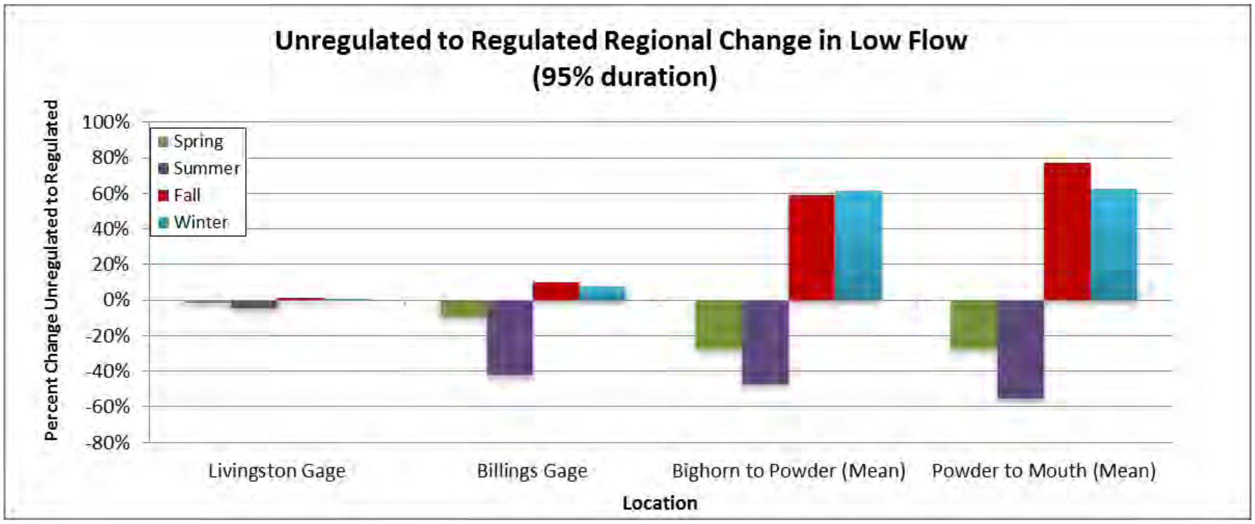

Figure 2-23 **Bar chart showing percent change in seasonal low flows from unregulated to regulated flow conditions by region.**

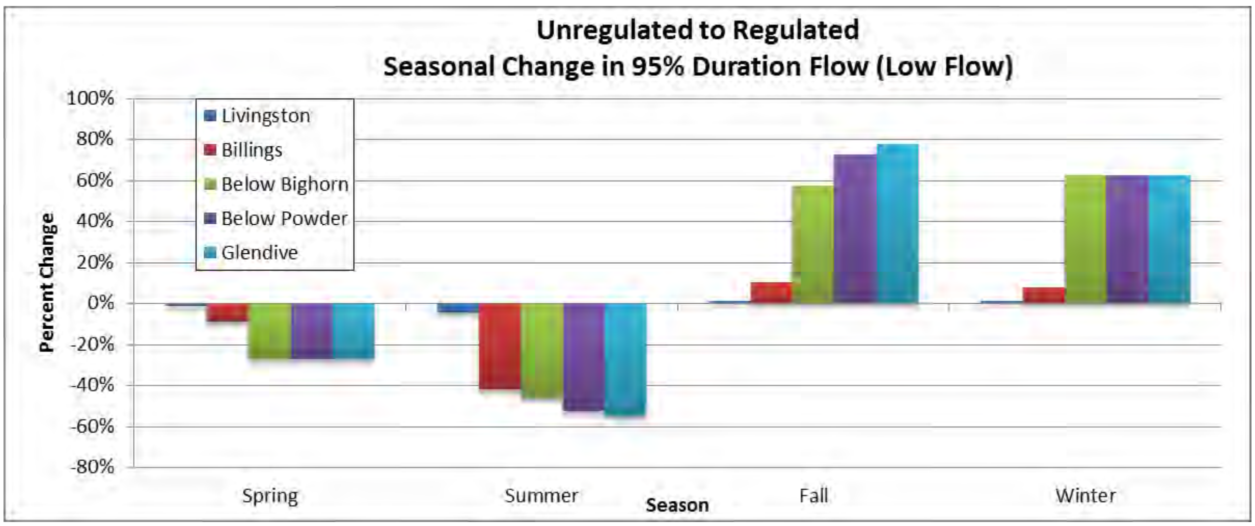

Figure 2-24 **Seasonal shifts in 95-percent duration discharges for selected locations on Yellowstone River.**

2.4.3.2 *Seasonal 5-percent Flow Duration*

Summary plots showing the seasonal differences in the 5-percent duration discharge between unregulated and regulated conditions are shown in Figure 2-25 through Figure 2-29. The seasonal 5-percent duration flow is that discharge which is equaled or exceeded approximately five days per three month season, and thus reflects seasonal high flows. The results indicate that seasonal shifts in the 5-percent seasonal flow duration include a substantial reduction in spring and summer flows and a minor increase in fall and winter flows. Spring and summer flows have dropped more than 10,000 cfs downstream of the Bighorn River confluence, which is about 20 percent of the total unregulated 5-percent duration flow.

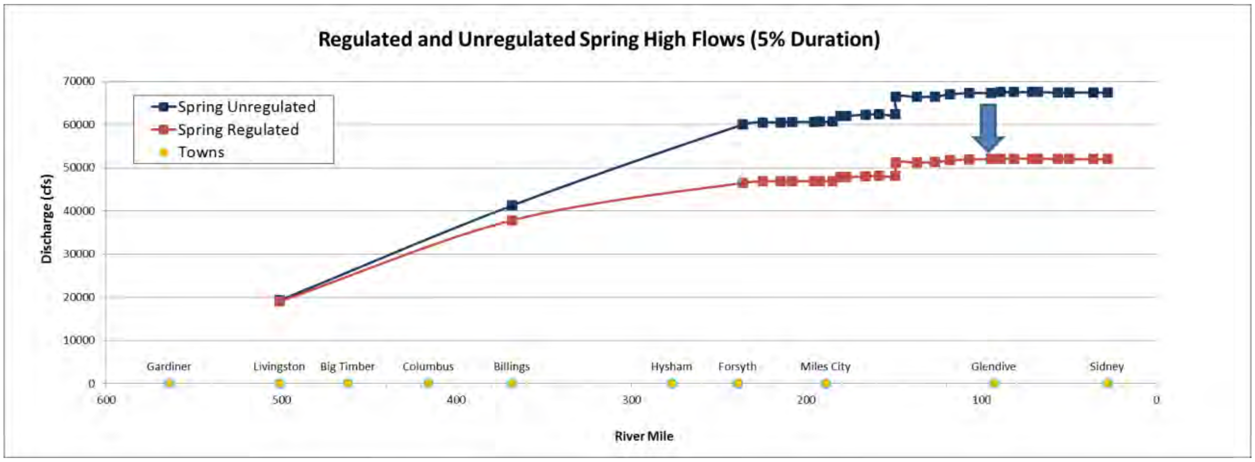

Figure 2-25 **Regulated and unregulated spring 5-percent duration flows.**

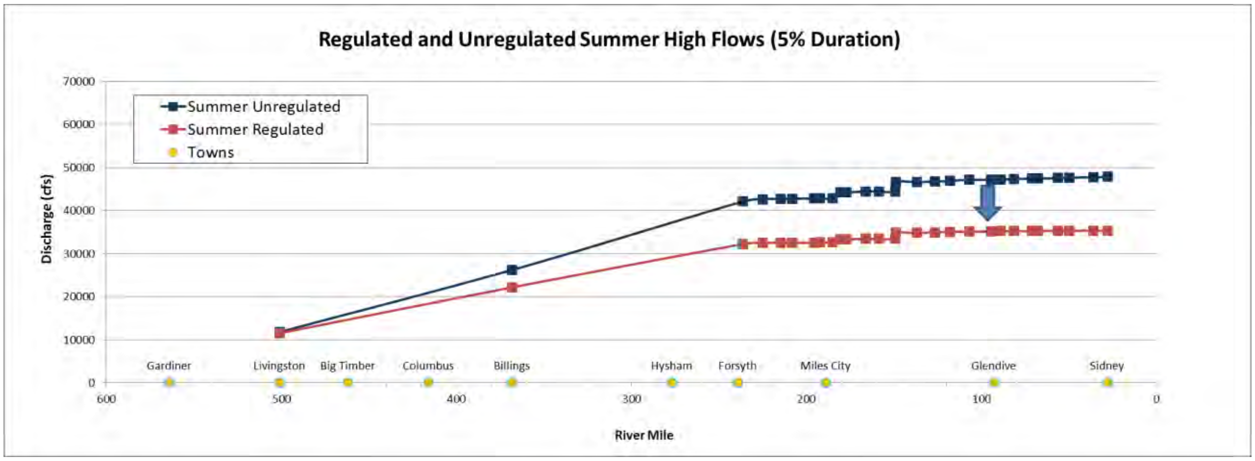

Figure 2-26 **Regulated and unregulated summer 5% duration flows**

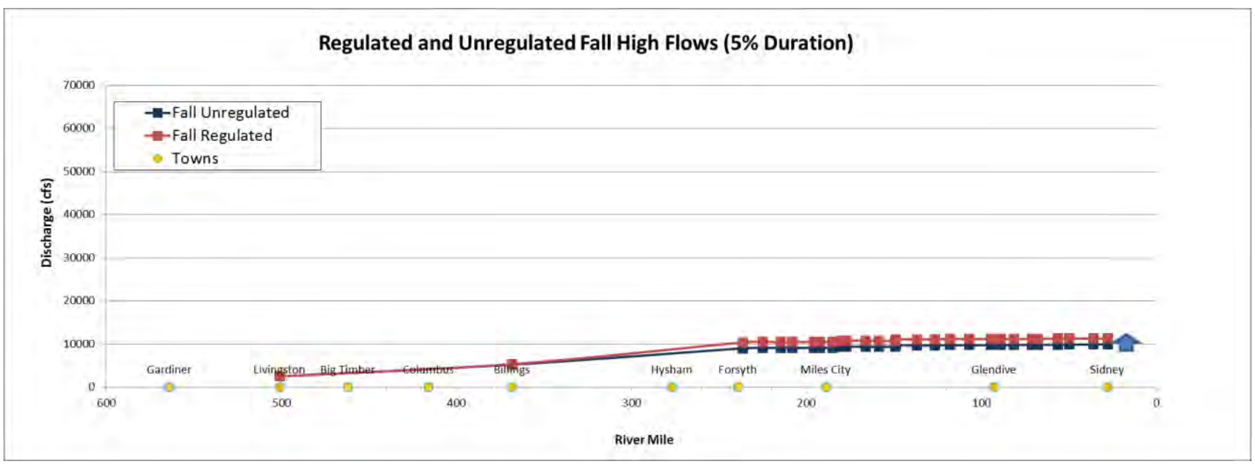

Figure 2-27 **Regulated and unregulated fall 5-percent duration flows**

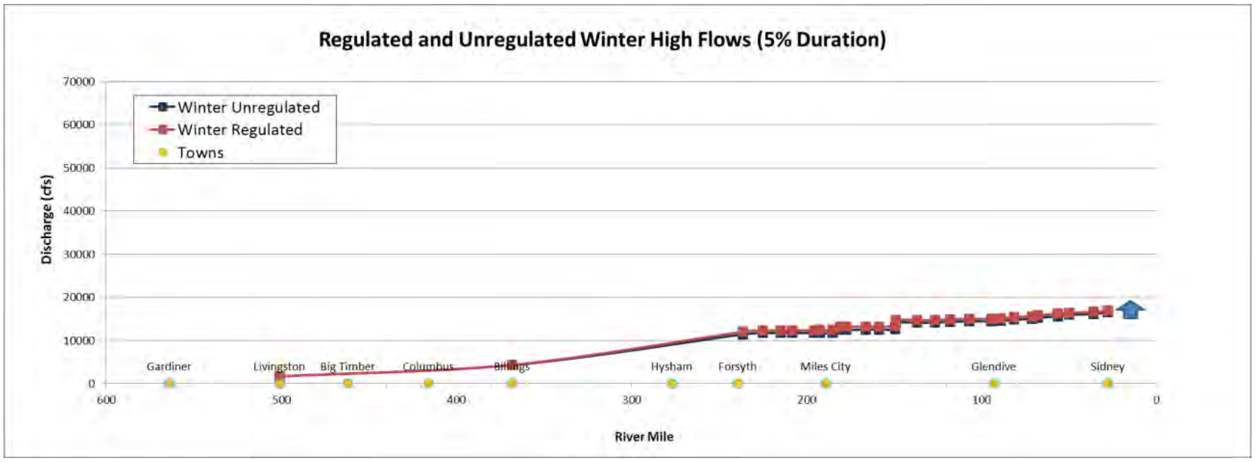

Figure 2-28 Regulated and unregulated winter 5-percent duration flows.

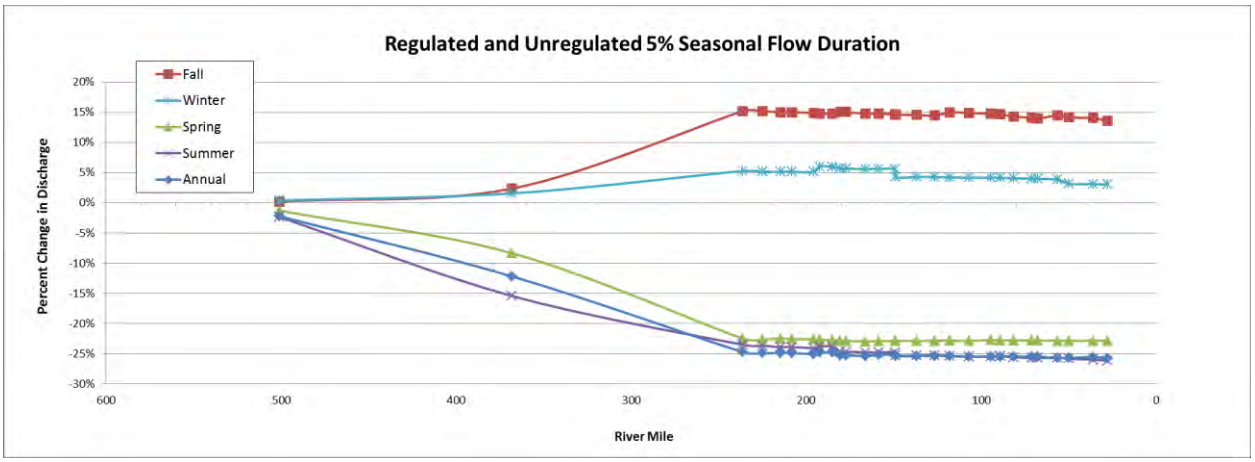

Figure 2-29 Percent change from seasonal unregulated to regulated 5-percent duration flows.

2.5 Low Flows: 7Q10

Low-flow statistics for regulated and unregulated conditions were developed by the USGS for all reaches between Gardiner and Sidney (Chase, 2013 and 2014). These data were selectively summarized to display the results for annual and seasonal 7Q10, which is the lowest 7-day average flow that has a 10-percent chance of occurring in any given year. In 1986, the EPA recommended the use of this statistic for water quality standards and toxic waste-load allocation studies related to chronic effects on aquatic life (www.water.epa.gov).

When viewed on an ***annual*** basis, a comparison of the regulated and unregulated flow conditions indicates that the annual 7Q10 values have increased downstream of the Clarks Fork river, with a marked increase downstream of the Bighorn River confluence. Below the confluence, the 7Q10 has more than doubled under regulated conditions (Figure 2-30).

Although the annual data show an increase in this value, the ***seasonal*** data indicate that whereas the 7Q10 for both fall and winter have increased, the values have substantially decreased during both spring and summer. Below the Bighorn River confluence near Forsyth, the 7Q10 has dropped from approximately 4,700 to 3,000 cfs in the summer, which is a drop of over 30 percent (Figure 2-31 and Figure 2-32). The drop in summer 7Q10 begins much further upstream, indicating that that water uses not associated with Yellowtail Dam operations affect the lowest flow condition. At the Billings gage, for example, the 7Q10 has dropped by approximately 1,000 cfs, or 30 percent. This hydrologic change may significantly affect water quality and fisheries habitat conditions on the river during periods of low flow.

Figure 2-30 and Figure 2-31 show that 7Q10 values drop in the downstream direction below Miles City, and this trend is evident under both unregulated and regulated conditions. This indicates that under extreme low-flow conditions, natural losses exceed inputs in the lower river. From Miles City to Sidney, a distance of 161 miles, the average loss of summertime 7Q10 flows in the downstream direction is about 7cfs per mile. One striking aspect of this trend is that under regulated conditions, the annual 7Q10 at Sidney is similar to that at Gardiner, which is over 500 miles upstream.

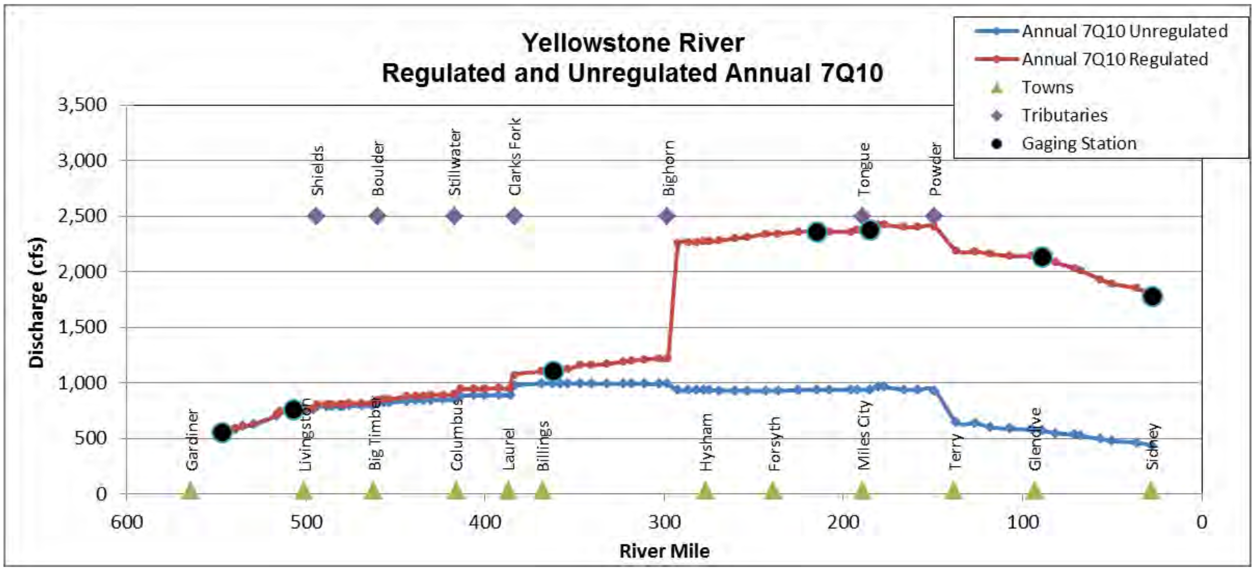

Figure 2-30 Annual 7Q10 discharge for regulated and unregulated conditions.

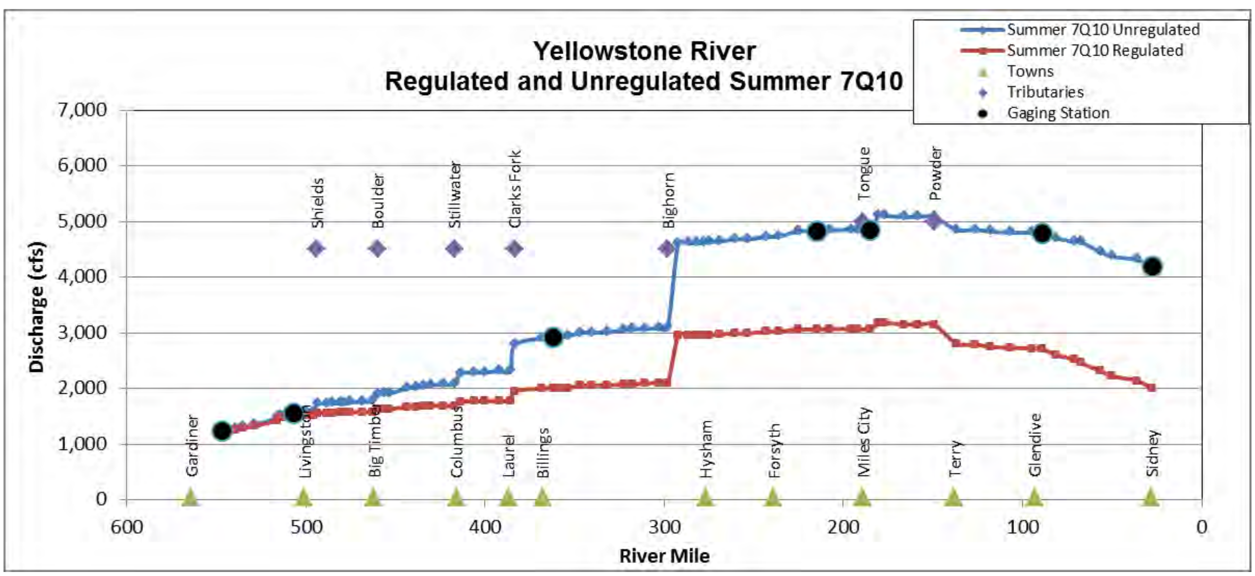

Figure 2-31 Summer 7Q10 for regulated and unregulated conditions.

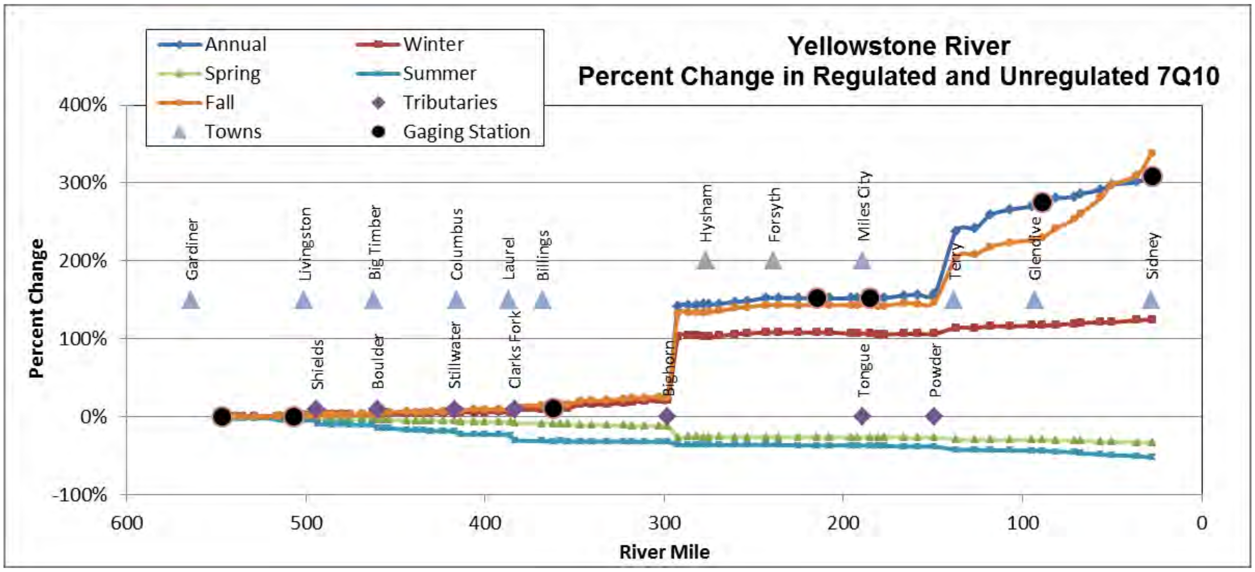

Figure 2-32 Percent change in 7Q10 from unregulated to regulated conditions.

3.0 CHANGING FLOW PATTERNS OBSERVED IN GAGE RECORDS

Available information related to the empirical evaluation of gage records is described below.

3.1 Baseflow Conditions: August Discharge Trends Since 1950

Leppi and others (2012) evaluated mean August discharge values for 153 streams throughout the Central Rocky Mountains and concluded the following:

1. Mean August stream discharges have decreased over the last half-century;

2. Low discharge values are occurring more frequently; and,

3. Climatic variables are influencing August discharge trends.

Figure 3-1 shows the broad conclusions of the work by Leppi and others (2012). Almost all of the sites in the Yellowstone basin show trends of decreasing August flows over their periods of record. Leppi selected “pristine” sites to remove confounding influences of water use such as irrigation and municipal depletions. On the Yellowstone, the site analyzed was the Yellowstone River at Yellowstone Lake Outlet (USGS 06186500).

Using the Yellowstone River at Yellowstone Lake outlet gaging station (USGS 06186500) as a pristine condition example, Leppi and others (2012) concluded that August discharges have dropped 25.4 percent over the period of record analyzed (1950-2008). The site was also characterized by an increase in December-July air temperatures. The decreasing trends in discharge are not limited to just August; similar trends in reduced flow can be seen from July-September (Figure 3-2).

With their analysis for gage records throughout the North Central Rockies, Leppi and others (2012) concluded that non-regulated watersheds of the Central Rocky Mountains including the Upper Yellowstone River watershed have experienced significant declines in stream discharge over the last 50 years.

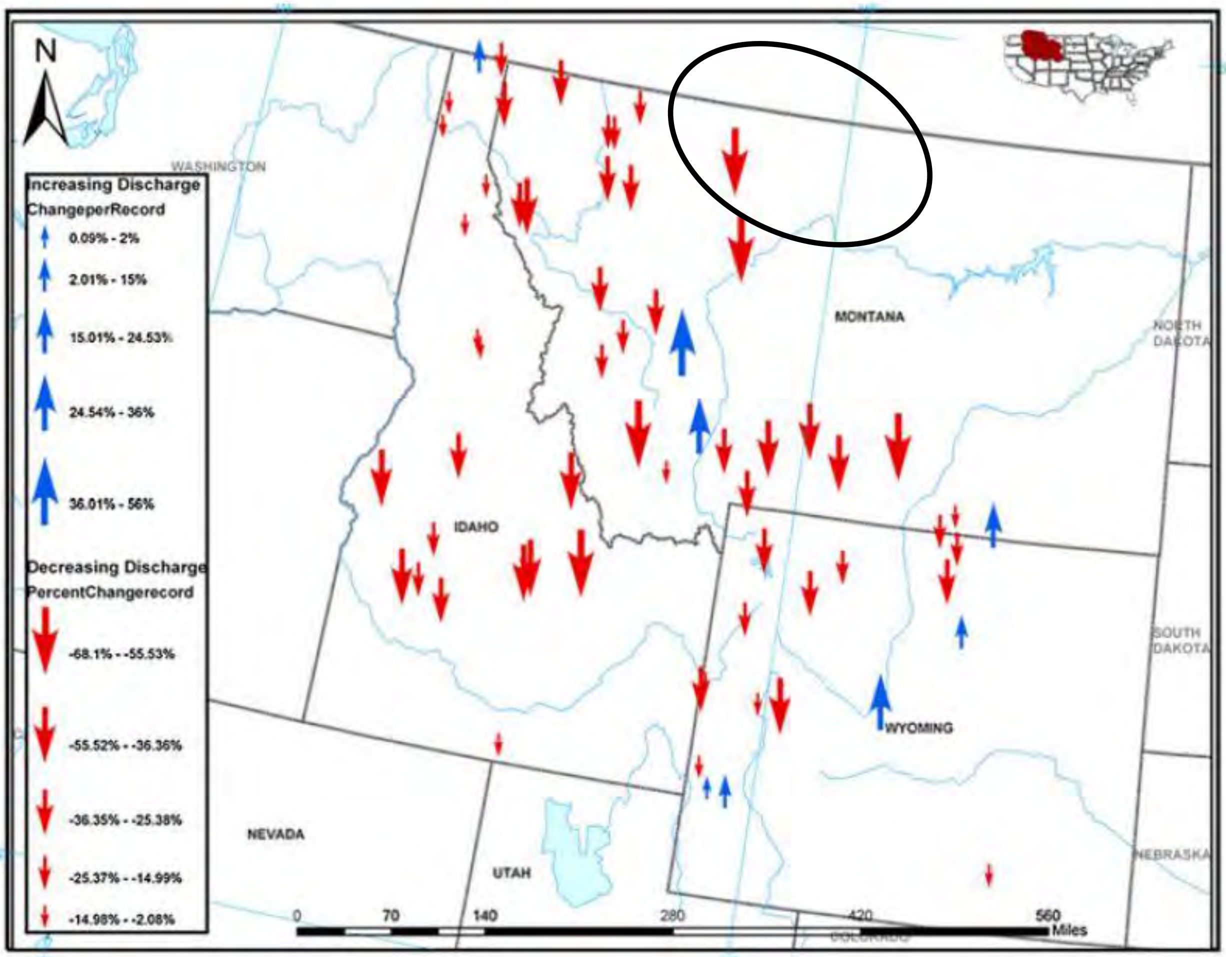

Figure 3-1 **Amount and type of normalized discharge change per analyzed flow record as presented by Leppi et al. (2012). Red arrows signify decreasing flows and blue arrows signify increases. Yellowstone basin sites are circled.**

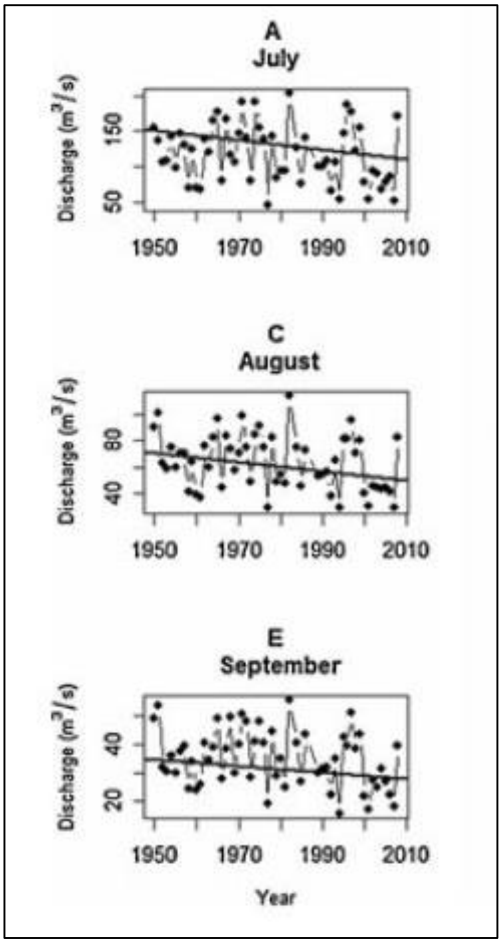

Figure 3-2 Mean monthly flow trends at Yellowstone Lake Outlet (Leppi et.al., 2012, Figure 6).

3.2 Hydrographic Trends Analysis: Watson (2014)

Watson (2014) evaluated hydrographic trends on the Yellowstone River and its tributaries, and concluded that declines in the volume and magnitude of flows have occurred, most significantly in areas where there are no water storage facilities. He also concluded that there is less water available late in the irrigation season because high flows are being delivered to the mainstem earlier in the year. As a result there is an earlier seasonal return to baseflow in the system.

The hydrologic analysis completed by Watson (2014) indicated that the declining flows in the Yellowstone River Basin extend from the headwaters of the river to the mouth. Watson describes potential implications for water users including difficult water allocation decisions, as well as increasing demands persisting into the fall due to earlier runoff patterns.

Watson concluded the following:

1. There is strong evidence of decreasing annual flow, decreasing annual minimum discharge, decreasing peak discharge, and earlier return of baseflow conditions throughout the Yellowstone River basin;

2. There is evidence of more runoff occurring in winter months and less in spring and summer; and,

3. There is some evidence of earlier peak discharge although most trends are not statistically significant.

4. Watson's results support those presented in earlier sections, and emphasize that the hydrological trends are regional in nature.

3.2.1 Impacts of Yellowtail Dam: Indicators of Hydrologic Alteration (IHA) Analysis

To estimate the impacts of Yellowtail Dam on Yellowstone River Hydrology, the USGS gage records at St. Xavier (USGS 06287000), Glendive (USGS 06327500), Miles City (USGS 0609000), and Billings (USGS 06214500) were analyzed using the Indicators of Hydrologic Alteration software developed by the Nature Conservancy (TNC, 2009). The gage records were analyzed for pre- and post- 1967 conditions, to depict the timeframes before and after completion of Yellowtail Dam on the Bighorn River. The Billings gage was evaluated to help shed light on trends that are evident upstream of the influences of Yellowtail Dam. The St. Xavier gage is on the Bighorn River and provides an opportunity to determine IHAs in a highly impacted area just below Yellowtail Dam.

3.2.2 Potential Impacts of Boysen and Buffalo Bill Reservoirs

It is important to note that there are two additional large reservoirs in the Bighorn River watershed, both of which are located upstream of Yellowtail Dam in Wyoming. Buffalo Bill Dam was built on the Shoshone River six miles upstream from Cody Wyoming in 1910. It has a capacity of 650,000 acre feet. Boysen Dam was constructed between 1947 and 1952 on the Wind River approximately 17 miles south of Thermopolis, Wyoming. It has a design controlled storage capacity of 802,000 acre-feet of water (www.usbr.gov). These two reservoirs collectively impound about the same amount of storage provided by Yellowtail Dam, which was completed in 1967 and stores about 1.4 million acre-feet. In considering hydrologic alterations, Buffalo Bill Dam may have already impacted Yellowstone River flows by 1910. These impacts cannot be ascertained due to the lack of pre-1910 gage data. Boysen Reservoir was completed in 1952 and as such its impacts may be reflected in the flow records.

3.2.3 June High Flow

In order to roughly assess the impact of Yellowtail Dam on seasonal high flows, the data were evaluated for pre- and post- dam conditions during the month of June. Figure 3-3 shows that at Billings, monthly flows in June show little change across the flow record. On the Bighorn River at St Xavier, however, post-dam June flows are markedly lower than the pre-dam condition (Figure 3-4). There also appears to be some impact a shift in June flows in the early 1950s, which may reflect the completion of Boysen Dam on the Wind River. The Miles City and Glendive gages show reductions in the median value of approximately 10,000 cfs from pre- to post- dam conditions (Figure 3-5 and Figure 3-6). The results indicate that the reduced June discharges observed at St. Xavier during the month of June do translate down the Yellowstone River.

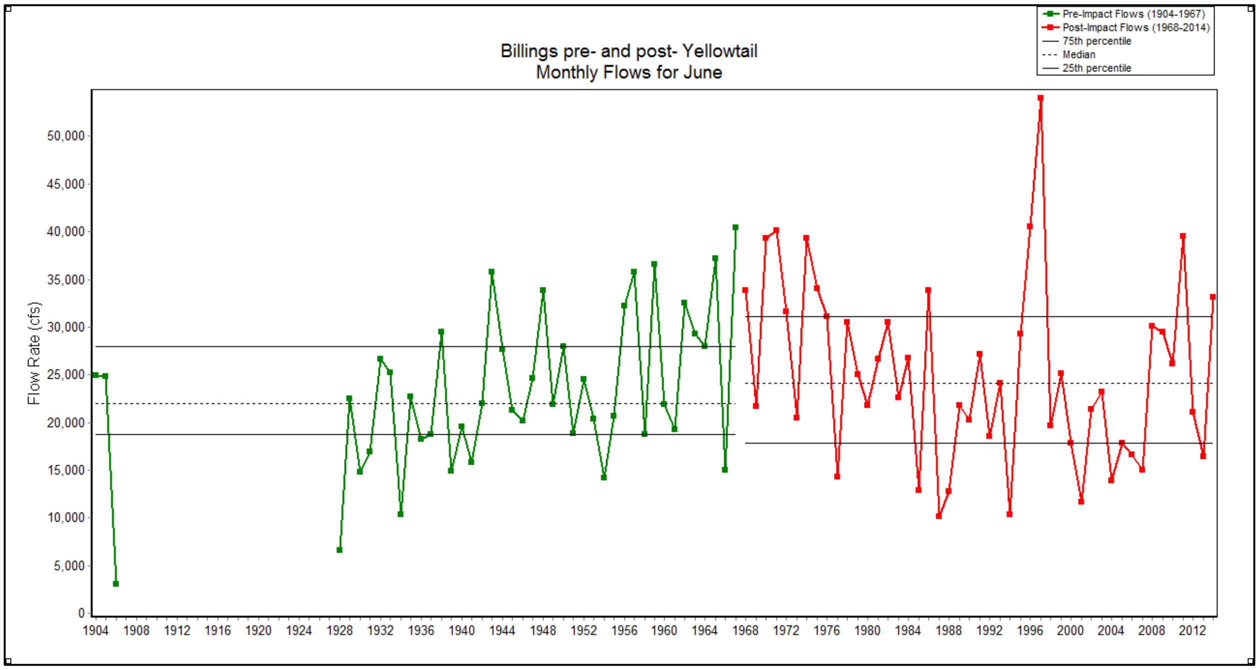

Figure 3-3 **Pre- and post- Yellowtail monthly June flows, Billings; median values shown as dotted line.**

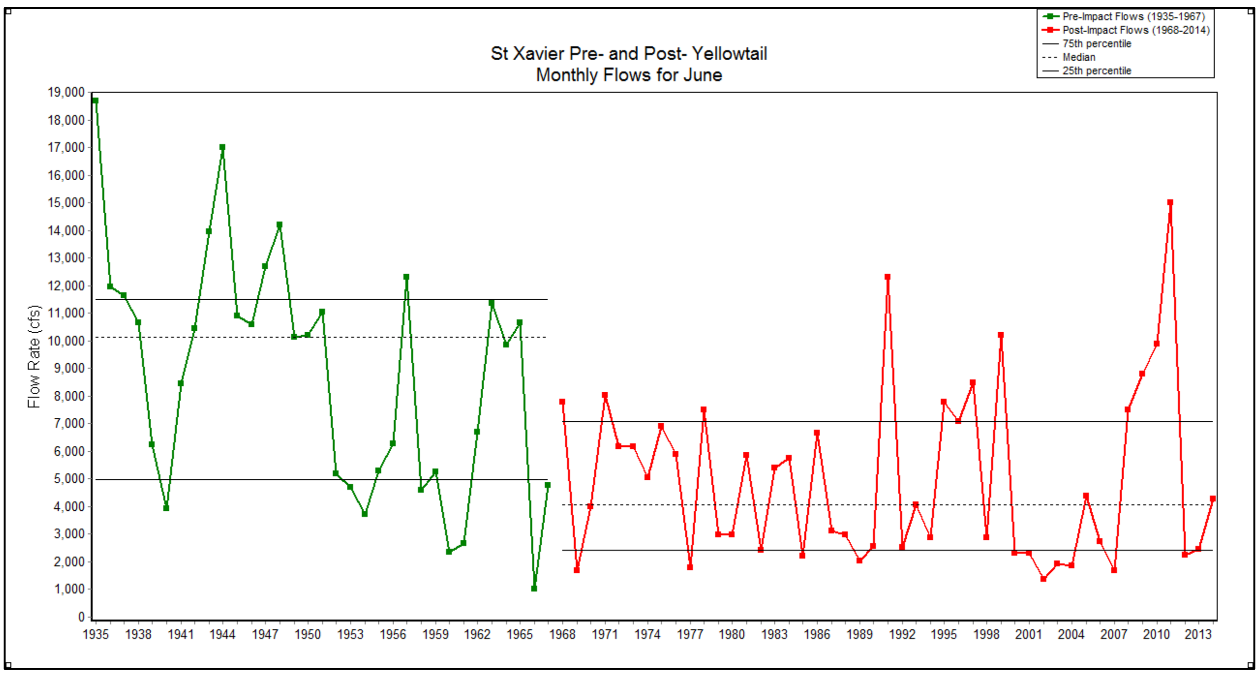

Figure 3-4 **Pre- and post- Yellowtail monthly June flows on the Bighorn River at St Xavier; median values shown as dotted line.**

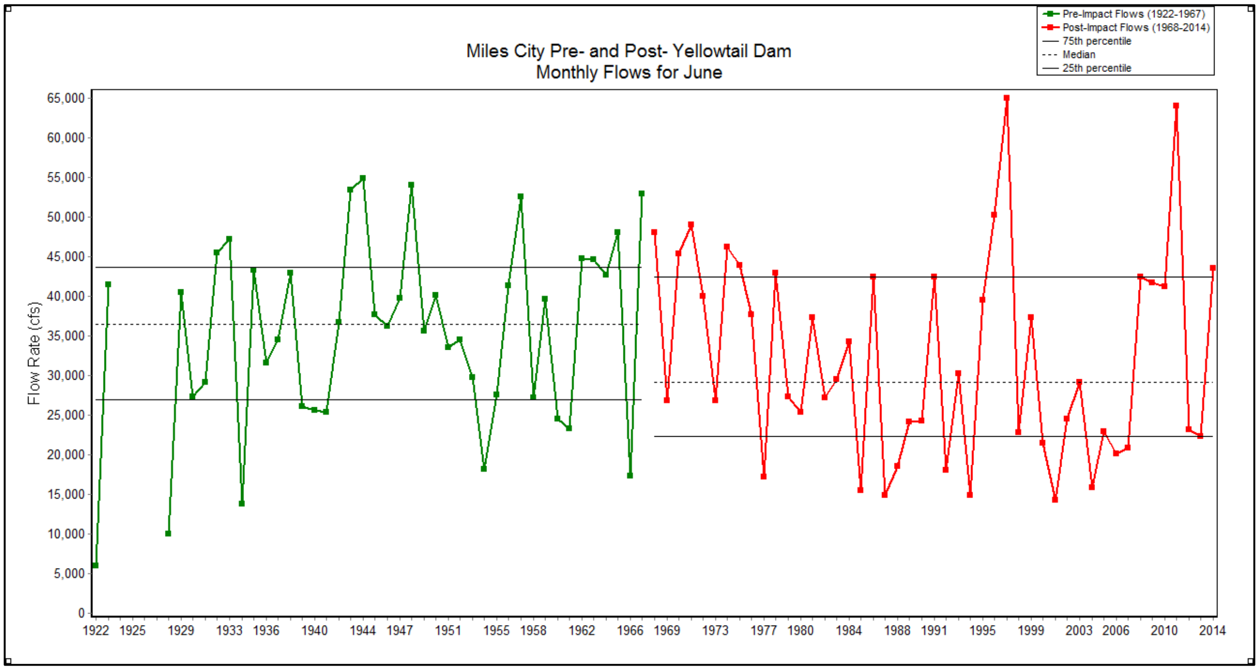

Figure 3-5 **Pre- and post- Yellowtail monthly June flows, Miles City; median values shown as dotted line.**

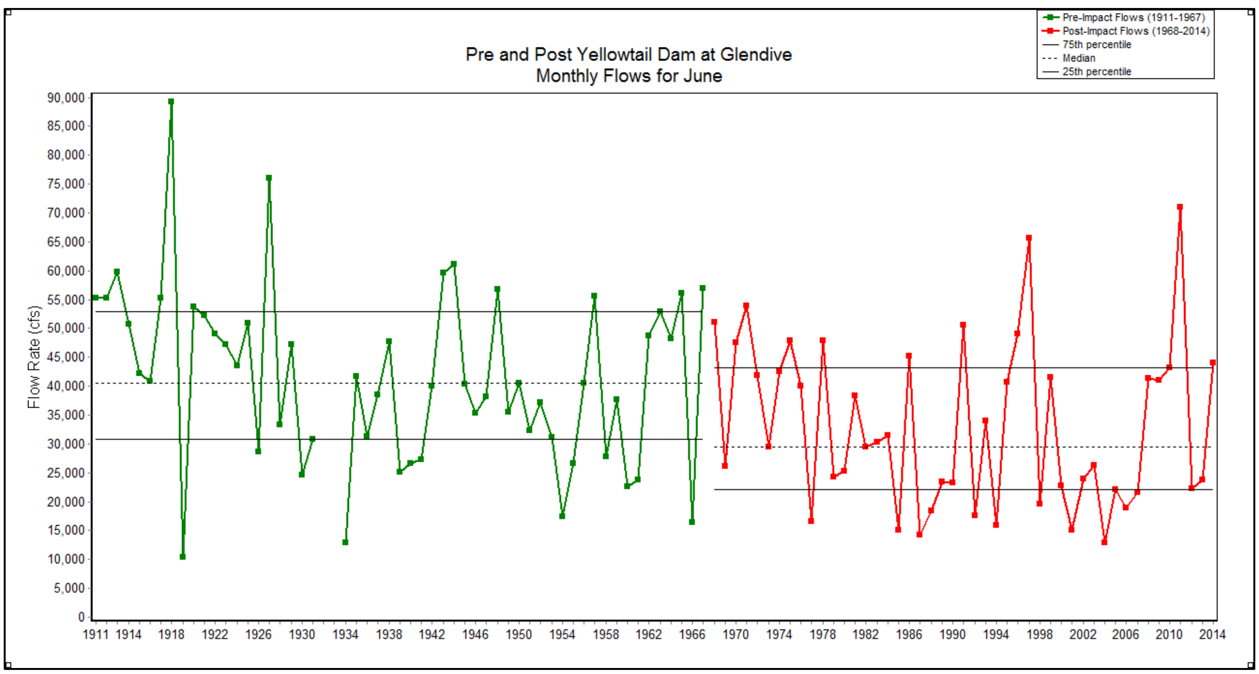

Figure 3-6 **Pre- and post- Yellowtail monthly June flows, Glendive; median values shown as dotted line.**

3.2.4 Rising and Falling Limb

Another aspect of hydrologic modifications by dams is the rate of change in flows during the rising and falling limbs of a hydrograph. IHA allows the computation of “rise rates” and “fall rates” to depict these rates of change. Figure 3-7 and Figure 3-8 show that the rise and fall rates on the Bighorn River at St. Xavier have been markedly affected by the dam; rise and fall rates have both been reduced, indicating a substantial "dampening" of the natural hydrograph. Figure 3-9 and Figure 3-10 show the same data for the Yellowstone River at Miles City. The results indicate that the impact on rise rates and fall rates at Yellowtail Dam are transmitted downstream at least as far as Miles City, although the impact is markedly lower than on the Bighorn River itself.

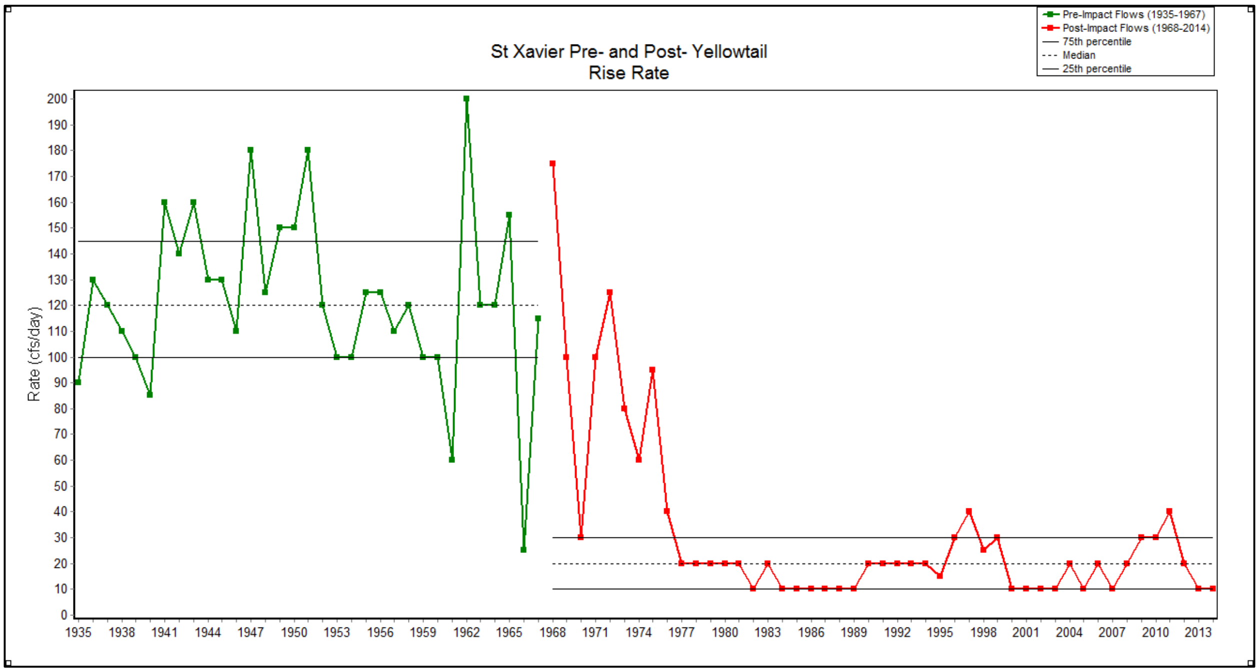

Figure 3-7 **Pre- and Post- Yellowtail Dam rise rates, Bighorn River at St. Xavier; median values shown as dotted line.**

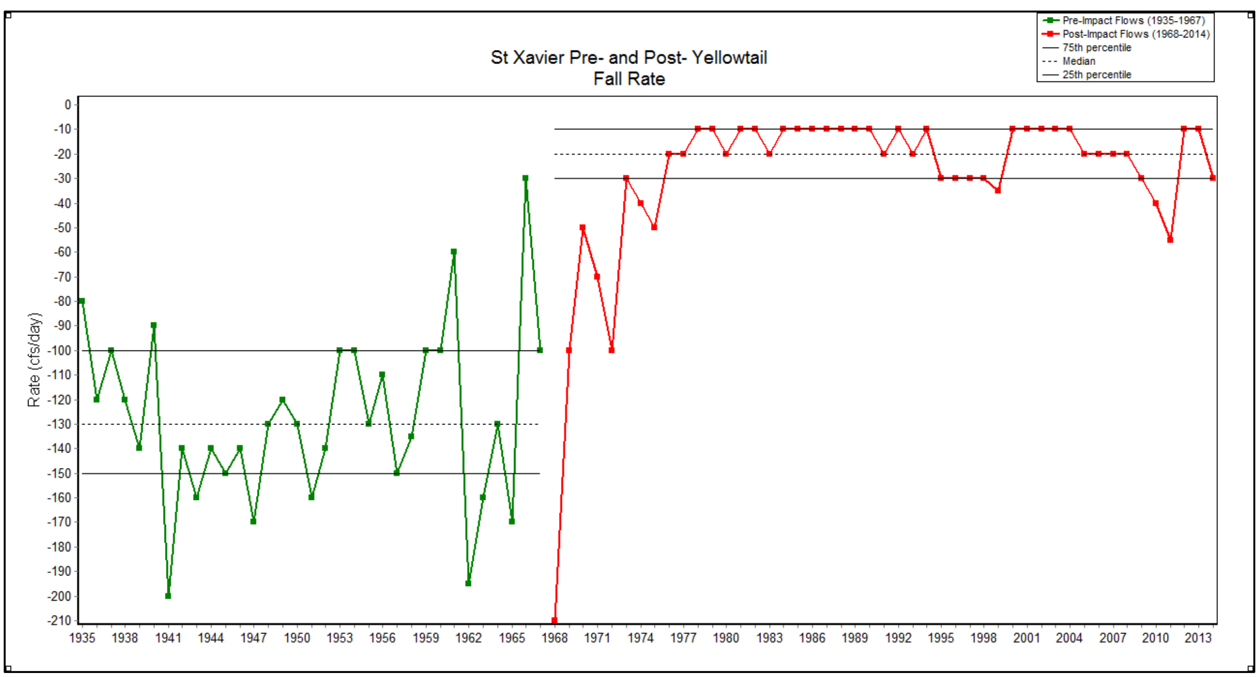

Figure 3-8 **Pre- and Post- Yellowtail Dam fall rates, Bighorn River at St. Xavier; median values shown as dotted line.**

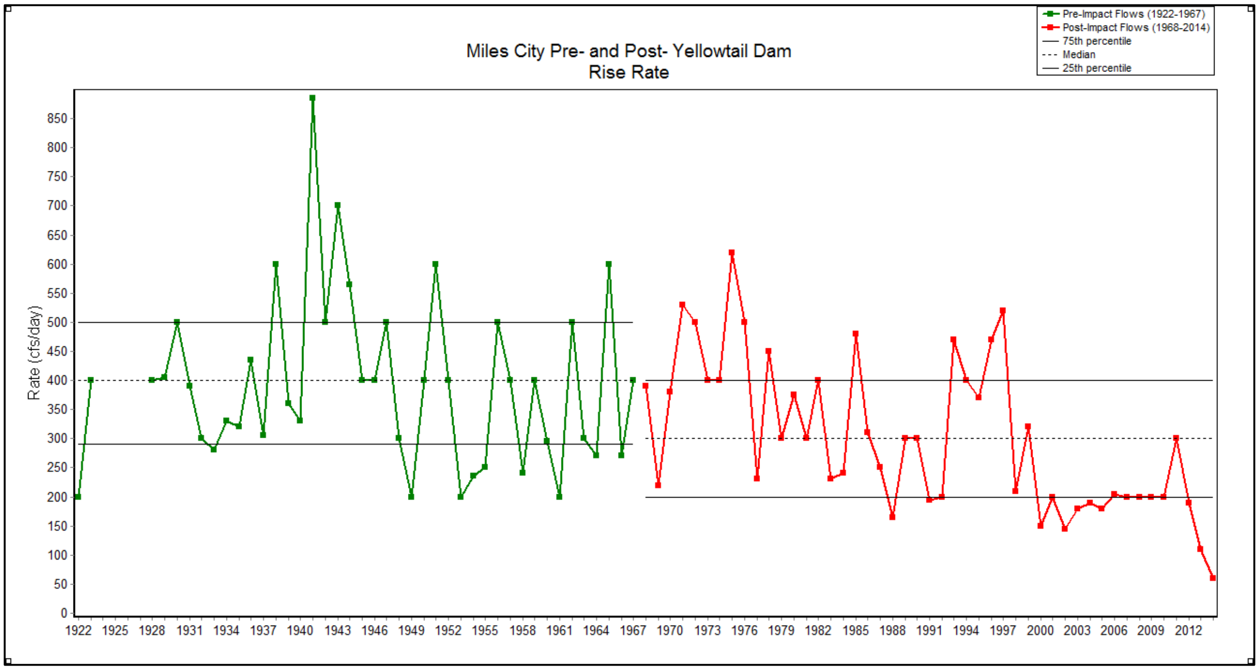

Figure 3-9 **Pre- and Post- Yellowtail Dam rise rates, Yellowstone River at Miles City; median values shown as dotted line.**

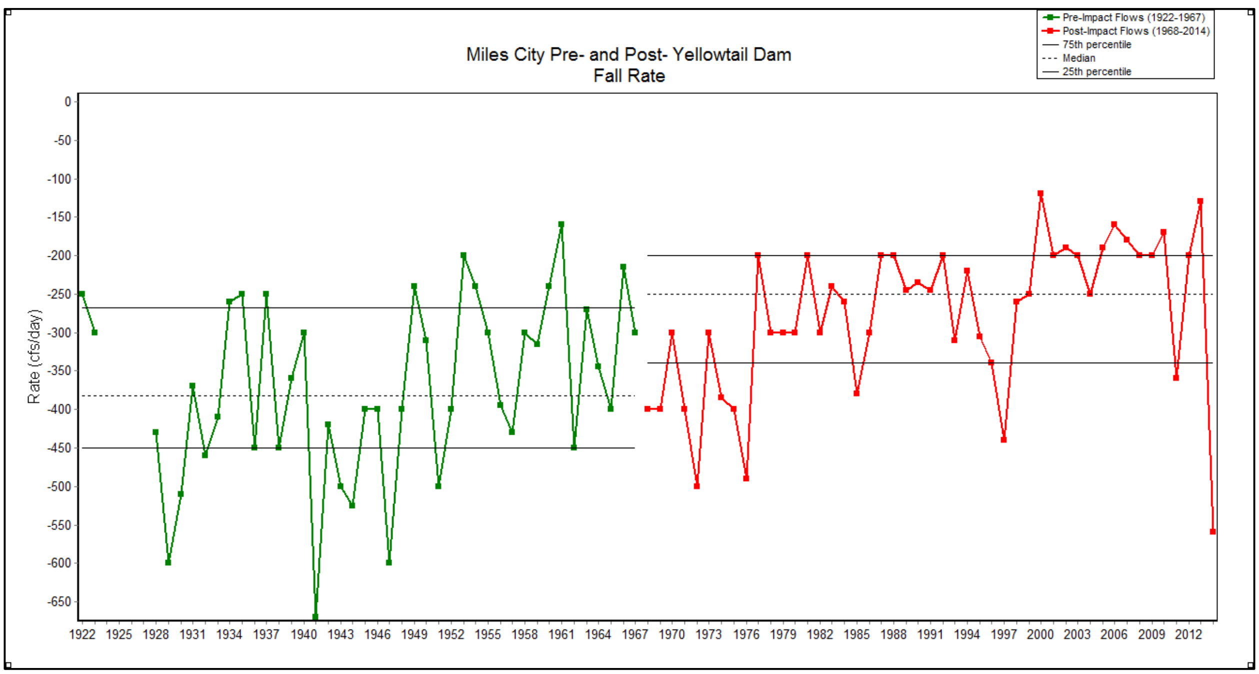

Figure 3-10 **Pre- and Post- Yellowtail Dam fall rates, Yellowstone River at Miles City; median values shown as dotted line.**

3.3 Impacts of Yellowtail Dam: Median Daily Flow Hydrographs

In order to further characterize the impacts of Yellowtail Dam on the hydrology of the lower Yellowstone River, daily flow records for the USGS gaging station at Miles City (USGS 06329500) and Sidney (USGS 06329500) were summarized in terms of pre- and post- dam annual hydrographs. The 1921-2013 flow record was divided into pre- and post- 1967 datasets and the median flow was calculated for each day of the year within each dataset. The median daily flow is that which was exceeded on one-half of the days in the record (also known as the 50th percentile value). Median flows were used instead of mean daily flows to prevent the numbers from being overly influence by extreme events. The results show that the post-dam hydrograph exhibits dampened flows during June/July relative to the pre-dam condition (Figure 3-11 and Figure 3-12). Winter flows show increases at both sites. Thus, the hydrographs support the unregulated/regulated flow comparison results in that mean spring runoff events have been reduced by about 10,000 cfs at each gage, which is similar to the unregulated/regulated change in the 2-year peak discharge.

The annual hydrographs also capture impacts to the early spring pulse in late March and early April. The Miles City gage shows that with increased overall winter flows, the spring pulse in late March has become less defined. The Sidney gage shows the early spring pulse starting somewhat earlier, typically in mid-February. The discrepancy between the two suites of data are at least in part to changes on the Powder River, where hydrographs constructed for the same timeframes show a distinctly earlier spring pulse since the 1960s (Figure 3-13). A plot of the total change in mean daily flow between pre- and post- dam conditions for the Miles City and Sidney gages is shown in Figure 3-14.

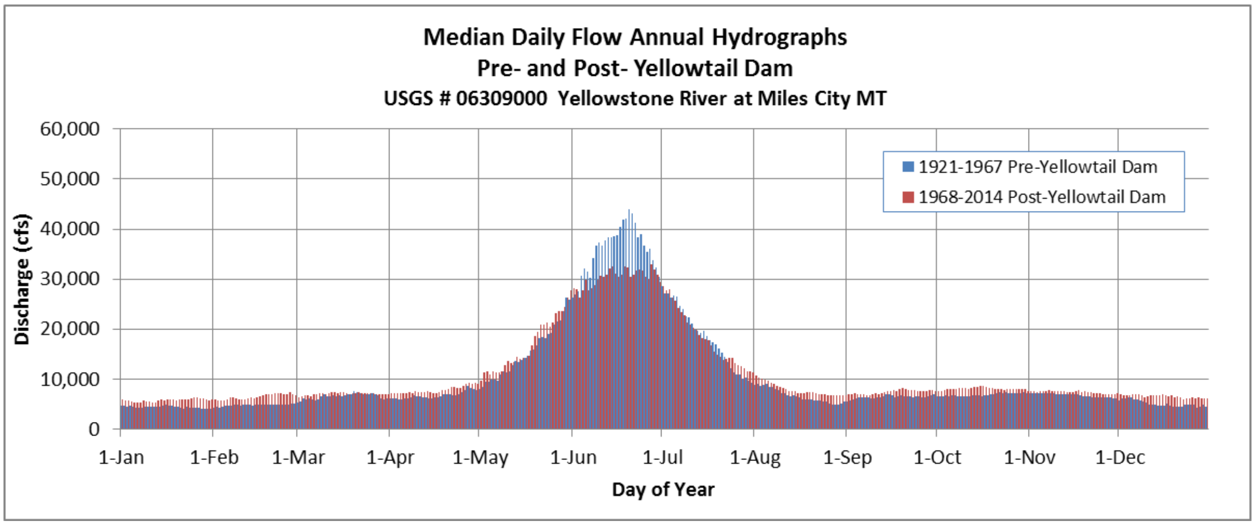

Figure 3-11 Median daily flow annual hydrographs for pre- and post- Yellowtail Dam conditions, Yellowstone River at Miles City MT.

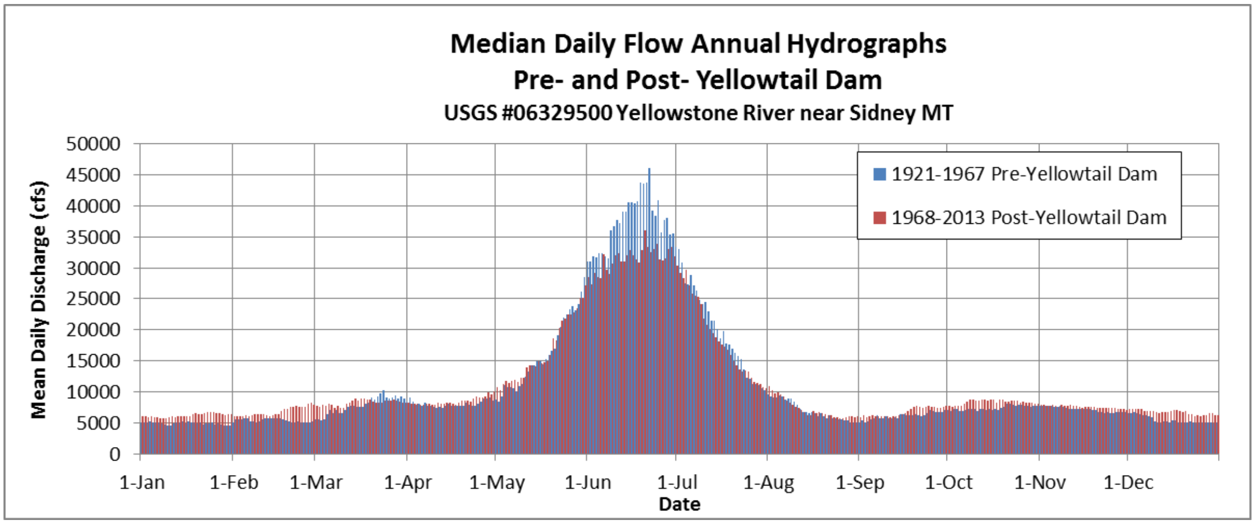

Figure 3-12 Median daily flow annual hydrographs for pre- and post- Yellowtail Dam conditions, Yellowstone River near Sidney MT.

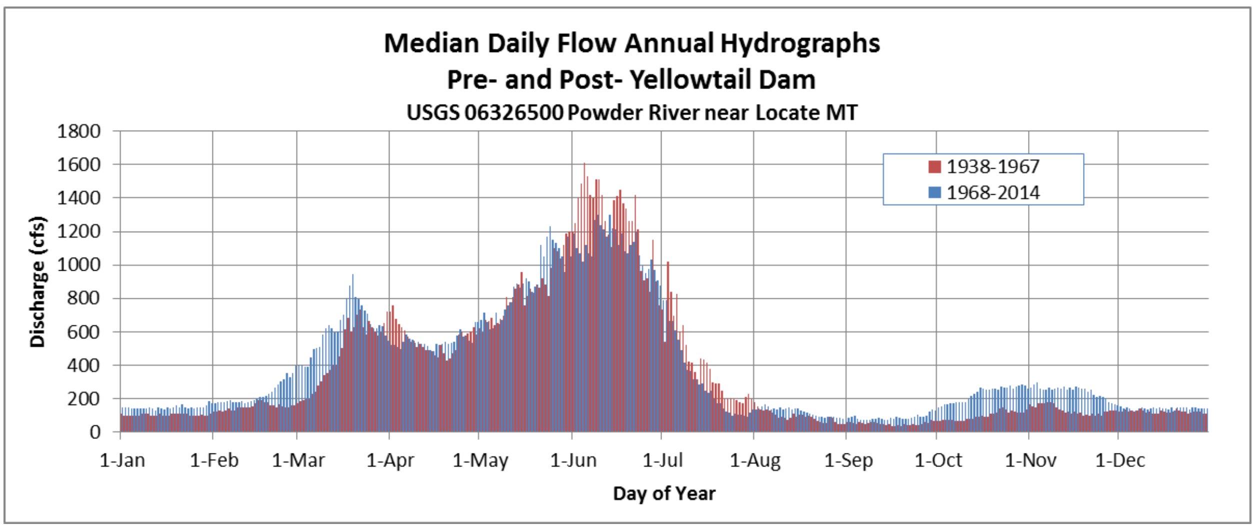

Figure 3-13 Median daily flow annual hydrographs for pre- and post- Yellowtail Dam conditions, Powder River near Locate, MT.

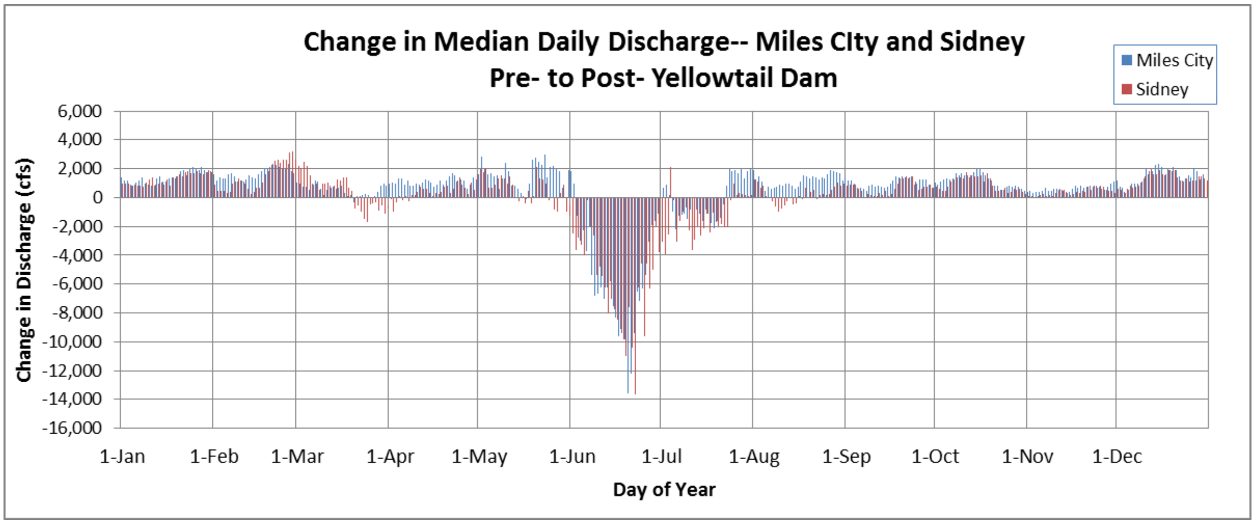

Figure 3-14 Pre- and Post- Yellowtail Dam change in median daily discharge on Yellowstone River at Miles City and Sidney.

3.4 Impacts of Yellowtail Dam: Recent Changes in Winter Flow Releases

Although the comparison of regulated and unregulated flows indicates that in general, winter low flows have increased on the Yellowstone River below the Bighorn River confluence (Section 2.4.3), this general trend has been reduced in recent years due to an apparent change in flow management strategies at Yellowtail Dam. Using the IHA program to compare mean December discharges on the Bighorn and Yellowstone Rivers since the dam was constructed shows that since about 2000, there has been an overall reduction in winter flow releases from Yellowtail Dam as measured at St Xavier (Figure 3-15). This trend is also seen on the Yellowstone River at Miles City (Figure 3-16).

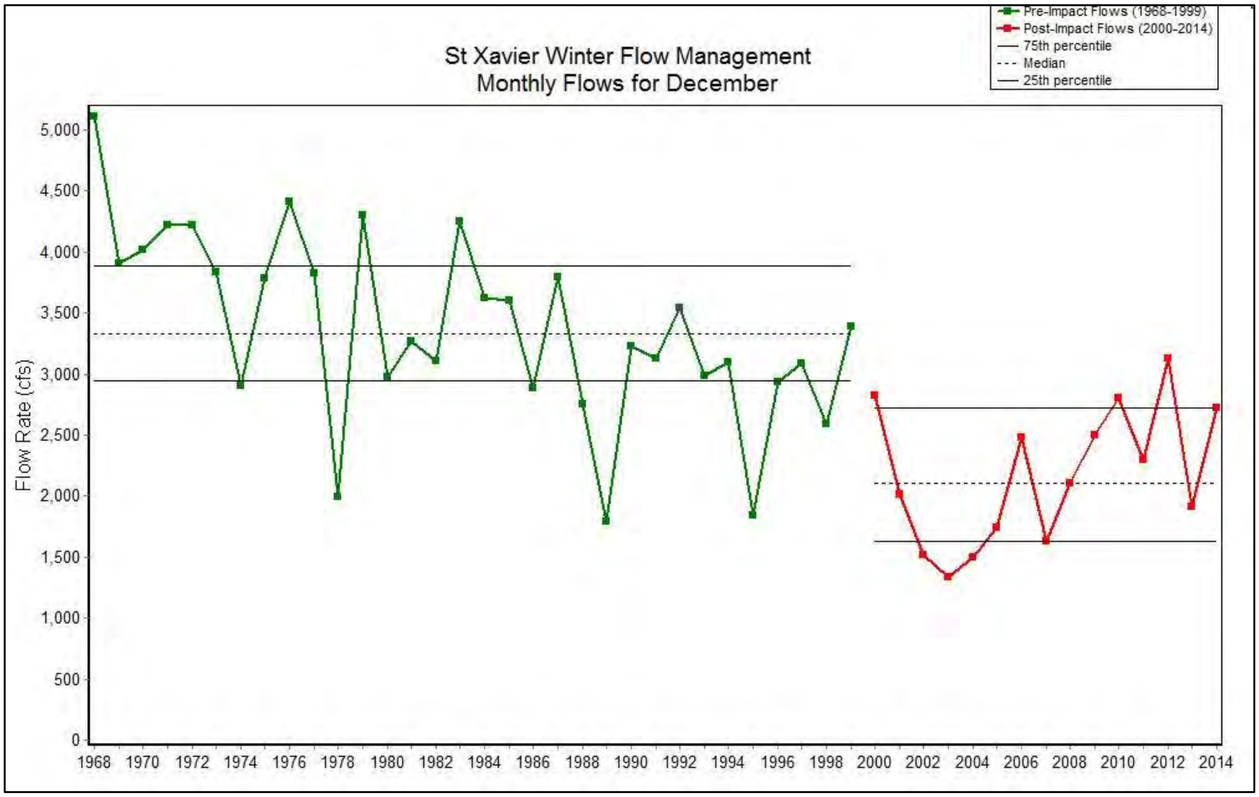

Figure 3-15 **Monthly flows measured on Bighorn River at St Xavier showing trend towards reduced December flow rates since dam construction (1968); median post-2000 releases are ~1200 cfs less than pre-2000 releases (dotted line).**

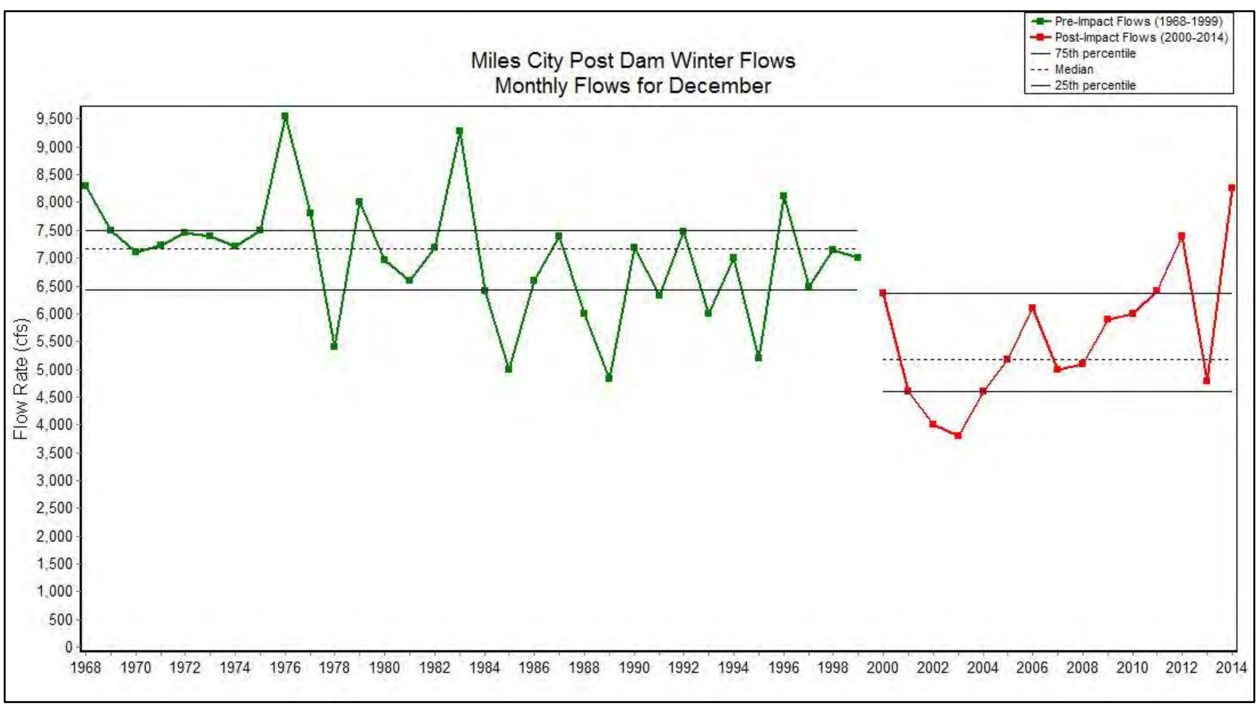

Figure 3-16 **Mean December discharge on Yellowstone River at Miles City showing trend towards reduced December flow rates since 2000; median values shown as dotted line.**

4.0 WATER USE

With regard to cumulative effects, it is important to consider the overall sources of hydrologic impacts in the basin. The following summary is intended to provide an overview of relative water use in the basin. These uses are based on available data that summarize total and consumptive water withdrawals during the year 2000 (Cannon and Johnson, 2004) (Figure 4-1). The data are summarized by both county and drainage basin. Although there has been increasing amounts of oil and gas development in the basin over the past decade, the 2000 data will not capture any of the increased post-2000 water use in support of the oil and gas industry. The Draft Montana State Water Plan indicates a potential state-wide water use of 3,500 acre-feet per year for oil production stimulation (DNRC, 2013).

4.1 Water Use by County

Table 4-1 lists the estimated water withdrawals summarized for the year 2000 for Montana counties in the Yellowstone River Basin (Cannon and Johnson, 2004). The estimates show irrigation constituted 95 percent of the total water use in 2000. The counties with the largest amount of total water use include Yellowstone and Carbon Counties (Figure 4-2).

Table 4-1
Estimated water withdrawals for selected Montana counties in Yellowstone River Basin, 2000 (Cannon and Johnson, 2004).

	Withdrawals by Category, Mgal/d, million gallons per day							
County	Irrigation	Public Supply	Self-Supplied Domestic	Self-Supplied Industrial	Thermoelectric Power Generation	Livestock	Total (Mgal/Day)	Total (af/yr)
Bighorn	253	1.1	0.5	0.0	0.0	1.5	255.7	287,170
Carbon	581	1.4	0.4	0.1	0.0	0.9	583.4	655,240
Custer	88	1.5	0.2	0.0	0.0	1.2	91.1	102,280
Dawson	77	2.2	0.2	0.1	0.0	0.7	80.3	90,220
McKenzie ND	12	0.3	0.2	0	0	0	12.5	14,020
Park	352	2.2	0.5	0.0	0.0	0.7	355.7	399,560
Prairie	57	0.0	0.1	0.0	0.0	0.5	57.4	64,510
Richland	376	1.2	0.3	0.8	31.7	0.9	410.8	461,430
Rosebud	159	1.5	0.0	0.1	25.6	1.3	187.9	211,050
Stillwater	192	0.6	0.4	0.0	0.0	0.9	194.2	218,090
Sweet Grass	323	0.3	0.1	0.0	0.0	0.8	324.1	364,020
Treasure	108	0.2	0.0	0.0	0.0	0.5	108.3	121,590
Yellowstone	447	23.0	1.4	9.9	52.7	1.8	535.2	601,110
Total	**3024**	**35.5**	**4.3**	**11.0**	**110.0**	**11.4**	**3196.5**	**3,590,290**

Summaries of water uses specific to irrigation show that Yellowstone and Carbon Counties showed the largest amount of irrigation water use (Figure 4-3). The Clarks Fork River valley flows through Carbon County, and the reduction in flows at the mouth of the Clarks Fork described in earlier sections is supported by this relatively high level of water use for irrigation. Total consumptive use for irrigation is estimated to be about 20 percent of the total withdrawal value (Table 4-2 and Figure 4-4; Cannon and Johnson, 2004). Consumptive use estimates were not available for McKenzie County North Dakota.

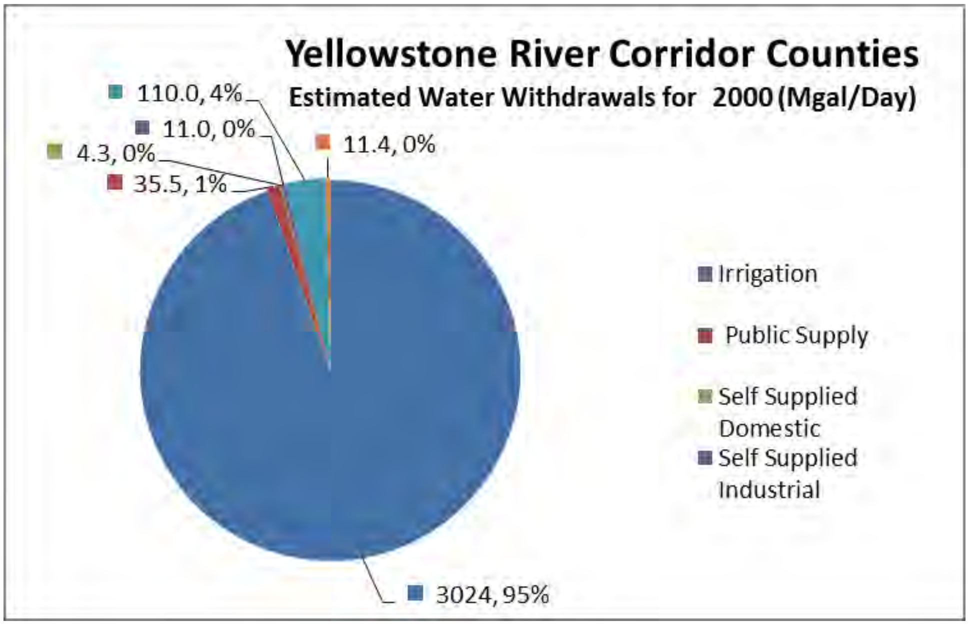

Figure 4-1 **Total estimated year 2000 water withdrawals by type of use (Cannon and Johnson, 2004).**

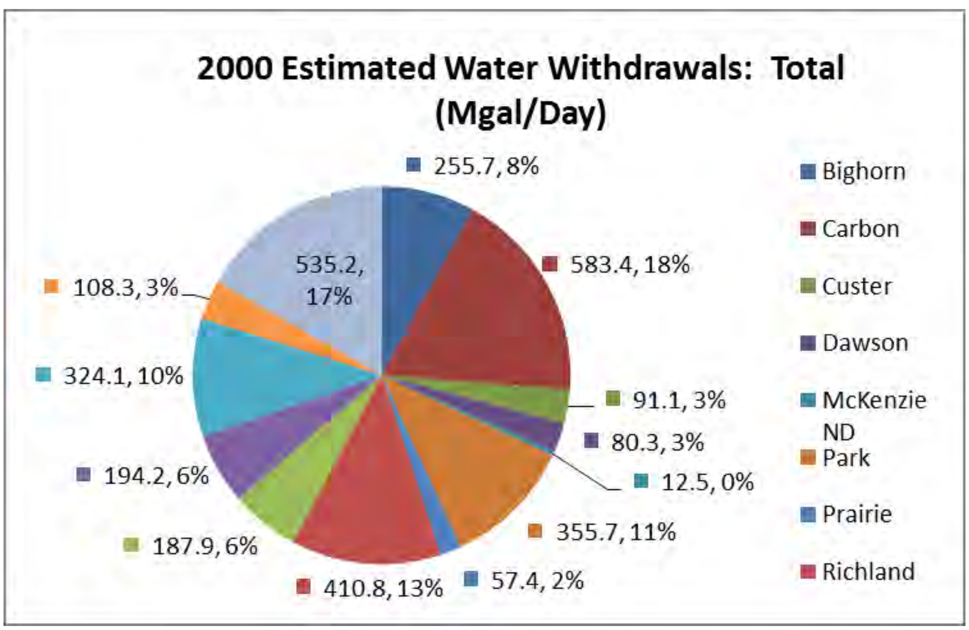

Figure 4-2 **Total estimated year 2000 water withdrawals by county (Cannon and Johnson, 2004).**

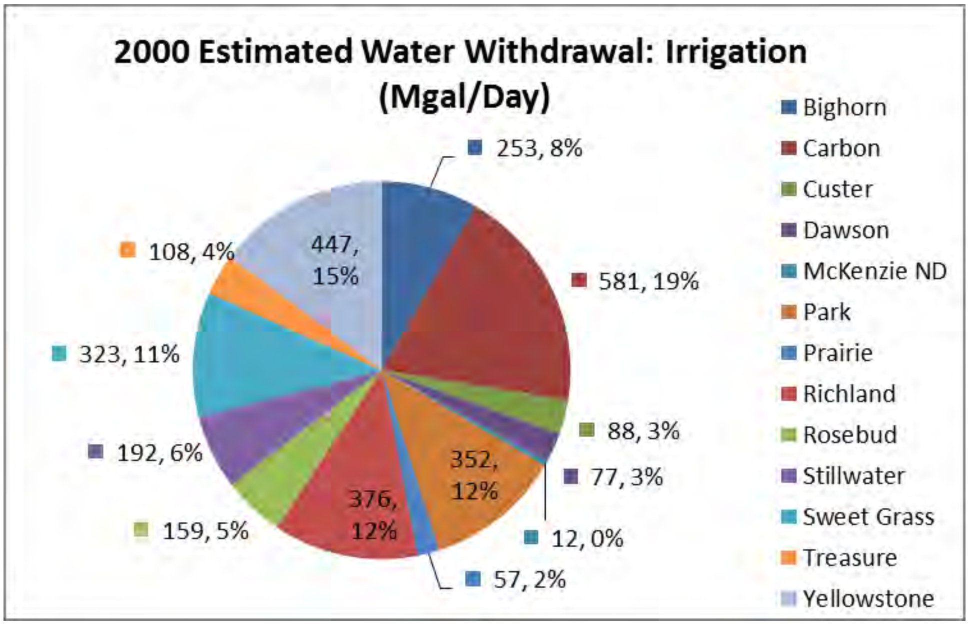

Figure 4-3 Estimated 2000 water withdrawals in Montana for irrigation by county (Cannon and Johnson, 2004).

Table 4-2
Estimated total and consumptive irrigation water use by county (Cannon and Johnson, 2004); data not available for McKenzie County ND.

	Total Estimated Irrigation Withdrawals				Estimated Consumptive Use	
County	Groundwater Withdrawals (Mgal/D)	Surface Water Withdrawals (Mgal/d)	Total Withdrawals Mgal/d	Total Withdrawals (acre-ft/yr)	Total Consumptive Use for Irrigation (Mgal/d)	Total Consumptive Use for Irrigation (acre-ft/yr)
Big Horn	2.6	250	253	283,780	57	63,720
Carbon	0.8	580	581	652,070	93	104,640
Custer	0.7	88	88	99,100	29	32,300
Dawson	0.2	77	77	86,780	22	24,670
Park	2.6	350	352	395,740	58	65,630
Prairie	0.5	55	57	63,850	15	16,610
Richland	1.7	374	376	422,170	65	72,710
Rosebud	1.6	158	159	178,990	37	41,880
Stillwater	4.4	188	192	215,990	37	41,630
Sweet Grass	0.6	322	323	362,620	48	54,160
Treasure	1.1	107	108	120,820	25	28,450
Yellowstone	4.9	442	447	501,560	104	116,250
Total	**16**	**1,646**	**1,661**	**1,866,000**	**331**	**371,690**

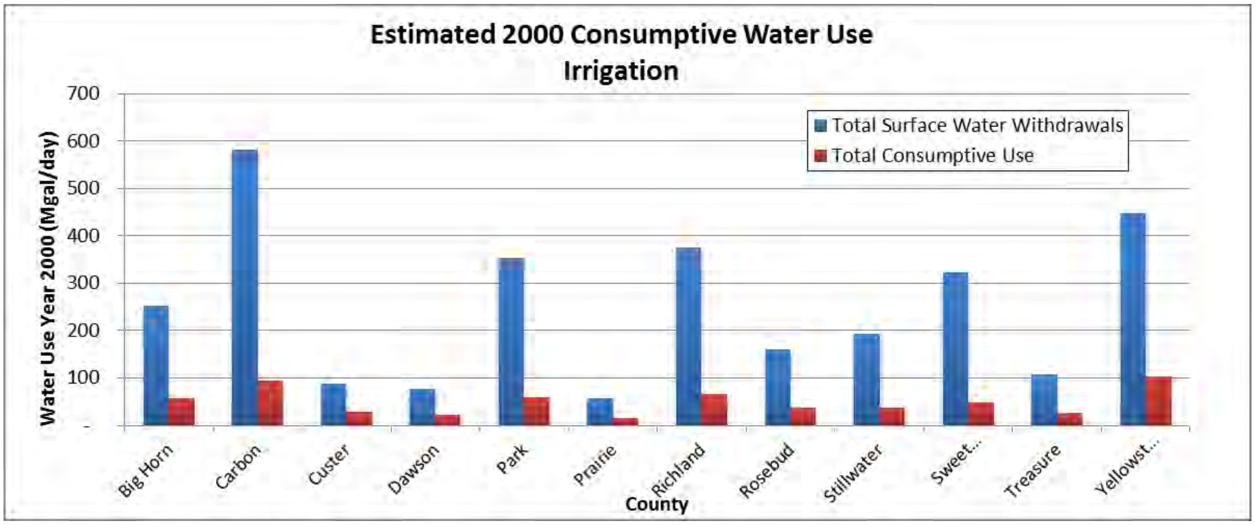

Figure 4-4 Irrigation water use by county showing total irrigation water withdrawals versus irrigation consumptive use (2000 estimates).

4.2 Water Use by Drainage Basin

In order to describe the summarize the estimated 2000 water use by drainage basin, individual 8-digit HUC data were summarized by major contributing basin. These summaries for total water use are shown in Table 4-3 and Figure 4-5. For these data, the "Upper Yellowstone" refers to the river corridor HUC basins above Billings; the "Middle Yellowstone" refers to the valley from Billings to the Bighorn River confluence, and the "Lower Yellowstone" refers to the stream valley below the Bighorn River, and includes the Big Porcupine drainage north of Forsyth and O'Fallon Creek. All other major contributing drainages are summarized independently. The "Bighorn" drainage includes only the Lower Bighorn River drainage area below Yellowtail Dam and the Little Bighorn River drainage; none of the summary values include any water use in Wyoming. The summaries show that the Upper Yellowstone, Lower Yellowstone, and Clarks Fork Drainages collectively account for almost 75 percent of the total water use in the Montana portion of the Yellowstone River watershed in 2000.

Table 4-3
Estimated 2000 total water use by basin (Cannon and Johnson, 2004).

	Withdrawals by Category, Mgal/day (million gallons per day)							
Drainage Basin	Irrigation	Public Supply	Self-Supplied Domestic	Self-Supplied Industrial	Thermo-electric Power Generation	Livestock	Total (Mgal/Day)	Total (af/yr)
Upper Yellowstone	871	25.5	0.88	9.9	53	1.9	962	1,080,060
Lower Yellowstone	713	6.3	0.69	1.0	57	3.8	782	878,280
Clarks Fork	527	1.4	0.33	0.1	0	0.7	530	595,210
Bighorn	243	1.0	0.34	0.0	0	0.9	245	275,020
Shields	172	0.1	0.14	0.0	0	0.2	173	194,230
Middle Yellowstone	159	0.3	1.15	0.0	0	1.2	162	181,500
Stillwater	127	0.2	0.20	0.0	0	0.5	128	143,600
Tongue	75	0.2	0.18	0.0	0	1.1	76	85,440
Powder	29	0.2	0.13	0.0	0	1.3	31	34,620
Pryor Creek	26	0.1	0.13	0.0	0	0.3	27	30,180
Rosebud	15	0.5	0.04	0.0	0	0.3	16	18,160
Total	**2958**	**36**	**4.2**	**11**	**110**	**12**	**3131**	**3,516,300**

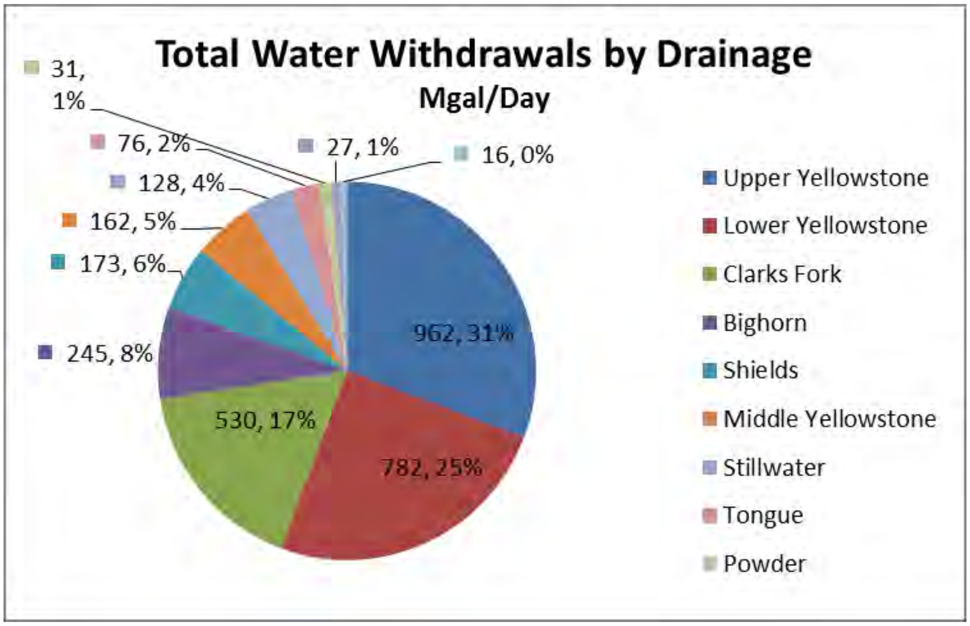

Figure 4-5 Estimated Year 2000 total Montana water use by drainage basin (Cannon and Johnson, 2004).

Water use for irrigation shows similar trends as total water use. Table 4-4 shows the total water use for irrigation, including groundwater and surface water withdrawals as well as estimated total consumptive use. For the year 2000, the total estimated water withdrawn for irrigation within Montana drainages contributing to the Yellowstone River was about 3 billion gallons per day or 3.3 million acre-feet per year. The total estimated consumptive use was about 588 million gallons per day, or 660,000 acre-feet per year. Over 70 percent of the total consumptive use was in the Upper Yellowstone, Lower Yellowstone, and Clarks Fork drainages (Figure 4-6 and Figure 4-7).

Table 4-4
Estimated total and consumptive irrigation water use in 2000 for Yellowstone River contributing drainages (Montana only).

	Total Estimated Irrigation Withdrawals				Estimated Consumptive Use	
Drainage Basin	Groundwater Withdrawals (Mgal/D)	Surface Water Withdrawals (Mgal/d)	Total Withdrawals Mgal/d	Total Withdrawals (acre-ft/yr)	Total Consumptive Use for Irrigation (Mgal/d)	Total Consumptive Use for Irrigation (acre-ft/yr)
Upper Yellowstone	7.0	864	871	978,110	157	176,760
Lower Yellowstone	6.1	707	713	800,830	159	178,080
Clarks Fork	0.9	527	527	592,370	85	95,950
Bighorn	2.6	240	243	272,490	55	61,950
Shields	1.0	171	172	193,660	29	32,600
Middle Yellowstone	1.8	157	159	178,540	37	41,250
Stillwater	2.7	124	127	142,670	24	26,710
Tongue	0.7	74	75	83,730	21	23,510
Powder	0.3	29	29	32,850	11	12,860
Pryor Creek	0.2	26	26	29,630	6	6,810
Rosebud	0.1	15	15	17,170	3	3,800
TOTAL	**23.2**	**2,934**	**2,958**	**3,322,050**	**588**	**660,340**

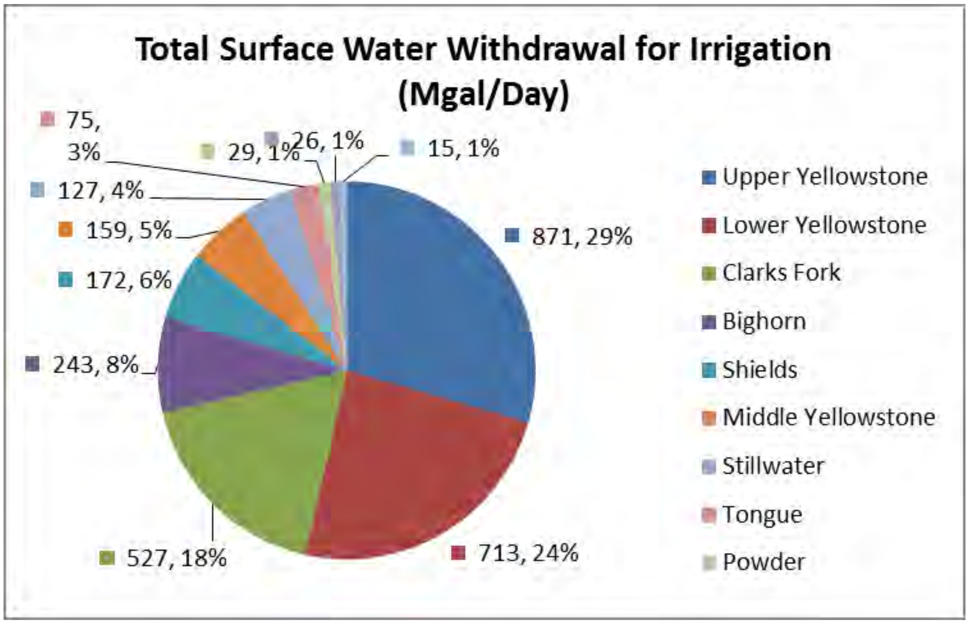

Figure 4-6 **Estimated total surface water volume withdrawn for irrigation by drainage basin for Year 2000 (Cannon and Johnson, 2004).**

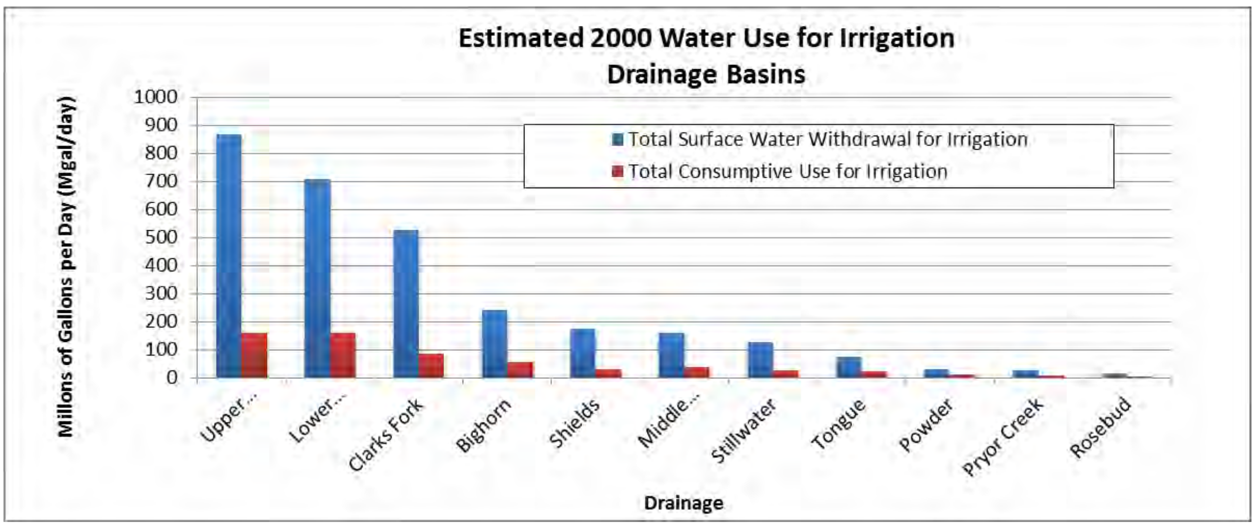

Figure 4-7 **Total and consumptive estimated Year 2000 water use for irrigation by drainage basin.**

4.3 Irrigation Depletion Patterns

On the Yellowstone River the two major influences of altered hydrology are Yellowstone Basin irrigation and Bighorn River water use (primarily reservoir impacts and irrigation). In an effort to help understand the relationships between irrigation and the altered hydrology of the Yellowstone River and make a qualitative assessment of the relative influences of irrigation and Bighorn River flow alterations, the depletion patterns for regulated and unregulated flow were compared at gages above and below the Bighorn River confluence. The Bureau of Reclamation depletions (2005) were based upon irrigation and reservoirs. All other depletions were estimated as a percentage of irrigation depletion. Irrigation depletion estimates included calculation of crop requirements, diversion needs and return flows. Reservoir depletions included storage changes, evaporation and precipitation, and seepage estimation.

Because the depletion estimates above Billings are dominated by irrigation, the change in mean monthly discharge measured at the Billings gage (Figure 2-3) shows a clear pattern of irrigation use. The following summary describes that pattern. In April, relatively minor depletions begin as irrigation ditches usually begin operations in mid- to late-April. During that time, irrigation water requirements are low and return flows are minimal following five months of no irrigation. In May and June, depletions increase as irrigation water requirements increase and return flows remain low due to low water use in previous months. In July, irrigation water requirements reach their maximum but depletions remain relatively constant as return flows from May and June begin to offset diversions. In August, return flows continue to increase as irrigation water requirements begin to decline. In September, irrigation water requirements are low and return flows remain high. In October, when most irrigation ditches cease operations, the return flow exceeds the irrigation water requirement and depletions become negative, although some irrigation continues. From November to March, irrigation water requirements are zero and return flows from the irrigation season decrease continuously to a low in March or early April immediately prior to the irrigation season.

The change in mean monthly discharge measured at the Forsyth gage or any gage downstream of the Bighorn confluence would be expected to show the same pattern with respect to irrigation depletions although the magnitude of the depletion would increase with the amount of irrigated land above any specific gage. Because depletions are based on irrigation and reservoirs, the difference in regulated and unregulated flow patterns between Forsyth and Billings (Figure 2-3 and Figure 2-4) can be attributed to the effect of Bighorn River flow alterations. In order to assess the relative roles of irrigation and Bighorn River flow alterations in altering hydrograph, the pattern of depletions by month at the Billings gage was taken to represent irrigation depletions alone. The change in unregulated flow to regulated flow due to irrigation was estimated at gages downstream of the Bighorn River using the Billings gage as a baseline and applying percentage increases to irrigation depletions based on the percentage increase in water use from the USGS. 2000 Water Use in Montana study (Cannon and Johnson, 2004). The USGS withdrawals were used to calculate the total withdrawals for all HUCs above a gage and assigned a percentage of the Billings withdrawal. Total irrigation withdrawals including all tributaries were 133 percent of the Billings total at the Forsyth gage. The percentages at Miles City, Glendive and Sidney were 144, 160 and 177 percent, respectively. The pattern of monthly depletion based on Bureau of Reclamation depletion analysis at Billings was applied to the percentage irrigation withdrawals from the USGS study to estimate monthly irrigation impact at gages downstream of the Bighorn confluence. The estimated depletions were removed from the total depletions at each gage and the remaining change in mean monthly flow was assumed to estimate the depletion due Bighorn River flow alterations. This process was used to estimate the effect of Bighorn River flow alterations on monthly mean flow at Forsyth, Miles City, Glendive and Sidney. The change in mean monthly flow attributable to Bighorn River flow alterations is remarkably consistent at the four locations (Table 4-5 and Figure 4-8). Slightly higher depletions during irrigation season and slightly more negative depletions during times of return flow at Glendive and Sidney may reflect greater irrigation depletion than estimated. Although the methodologies for estimating water use or depletion are similar and, thus, the datasets are not entirely independent, the consistent pattern of irrigation depletions and Bighorn River flow alteration influences increases confidence in estimation techniques and in the qualitative analysis of hydrologic alterations due to Yellowstone Basin irrigation and Bighorn River flow alterations.

Table 4-5
Monthly depletions with irrigation removed to estimate change in flow due to Bighorn River flow alterations

Month	Billings	Forsyth	Miles City	Glendive	Sidney	Mean
%Billings Withdrawal	100% (Baseline)	133% (cfs)	144% (cfs)	160% (cfs)	177% (cfs)	(cfs)
January	0	-1137	-1153	-1172	-1160	-1155
February	0	-907	-926	-940	-943	-929
March	0	-673	-678	-700	-692	-688
April	0	1184	1280	1290	1275	1270
May	0	6241	6757	7452	7464	6980
June	0	7294	7722	8180	7936	7786
July	0	5278	5810	6300	6248	5911
August	0	2788	3142	3490	3456	3221
September	0	600	714	800	767	721
October	0	-917	-1016	-1060	-1083	-1012
November	0	-1097	-1154	-1194	-1199	-1159
December	0	-1144	-1182	-1200	-1206	-1183

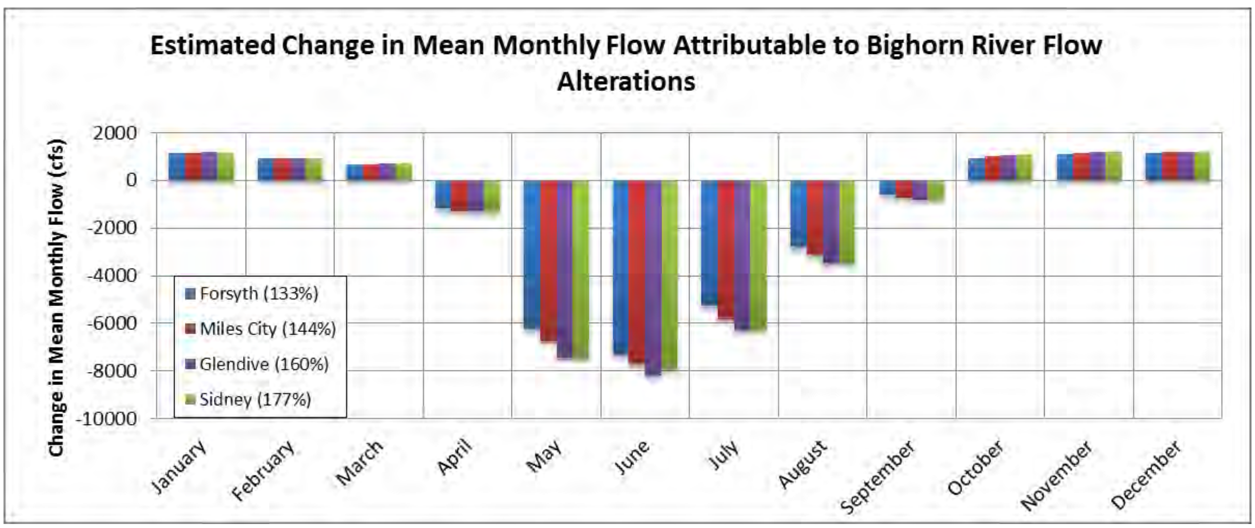

Figure 4-8 **Estimated change in mean monthly discharge attributable to Yellowtail Dam Operations on Bighorn River.**

The pattern of depletions to the Yellowstone River downstream of the Bighorn confluence is strongly influenced by Yellowtail Dam. Yellowtail Dam is operated in order to maximize three major priorities: hydropower generation, flood control and recreation/fisheries both above and below the dam. Hydropower generation and river fishery purposes benefit from stable reservoir releases over the winter months from November through March. During this time period the reservoir level is drawn down by as much as 25 feet (226 KAF). The effect on the Yellowstone River is to increase winter flows downstream of the Bighorn River. Although some negative depletions to fall and winter flows of the Yellowstone are due to irrigation return flow as demonstrated at the Billings gage, the dam contributes roughly 700 to 1200 CFS to the Yellowstone River during the fall and winter (Table 4-5).

Minor adjustments to releases are sometimes required prior to April 1, but unless spring runoff forecasts are much higher or lower than average, the release rates set in November are not changed. If forecasts for spring runoff are considerably higher than average, releases are increased to create space in the reservoir.

Beginning April 1, operation of the dam is governed by a rule curve based on desired reservoir elevations from April to July. The rule curve is updated frequently throughout the summer as forecasts are revised. The reservoir is filling during the spring and summer and depletions to the Yellowstone are substantial. Positive depletions to the Yellowstone River in April suggest that on average filling of the reservoir begins in April.

Releases from the reservoir in August through October are based upon an end-of-October reservoir elevation target of 3635 to 3640. An elevation of 3640 is the top of the joint-use conservation pool and the reservoir can be considered full. Elevations above 3640 are the exclusive flood control pool controlled by the United States Army Corp of Engineers. A target river release in August through October is 2500 CFS but if that target release prevents an end-of-October elevation of 3635 it will be reduced to a level sufficient to meet the end-of-March target elevation of 3617. The positive depletions to the Yellowstone River in August and September suggest that, in general, water is still accumulating in the reservoir in late summer contributing to low late summer flows. Figure 4-9 shows the daily average inflows and outflows at Bighorn Reservoir for 48 years of operation of Yellowtail Dam (1966-2013). The flow releases reflect discharges from the Yellotail Afterbay Dam to the Bighorn River (http://www.usbr.gov/gp/hydromet/index.html). The flow alterations due to the dam include increased winter flows, loss of definition of the early prairie runoff melt in mid-March, delay and suppression of spring runoff, and increased flows in August.

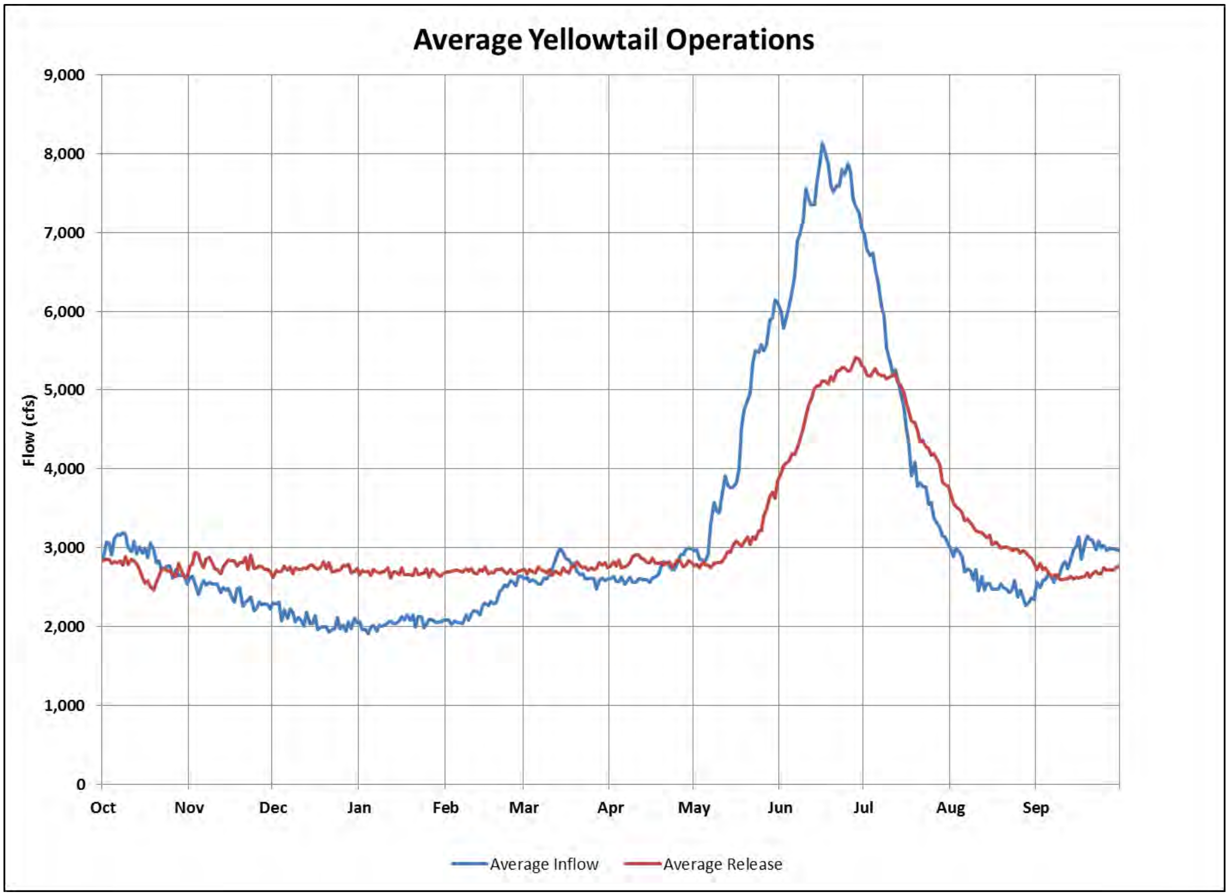

Figure 4-9 Inflow (blue) and outflow (red) hydrographs from Bighorn Reservoir showing effect of dam operations on Bighorn River hydrograph.

The difference in regulated versus unregulated flow at gages downstream from the Bighorn confluence shows a monthly pattern that is based upon irrigation depletions and Yellowtail Dam. These two influences are evident in the depletion patterns and tend to reinforce each other in terms of positive summer depletions and negative fall to winter depletions (Figure 4-10).

When compared to the total change in flow at the Forsyth gage, the estimations indicate that the relative influences of and Yellowstone Basin irrigation show a high degree of monthly variability (Figure 4-10 and Figure 4-11). During the winter months, over 80% of the increase in low flows is estimated to be due to dam operations, whereas the period of most strongly reduced flows (May to July) shows a much stronger influence of irrigation on streamflow patterns. Based on the estimates, the primary influence on flow reductions in August and September is irrigation.

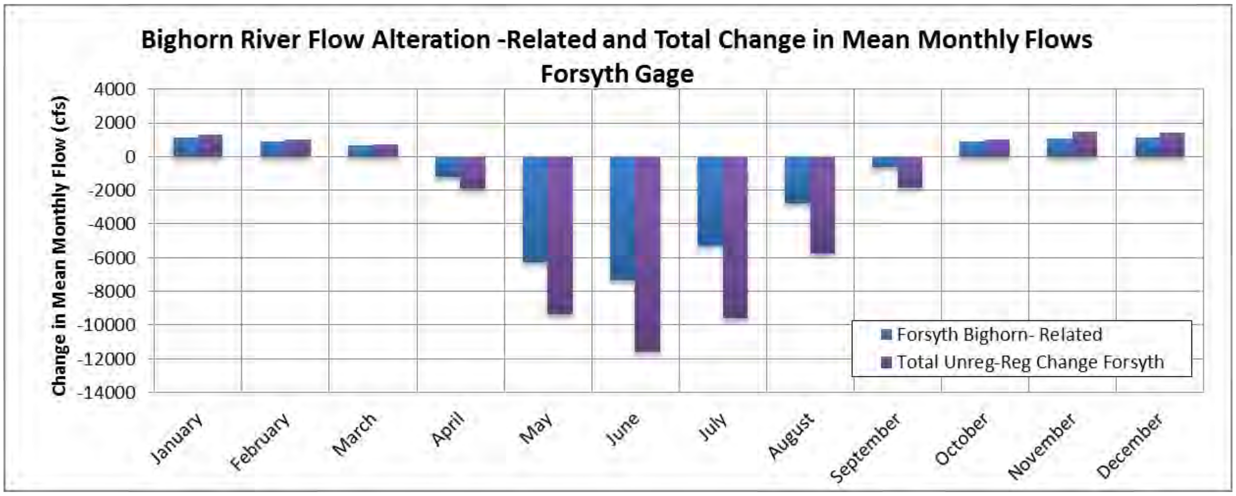

Figure 4-10 Comparison of change in monthly flow attributable to Yellowtail Dam operations and total change from Unregulated to Regulated conditions.

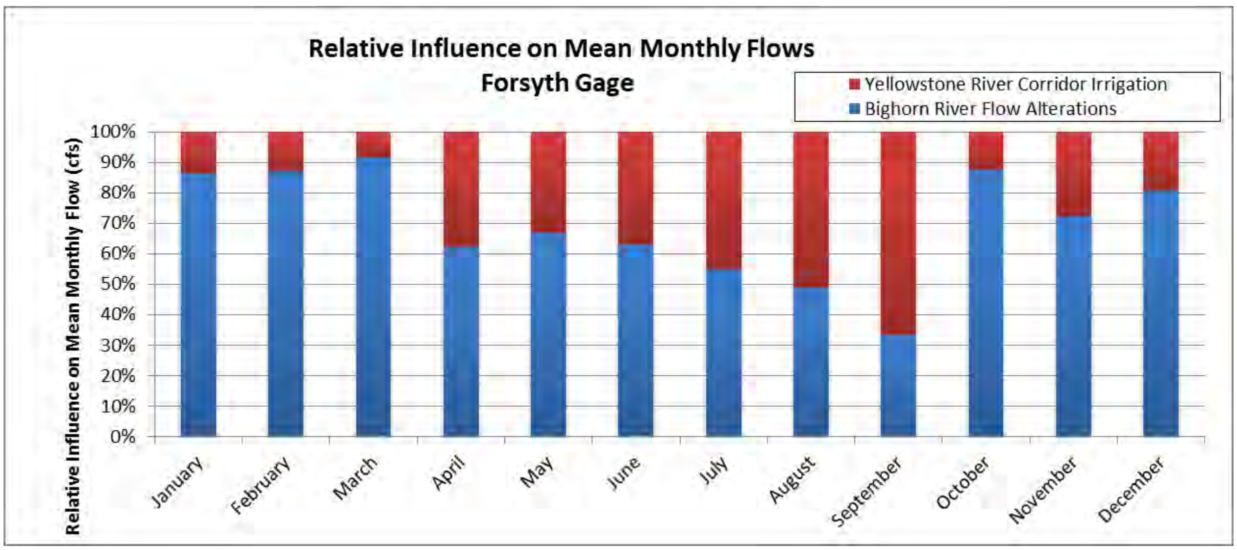

Figure 4-11 Estimated relative influence of Yellowtail Dam operations and irrigation on monthly flows at Forsyth.

The changes in mean monthly discharge of the Yellowstone River are accounted for primarily by irrigation depletions and the effects of Bighorn River flow alterations. One would expect that the 50-percent probability flow (Figure 2-9) would show a smooth increase in cumulative depletion from the headwaters to the confluence with the Missouri River with one major jump at the Big Horn River. This is the general pattern with the exception of a sharp increase in depletion at the Clarks Fork and a decrease in depletion at the Powder River. Although the data are interpolated between gaging stations (see Section 2.1) and care must be used in interpretation, there may be a physical explanation for these patterns. The level of appropriation on any tributary or stretch of the Yellowstone can be visualized by comparing the estimated water withdrawals as reported in the U.S.G.S. 2000 Water Use in Montana study upstream of a gage (Cannon and Johnson, 2004) with the 2000 mean annual flow of the tributary at the gage. The table below approximates water withdrawals on specific tributaries relative to the flow measured at their confluence with the Yellowstone (Table 4-6 and Figure 4-12). The same comparison is presented for several segments of the Yellowstone. For example, the estimated withdrawals in the Clarks Fork basin upstream of the stream gage are about 93% of the mean annual flow measured at the gage, indicating that the amount of water withdrawn is approximately equal to that reaching the mainstem Yellowstone River.

Although the ratios cited are only for comparison, the withdrawals on most stretches of the Yellowstone, the Stillwater and the Tongue cluster between 0.38 and 0.54. The Powder is far less appropriated (0.14) than most tributaries or the basin as a whole. Only the Bighorn gives comparable numbers and that tributary is strongly influenced by Yellowtail Dam. In contrast, the Clark’s Fork is highly appropriated (0.93). The noticeable increase in depletion at the mouth of the Clark’s Fork is possibly a result of that high appropriation. The decrease in depletion that occurs at the mouth of the Powder may reflect a relatively low appropriation. Two other noticeable results are the relatively low irrigation appropriation above Livingston and an increased irrigation appropriation in the lower Yellowstone.

4.4 Non-Irrigation

With regard to water uses other than irrigation, the primary 2000 use was for thermo-electric power generation. Cannon and Johnson (2004) stated the following in regards to this use:

All of the water used for this purpose was from surface water and was used for cooling purposes at fossil-fuel plants in Richland, Rosebud, and Yellowstone Counties. Power plants in Richland and Yellowstone Counties used surface water for once-through cooling and returned almost all withdrawn water back to the source (Figure 4-13). Power plants in Rosebud County recirculated their cooling water; however, that water was obtained from surface-water sources and was not returned to the source of withdrawal. Water consumed for thermoelectric power generation was about 27.70 Mgal/d, most of which was consumed in Rosebud County because cooling water used at power plants in Rosebud County was not returned to the source of withdrawal.

Table 4-6
Estimated withdrawal as percentage of mean annual flow.

Tributary	Estimated 2000 Withdrawals (CFS)	2000 Mean Annual Flow (CFS)	Ratio of Upstream Withdrawal to Flow at Gage.
Yellowstone (Livingston)	475.6	3338	0.14
Stillwater	196.5	515.2	0.38
Clark's Fork	815.9	881.5	0.93
Yellowstone (Billings)	2626.3	5371	0.49
Big Horn	375.3	2953	0.13
Yellowstone (Forsyth)	3506.3	8456	0.41
Tongue	115.3	237.7	0.49
Yellowstone (Miles City)	3776.8	8383	0.45
Powder	45.3	319.1	0.14
Yellowstone (Sidney)	4643	8576	0.54

* This ratio does not indicate the amount of water depleted from the tributary because it doesn't account for return flows and is based upon a single year (2000). The table should be used only for comparison purposes.

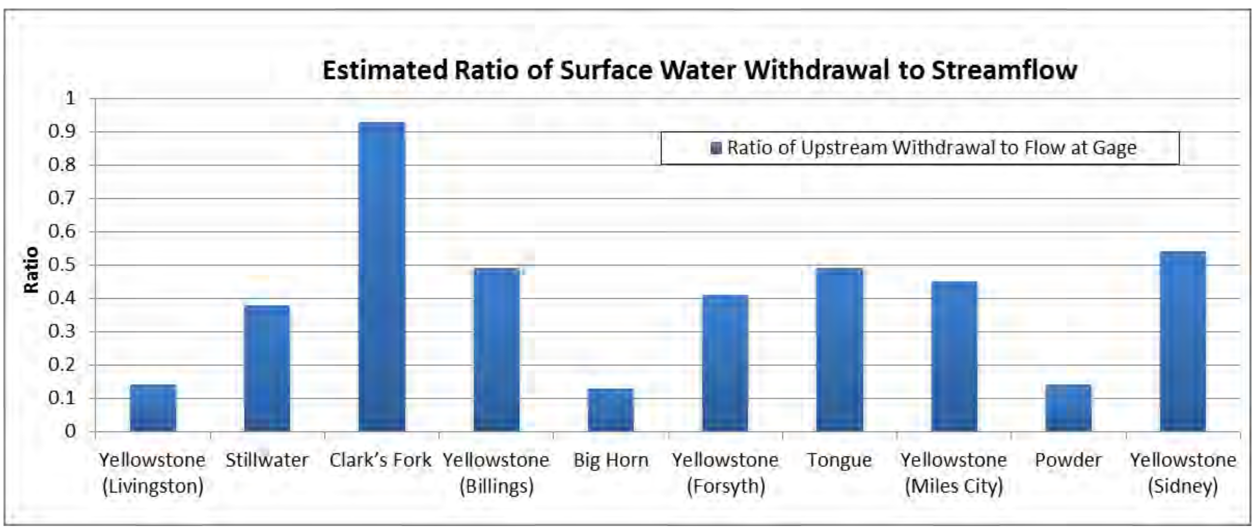

Figure 4-12 Estimated irrigation withdrawals as a percentage of mean annual flows in 2000; values do not include return flows and are provided as a general comparison.

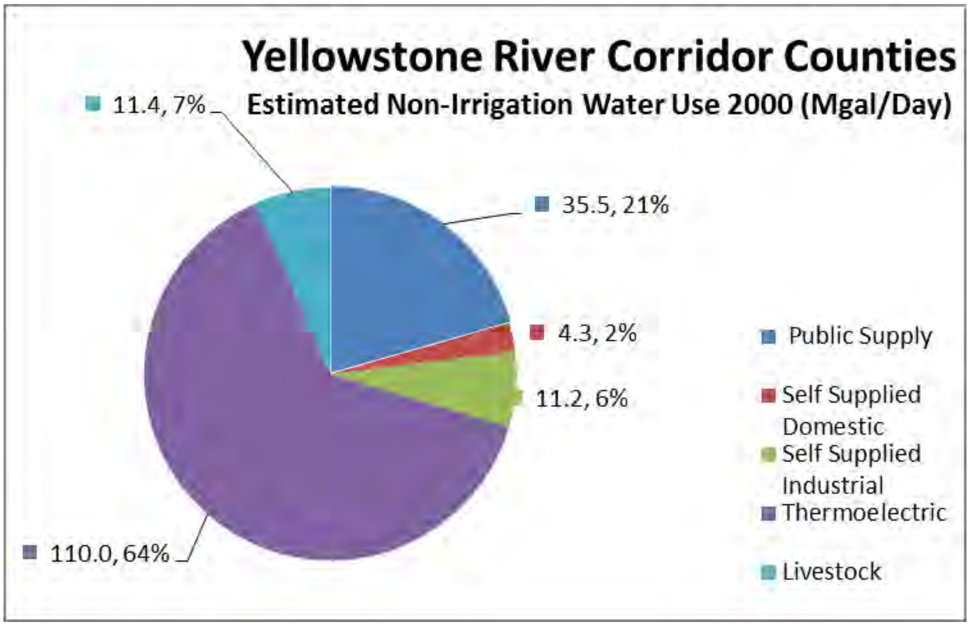

Figure 4-13 Non-irrigation water use estimated for year 2000, Yellowstone River Corridor Counties.

5.0 POTENTIAL HYDROLOGIC IMPACTS OF CLIMATE CHANGE

In their analysis of stream gage records on the Yellowstone River, Leppi and others (2012) concluded that climatic variables are influencing a decline in late summer baseflows on the upper Yellowstone River in Yellowstone National Park (Section 3.1). To date, the potential impact of climate change on the hydrology of the Yellowstone River has not been carefully assessed, although the body of research regarding the potential impacts of climate change in the Northern Rocky Mountain Region continues to develop. The Montana DNRC has noted that a growing number of studies have demonstrated that over the past 60 years or so, western North America has experienced a substantial decline in snow water equivalent, and that snowmelt runoff tends to occur earlier in the year. DNRC cites evidence that relative to pre-1950 conditions, more precipitation is falling as rain rather than snow, and low baseflow periods are more common (Montana DNRC, 2014a). Pederson and others (2011) assessed the historical variability and trends in snowpack records, stream gages, and meteorological stations within the Northern Rocky Mountain Regions and observed the following:

- A tendency for decreased snowpack and earlier melt at mid-elevation SNOTEL sites over the past four decades;
- Significant seasonal and annual decreases in the number of frost days ;
- Warmer spring temperatures and spring precipitation causing earlier snowpack depletion; and,
- An increased number of snow-free days

Pederson and others (2011) also indicate that the majority of the variability in selected snowpack and streamflow variables can be explained by changes in atmospheric circulation associated with Pacific Ocean surface temperatures.

In 2008, field and supervisory staff from Montana Department of Fish Wildlife and Parks (FWP) met with various stakeholders and scientists to discuss potential impacts of climate change on the biological resources of the Yellowstone River. A published summary of the Plenary Session conducted at that workshop includes describes a presentation by Wyoming State Climatologist Dr. Steve Gray, who described the following likely impacts of climate change in the Yellowstone River basin (Miller and others, 2008):

- Warmer temperatures throughout Montana;
- Earlier snowmelt
- Less snow accumulation as more winter precipitation falls as rain;
- More frequent and extreme droughts; and,
- More extreme variation in both temperature and precipitation.

As part of the development of a State Water Plan, Montana DNRC modeled a range of climate scenarios to estimate future shifts in temperature, precipitation and runoff. The results show that on a state-wide basis, virtually all model simulations project warmer temperatures and modest increases in precipitation (DNRC, 2014b). This results into either unchanged or increased streamflow volumes, with shifts in streamflow timing. The anticipated shifts in timing would be the result of an earlier snowmelt and an increase in rain relative to snow during the late winter and early spring. Figure 5-1 shows the modeling results for the Yellowstone River at Billings (DNRC, 2014b). Median daily hydrographs compiled for pre- and post- 1990 data on the Yellowstone River at Livingston show the same trend; over the past 15 years, runoff has typically started about a week earlier, and peaked 10 days earlier than it typically did between 1896 and 1990 (Figure 5-2).

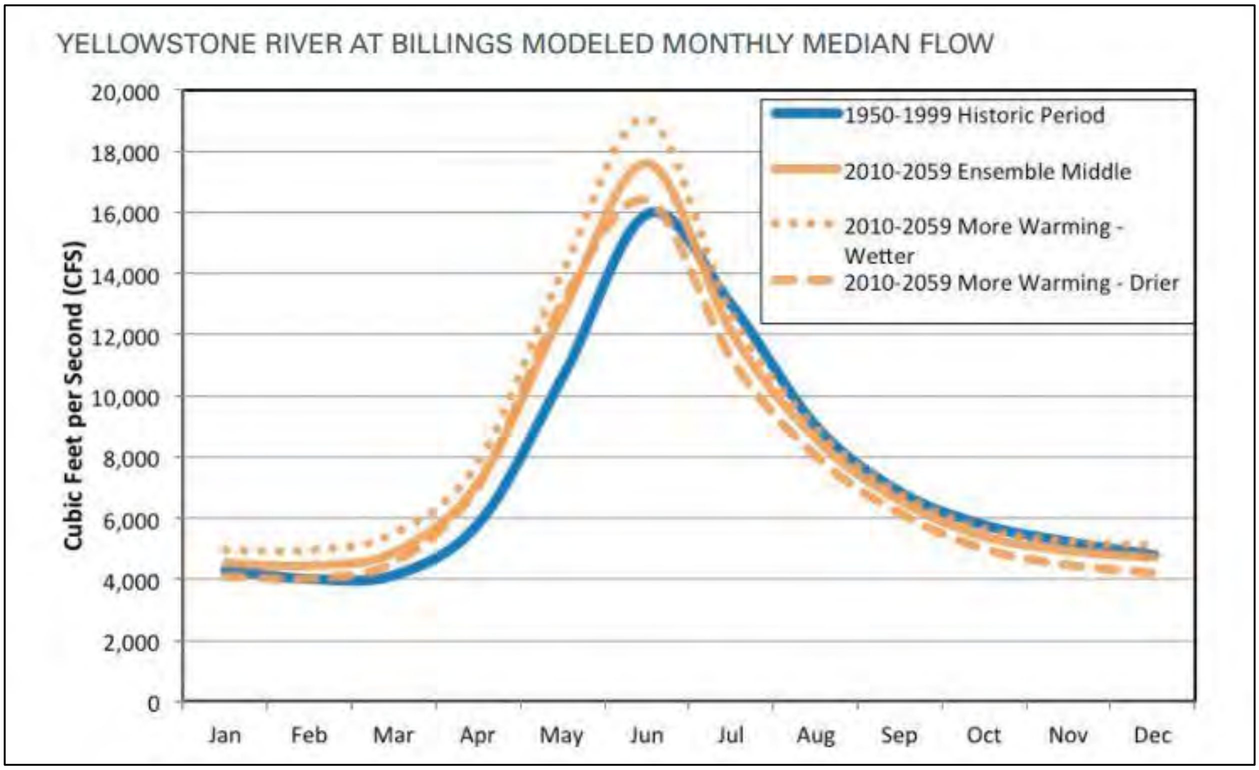

Figure 5-1 **Median monthly flow modeling results for Yellowstone River at Billings under future and historic climate scenarios (DNRC, 2014b).**

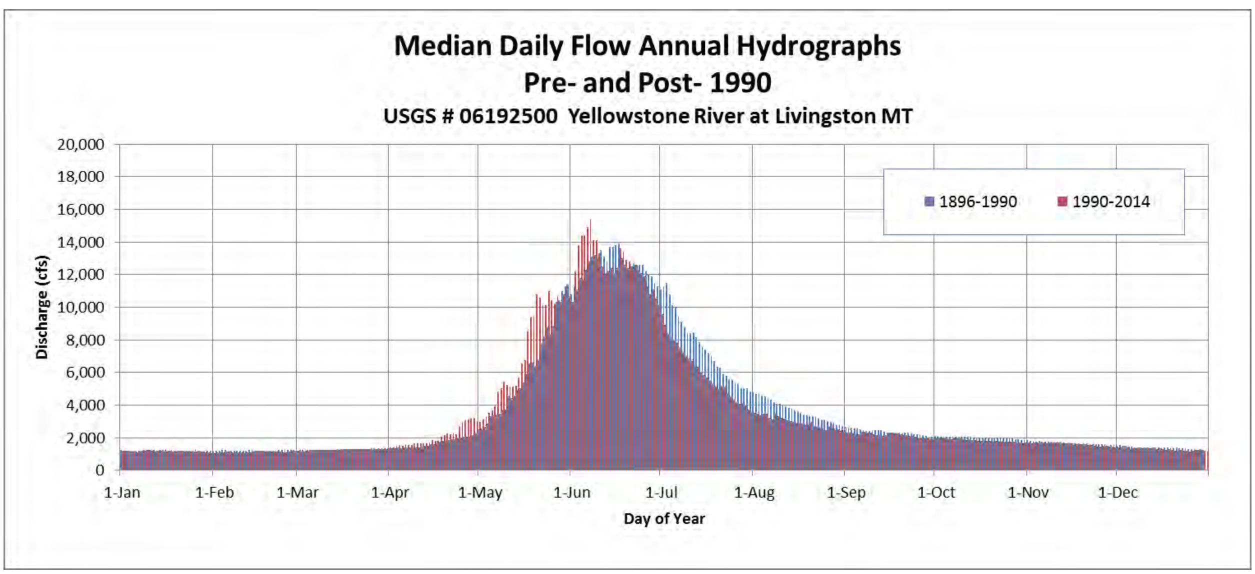

Figure 5-2 **Pre- and post- 1990 median daily hydrographs for Yellowstone River at Livingston showing recent shift to earlier runoff.**

6.0 LONG-TERM FLOW RECONSTRUCTIONS

Tree ring analyses by Bryan Swindell (Swindell, 2011) showed that within the Bighorn Basin, the 20th century was relatively wet compared to previous centuries, and that over the last 800 years, droughts were at least as long and severe as recent droughts. Pre-20th Century droughts consistently exceeded later droughts in terms of duration and intensity (Figure 6-1). The results are provided to provide some larger scale context for Yellowstone River hydrology. In terms of water availability, historic drought severities indicate that the flow statistics described for undeveloped to developed conditions could be substantially altered by drought scenarios that have occurred repeatedly prior to 1900.

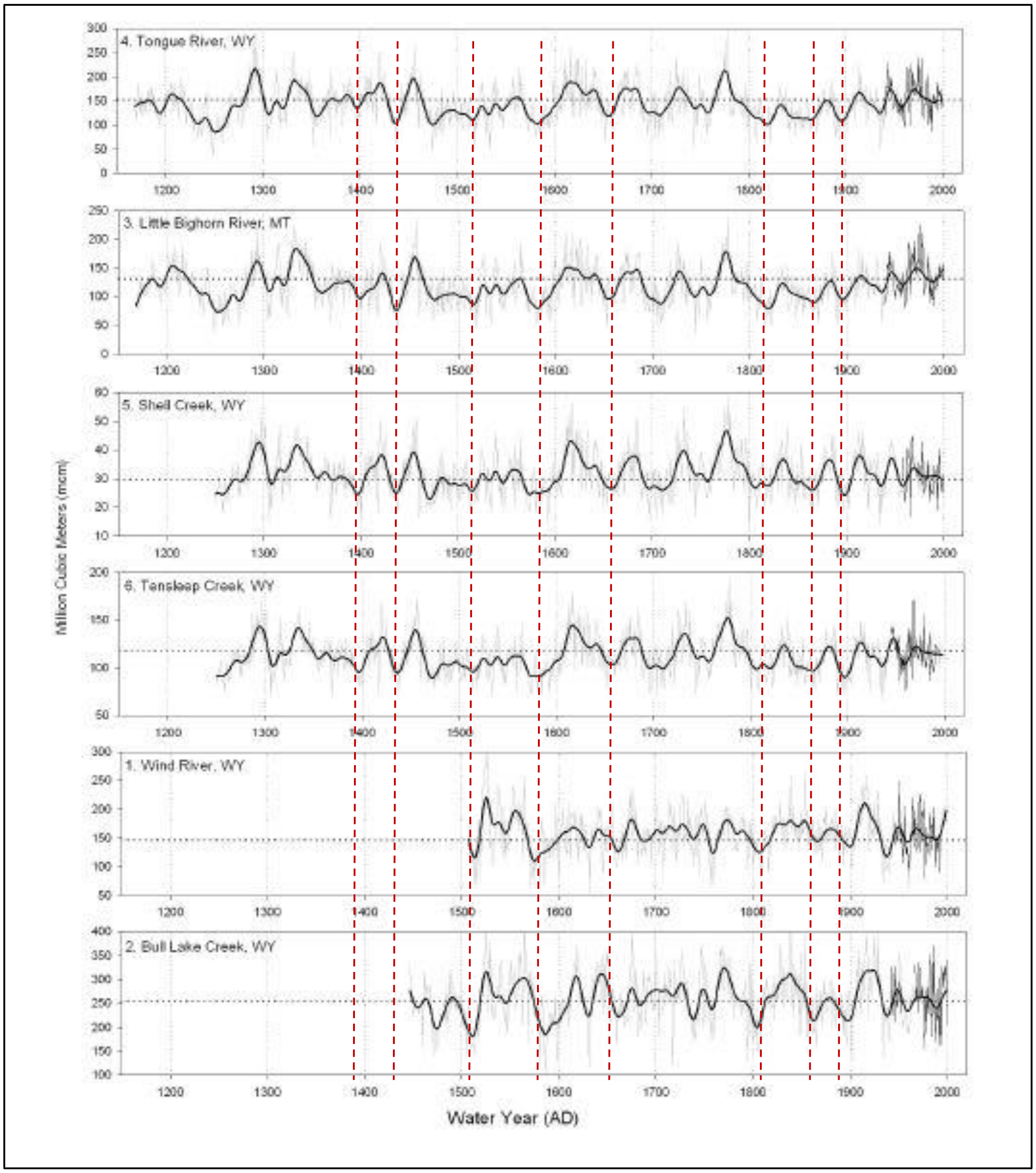

Figure 6-1 **Tree-ring-based streamflow reconstructions showing 20-year smoothing splines (bold black lines) from 1200 to 2001 (Swindell, 2011); example drought events shown by vertical dashed line.**

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 3

Floodplain Connectivity (Hydraulic Assessment)

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1.0 INTRODUCTION

This Appendix summarizes the comparison of the hydraulic mapping products generated by the US Army Corps of Engineers in support of the Yellowstone River Cumulative Effects Assessment (CEA). The Yellowstone River Corridor was modeled utilizing the HEC-RAS software and resulting water surfaces were delineated as part of the Hydraulic Analysis. This Floodplain Connectivity analysis compares the delineated floodplain boundaries under various conditions for the 2-, 5- and 100-yr flood events in an effort to characterize the impact of human influences on floodplain and side channel access in the Yellowstone River corridor.

The primary data sources used include the following:

1. Hydrologic Analyses Described in Appendix 2: Hydrology

2. Hydraulic Modeling Results Developed by the US Army Corps of Engineers (USACE, 2014):

The project reach for this assessment extends from Springdale (Park/Sweetgrass County Line) to the Missouri River confluence, a distance of 477 miles. Park County, which is located upstream of Springdale, was not included in the analysis. Hydraulic modeling of Park County was performed previously as part of the Upper Yellowstone River Task Force using different methodologies, and those results are not comparable to those presented here.

1.1 Major Findings in Support of Cumulative Effects Analysis

The primary findings of the hydraulic analysis of floodplain connectivity that may support multiple aspects of the CEA include the following:

1. Between Springdale and the mouth of the Yellowstone River (477 river miles), over 21,000 acres of 100-year floodplain area have been isolated due to physical encroachments, agricultural development, and hydrologic alterations.

2. The largest single contributing land use to floodplain isolation is reduced peak flows.

3. Land use influences are concentrated in localized areas of the river corridor.

4. Upstream of the Bighorn River confluence, typically less than 20% of the 5-year floodplain has been isolated; downstream of the confluence over 40% of the historic 5-year floodplain is now inaccessible to a 5-year flood.

5. Currently, there are about 6,300 acres of irrigated land within the existing 5-year floodplain footprint; 5,376 acres in flood irrigation and 871 acres under pivot irrigation

6. In total, there are over 17,000 acres of irrigated land in the historic 5-year floodplain.

7. If the 5-year floodplain could be used to approximate the minimum size of the Yellowstone River riparian forest, it could be estimated that at least 17,000 acres of historic riparian forest in the Yellowstone River corridor have been converted to irrigation, which translates to about 26 acres of conversion per river mile.

8. Isolation of the 2-year floodplain has resulted in reduced seasonal high flow channel inundation during that event.

9. The extent of 2-year floodplain isolation has been most significant between the confluences of the Bighorn and Tongue Rivers, where the developed 2-year inundation footprint is on the order of 40% smaller than that under undeveloped conditions.

2.0 FLOODPLAIN ISOLATION: COMPARISON OF "REGULATED AND "UNREGULATED" CONDITIONS

Floodplains are relatively flat topographic surfaces that are adjacent to rivers and prone to periodic flooding. Floodplains are commonly referred to in terms of the area inundated during a given flood event; for example, the 100-year floodplain, which is the area inundated during a 100-year flood event, is larger than the 5-year floodplain, which is the area inundated during a more frequent, smaller magnitude 5-year event. Floodplains provide functions that are an integral component of overall river health; including floodwater storage, aquifer recharge, soil rejuvenation, and creation of diverse habitats. During a flood, inundation on the floodplain area can dampen flood waves, reducing stream velocities and magnitudes downstream. The percolation of floodwaters into the floodplain alluvium recharges that shallow aquifer. When inundated, floodplains filter runoff and distribute nutrients and sediment.

Several types of river/floodplain alterations can result in the isolation of floodplain area and loss of its functions. Floodplains can be isolated due to reduced flows caused by dams or water withdrawals. Levees, commonly built to control flooding, directly isolate floodplain areas. And channel downcutting can result in the physical perching of the adjacent floodplain. The intent of this assessment is to evaluate the impacts of human development in the Yellowstone River corridor on floodplain connectivity for a series of flood events.

The main analysis performed to evaluate floodplain connectivity consists of a comparison of floodplain inundation extents under "unregulated" and "regulated" flow conditions, defined as the following:

- ***Unregulated:*** Flow statistics for a hydrologic record for which the effects of streamflow regulation have been removed; and,
- ***Regulated:*** Flow statistics for a hydrologic record that has been adjusted to represent near-present day (based on 2002) levels of development.

For the purposes of the Cumulative Effects Study, ***"Unregulated" reflects the undeveloped flow condition, whereas "Regulated" reflects the modern developed flow condition.***

The methodology applied to the floodplain connectivity assessment consisted of the following:

1. Develop flow statistics for Unregulated (Undeveloped) and Regulated (Developed) conditions within the river corridor (these results are summarized separately in Appendix 2: Hydrology.
2. Develop a HEC-RAS model of the Yellowstone River under current conditions.
3. Develop a second model to depict undeveloped conditions: remove all physical features such as dikes, berms, and transportation encroachments from model, and adjust roughness values in urban areas.
4. Run the model using undeveloped flows and undeveloped floodplain.
5. Run the model using developed flows and developed floodplain.
6. Intersect resulting inundation polygons for the "regulated" and "unregulated" conditions to identify areas historically connected but currently disconnected.

7. Attribute major areas (over 5 acres in extent) that have been isolated in terms of cause of disconnection.

8. Evaluate results.

This methodology was carried out for the 100-year floodplain. For the 5-year floodplain, isolated areas both less than and greater than 5 acres were summarized by total acreage, and not attributed in terms of cause of disconnection. For the 2-year floodplain, isolated acreages were not available, so the HEC-RAS modeling output was used to evaluate change in wetted topwidth under undeveloped and developed conditions, as a surrogate for inundated floodplain and channel areas.

Both the undeveloped and developed HEC-RAS models used existing conditions terrain data, which defines both river location and channel size. As a result, the unregulated/unregulated model output does not capture potential historic differences in channel form or location.

Figure 2-1 shows example output of the inundation polygons that were intersected to calculated change in inundated area for the 5- year flood event.

Note: This analysis was not performed for Park County.

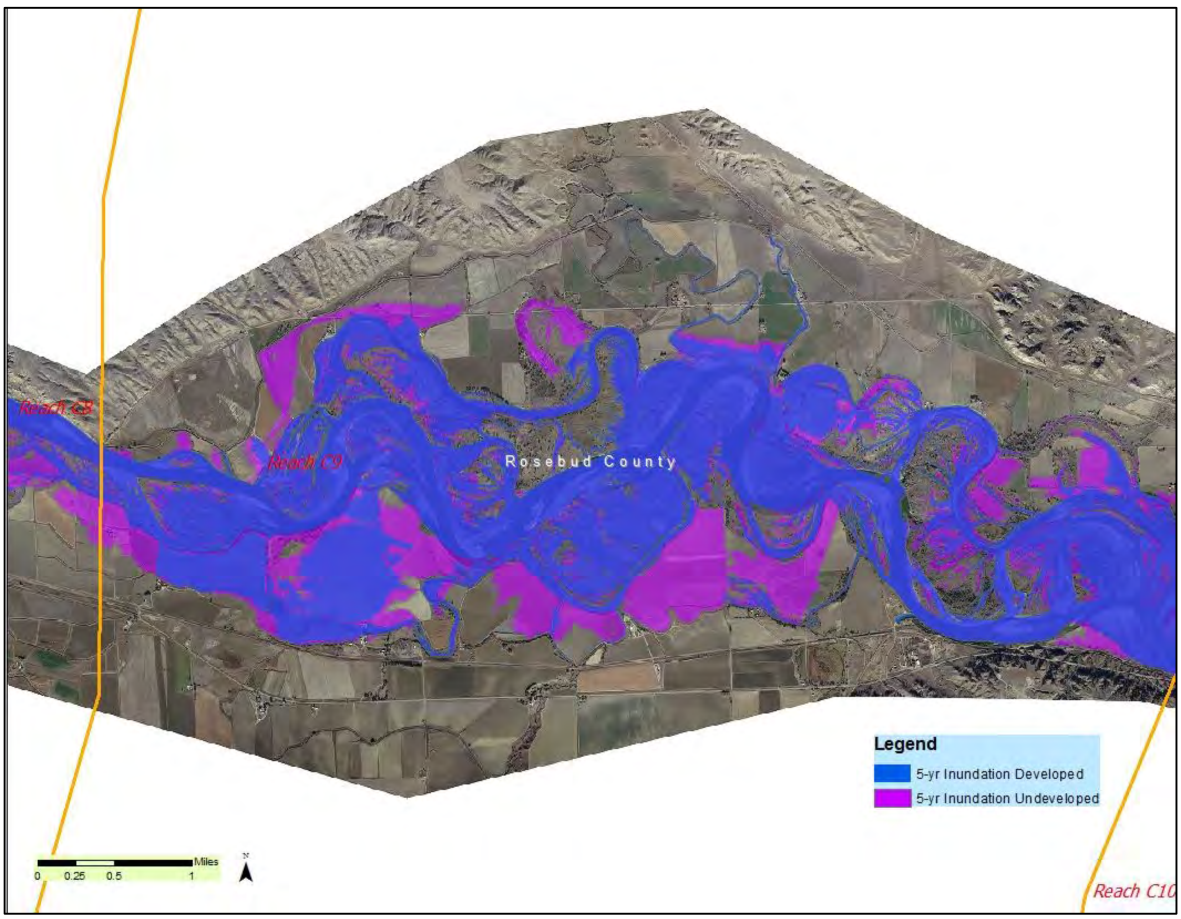

Figure 2-1 Example output (Reach C9 in Rosebud County) showing difference between 5-year undeveloped and 5-yeardeveloped conditions floodplain inundation.

2.1 Isolation of Historic 100-Year Floodplain

Areas of isolated 100-year floodplain that are larger than 5 acres have been summarized and attributed by cause of isolation. The isolation reflects either the influence of physical blockages such as dikes, levees, or transportation encroachments, or the influence of an altered hydrologic regime on flow levels. The most extensive loss of 100-year floodplain area has occurred between Bighorn River confluence and Miles City, where over 10,000 acres of historic floodplain has been isolated from the river (Figure 2-2). Relatively high rates of cumulative floodplain also occur below Intake.

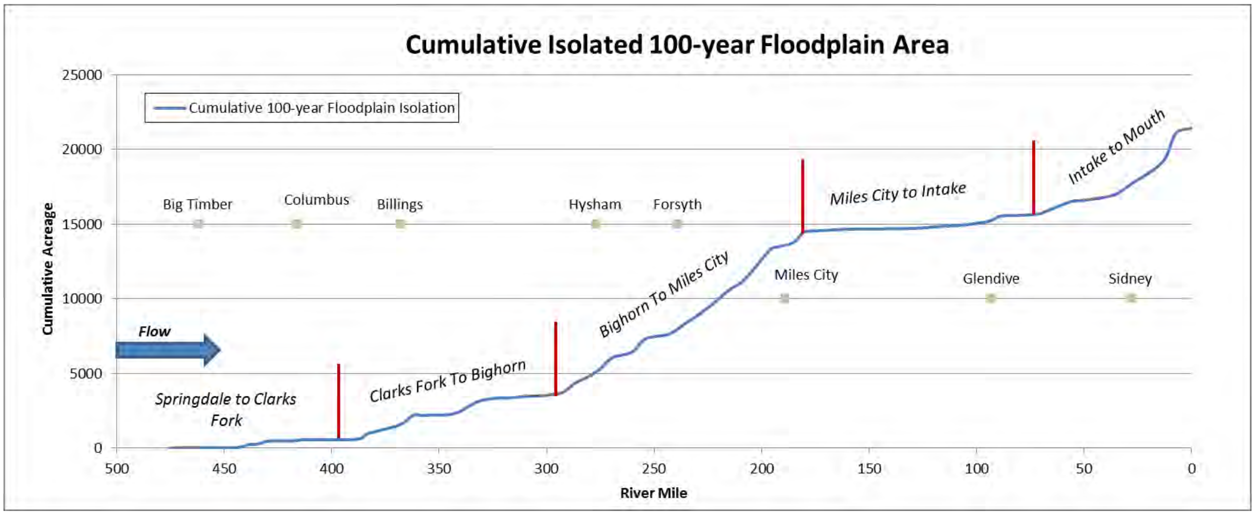

Figure 2-2 Cumulative floodplain isolation for all land uses.

2.1.1 Land Use Relationships

Areas of isolated 100-year floodplain have been attributed in terms of the following land uses:

1. ***Transportation:*** Highways, roads and bridges;
2. ***Abandoned Railroad:*** Includes the abandoned Milwaukee Line, which is a prominent floodplain feature in Region C (Bighorn River to Powder River);
3. ***Railroad:*** Active rail lines
4. ***Urban/Exurban Development***
5. ***Agriculture:*** Specific agriculture-related features including topographic modifications, irrigation ditches, levees, and riprap;
6. ***Hydrologic Alterations:*** Those changes where a reduced floodplain footprint is not associated with any discreet physical feature, such that the loss is more closely associated with the reduced flows in the Regulated Flow condition. In many cases these polygons include agricultural lands where grading may have contributed to the isolation.

Figure 2-3 shows an example of a reach with several identified causes of floodplain isolation. On the north side of the river valley, the abandoned Milwaukee line has isolated the undeveloped 100-year floodplain, and the modern rail line on the south side the valley has similarly isolated historic floodplain against the valley wall. Within the active meanderbelt, floodplain has been isolated by hydrologic alterations, some of which may be exacerbated by agricultural field grading.

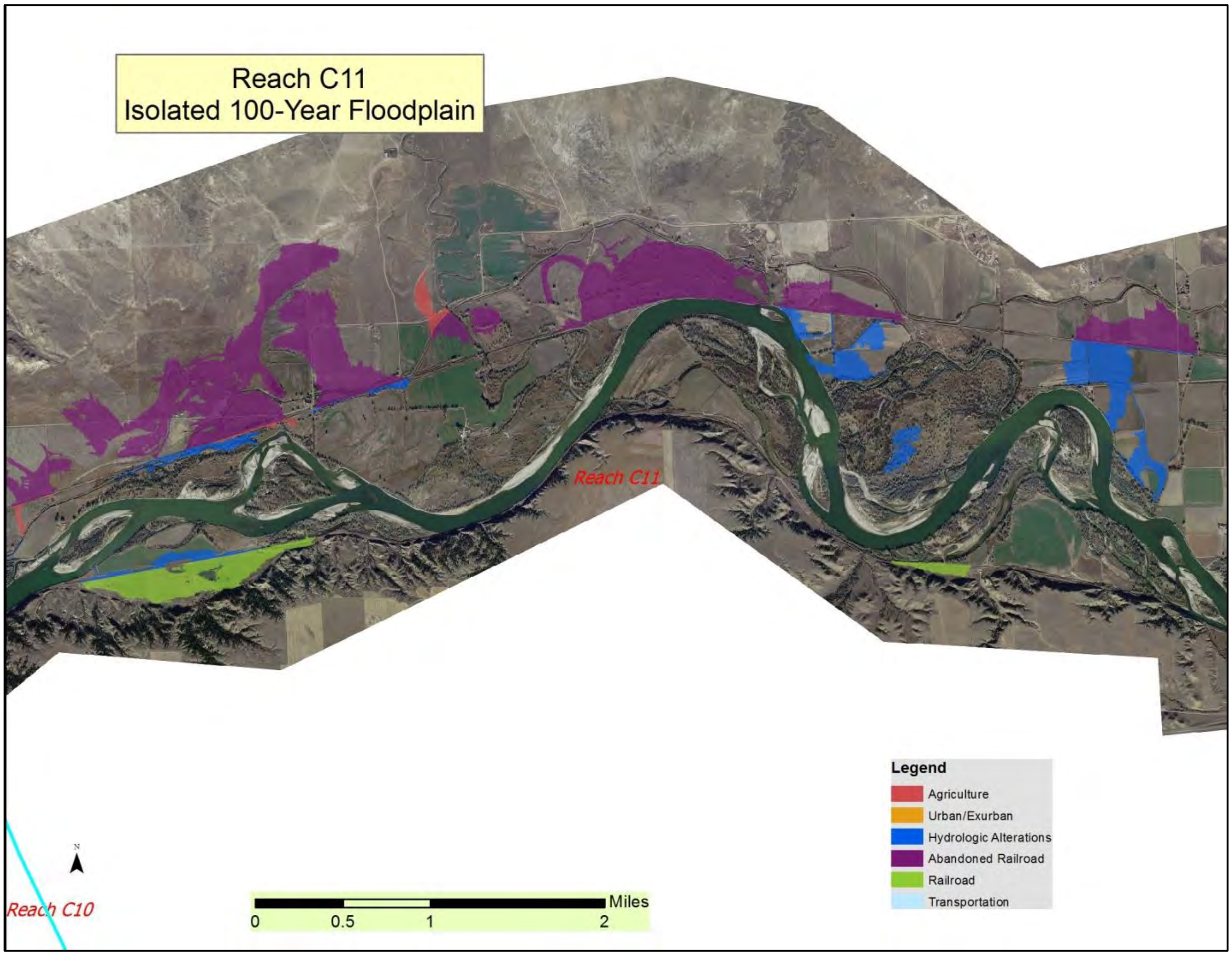

Figure 2-3 Example 100-year floodplain isolation polygons, Reach C11 below Forsyth.

Table 2-1 and Figure 2-5 show the total acreage of floodplain isolated by type of impact for the entire study reach (Park County data were not available). The most prominent impact is flow alterations, followed by active railroad embankments and agriculture (Figure 2-4). Of the 8,604 acres of floodplain isolated due to reduced peak flows, some of those isolated areas on agricultural lands may also be affected by land grading and drainage modifications (Table 2-1).

Table 2-1
Total Acreage of 100-year Floodplain Isolation.

Impact	Floodplain Isolation (acres)
Hydrologic Alterations	8,604
Agriculture	3,720
Railroad	3,526
Abandoned Railroad	2,303
Transportation	2,054
Urban/Exurban	1,230
TOTAL	21,437
Agriculture:	
Irrigation Ditch	1,388
Agricultural Levee/Riprap	2,331
TOTAL Agriculture	3,720

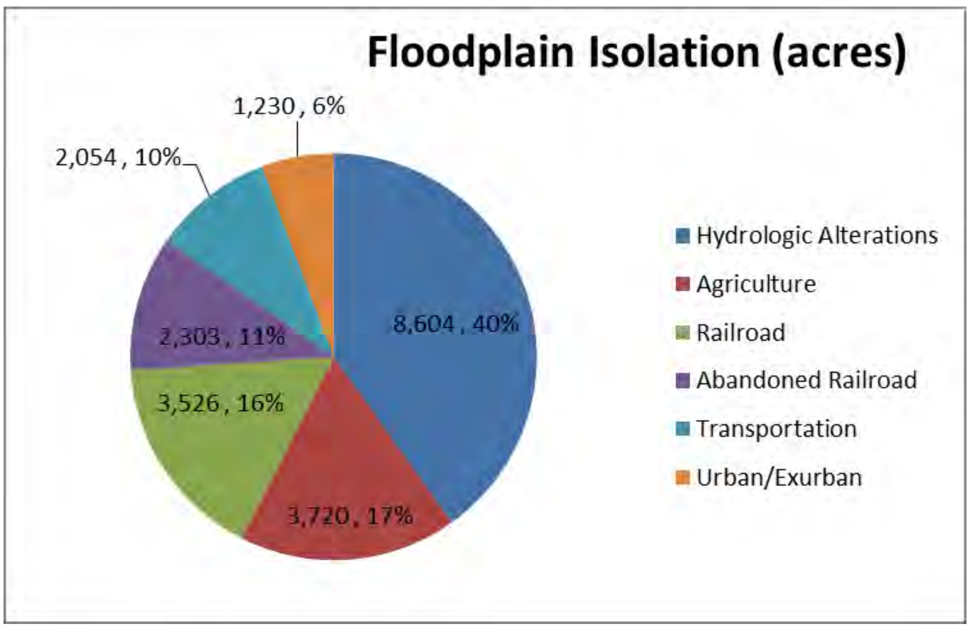

Figure 2-4 Relative influence of land uses on 100-year floodplain isolation.

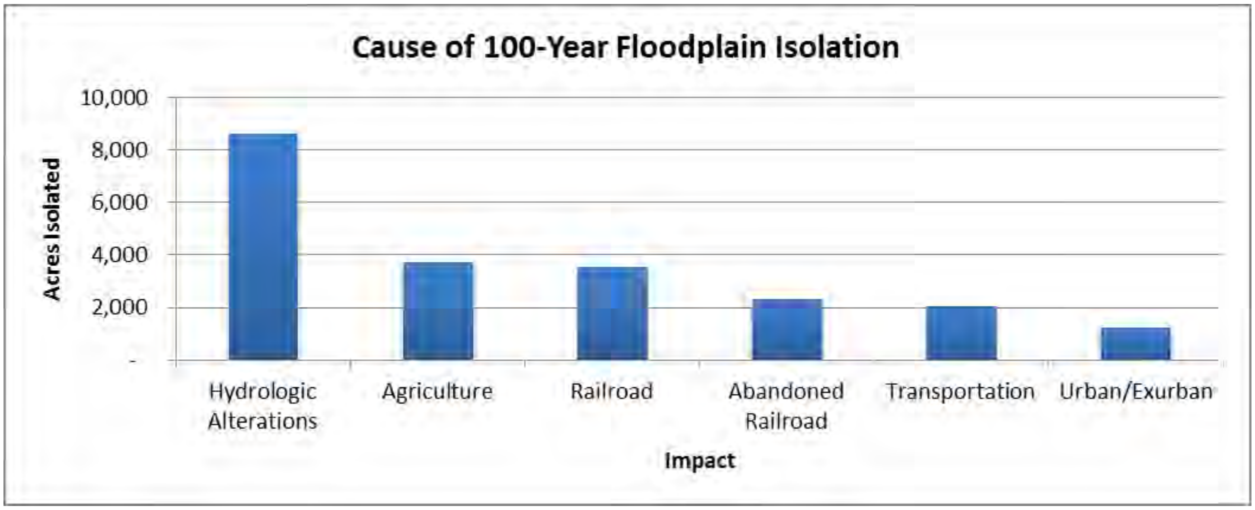

Figure 2-5 Total floodplain isolation by type of impact.

Figure 2-6 and Figure 2-7 show the extent of floodplain isolation by reach. The most extensive areas of isolation are as follows:

1. ***Reaches A18-B2:*** This area extends from Laurel to Billings, where the vast majority of floodplain isolation is transportation related, primarily due to the I-90 Interstate embankment.

2. ***Region C:*** From the mouth of the Bighorn River to Reach C14 at Hathaway, the Yellowstone Valley is especially broad, supporting agriculture and some development. The abandoned Milwaukee rail line parallels the river on the north floodplain, and the active line is on the south. As the valley is broad and flat in this area, hydrologic alterations have also resulted in substantial reduction in floodplain area. Development–related floodplain isolation in Region C is mainly due to the urban levees in Forsyth (C10) and Miles City (C17).

3. ***Region D:*** The lowermost portion of the river below Intake (D9) is also very broad and extensively farmed. Most of the isolation in this area is due to contraction of the flat floodplain due to flow alterations; much of this area is agricultural ground that may also be affected by field grading/ topographic modifications.

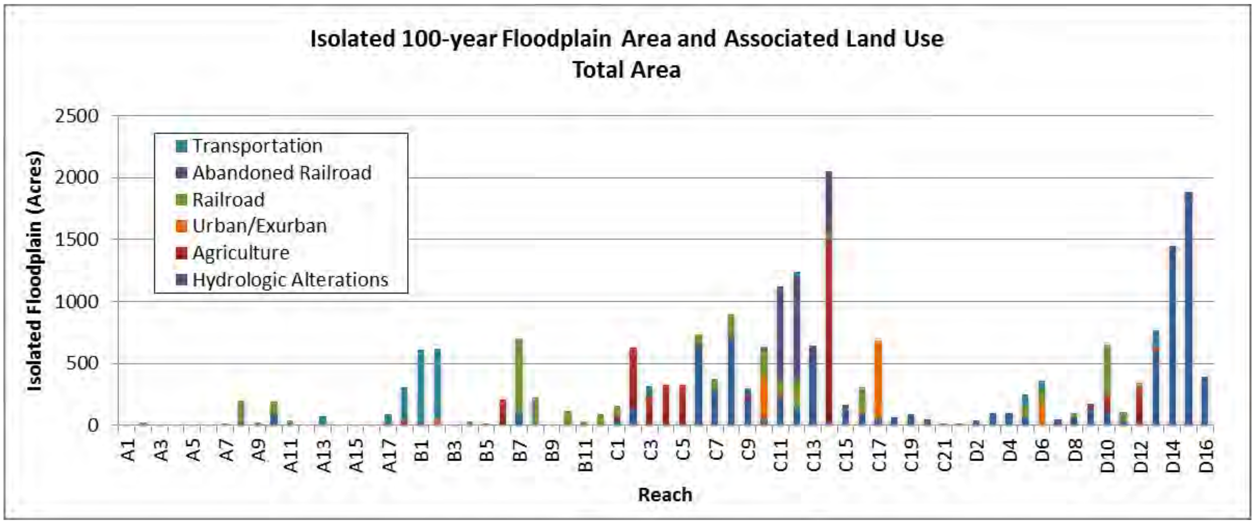

Figure 2-6 Total floodplain isolation by reach.

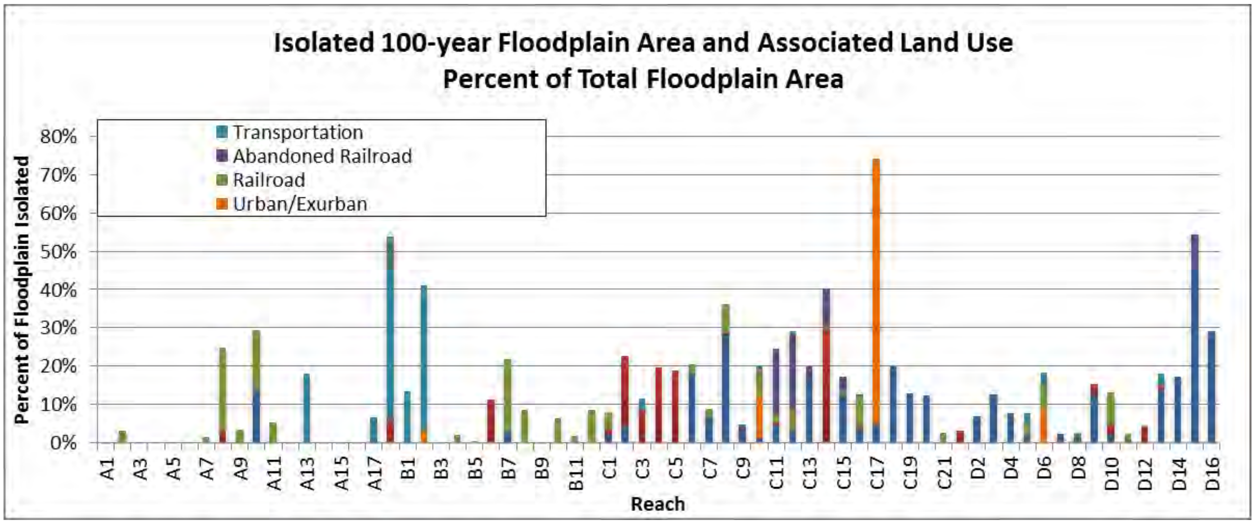

Figure 2-7 Percent floodplain isolation by reach.

Figure 2-8 shows that with respect to each land use, the floodplain isolation is concentrated in given areas. For example, transportation-related isolation is almost entirely occurring in the vicinity of Billings. Agricultural isolation is most common near Hysham and upstream of Miles City. The influences of specific aspects of agricultural land uses on floodplain isolation are summarized in Figure 2-9. Floodplain isolation from the individual influences of ditches and levees are spatially concentrated in a very few areas. Ditch berms are most pronounced just upstream of Hysham, with riprap and levees concentrated upstream of Miles City. The area of extensive floodplain isolation due to agricultural development is shown in Figure 2-10; this area has a long series of low dikes that have isolated floodplain area north of the river. Table 2-2 summarizes the primary causes of floodplain isolation, areas of impact, and associated land use drivers.

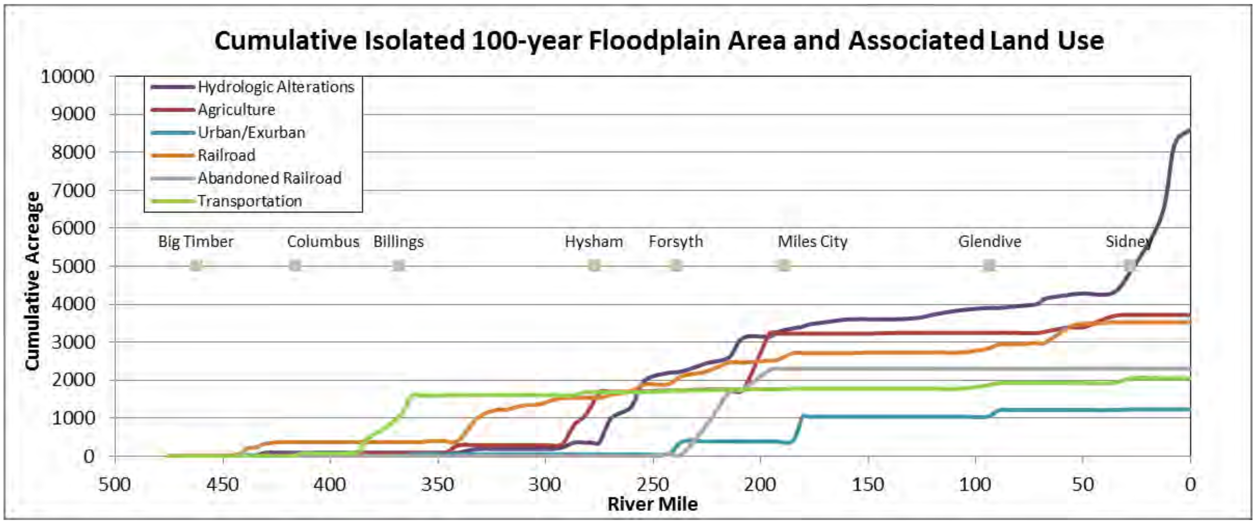

Figure 2-8 Cumulative floodplain isolation; values accumulate in the downstream direction.

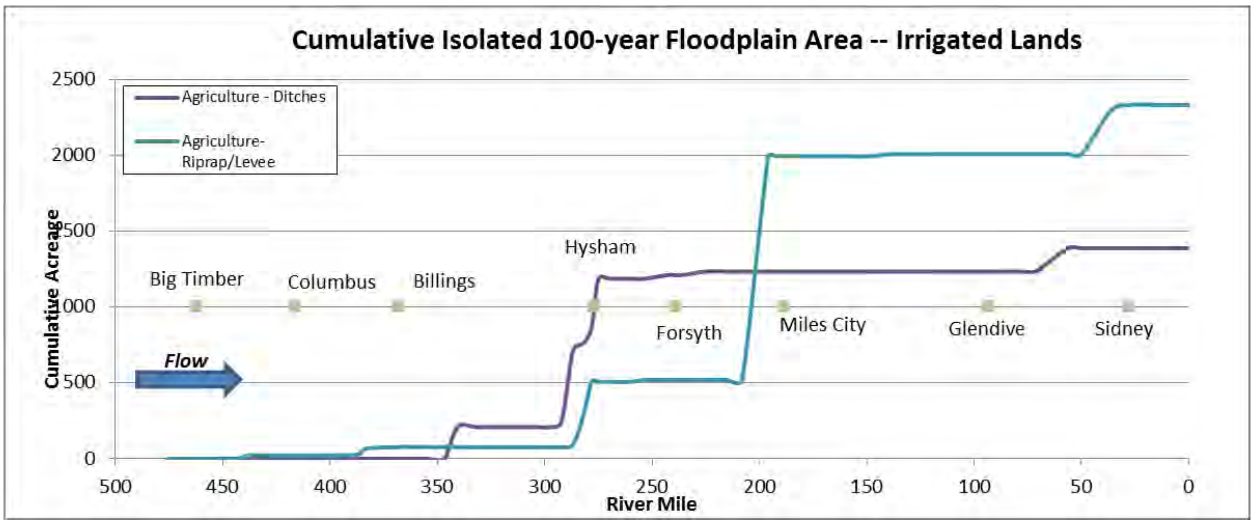

Figure 2-9 Cumulative floodplain isolation associated with agricultural land uses.

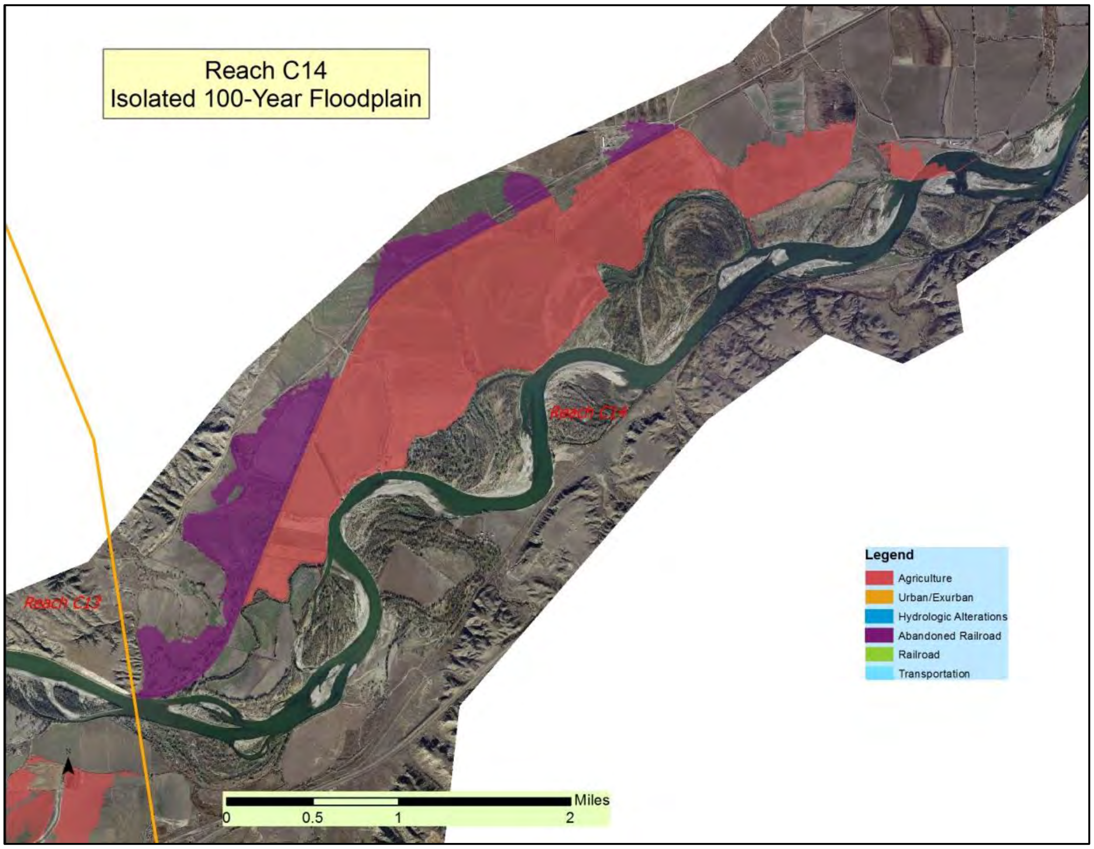

Figure 2-10 **Isolated floodplain area in Reach C14 upstream of Miles City showing impacts of agricultural and abandoned railroad land uses.**

Table 2-2
Summary of main locations and causes of floodplain isolation.

Cause of Isolation	Area(s) of Impact	Main Driver(s)
Hydrologic Alterations	Below Hysham	Yellowtail Dam impacts in broad flat valley sections
Urban/Exurban	Forsyth, Miles City, and Glendive	Urban levees
Railroad	Below Billings; greatest impact above between Billings and Hysham	Direct isolation by active rail line
Abandoned Railroad	Forsyth to Miles City	Abandoned Milwaukee Line
Transportation	Billings	I-90
Agriculture		
Dikes and Levees	Bighorn to Hysham, western Custer County	Agricultural Levees
Irrigation Ditches	Bighorn to Hysham	Ditch Embankments

2.2 Isolation of Historic 5-Year Floodplain Area

Isolation of the 5-year floodplain was evaluated in a similar fashion as the 100-year floodplain analysis, however in this case all acreage was summarized, not just areas greater than 5-acres in extent. This is because the 5-year floodplain is relatively complex and discontinuous, so capturing isolation required a more detailed summary of relatively small isolated areas. Because of the very large number of polygons summarized, they were analyzed for total acreage rather than cause of isolation.

In terms of the percent reduction in floodplain area, the 5-year floodplain area shows a 20- to 50-percent reduction in overall footprint between undeveloped and developed conditions (Figure 2-11). The isolation of the 5-year floodplain has been most prominent downstream of the Bighorn River confluence (Reach C1).

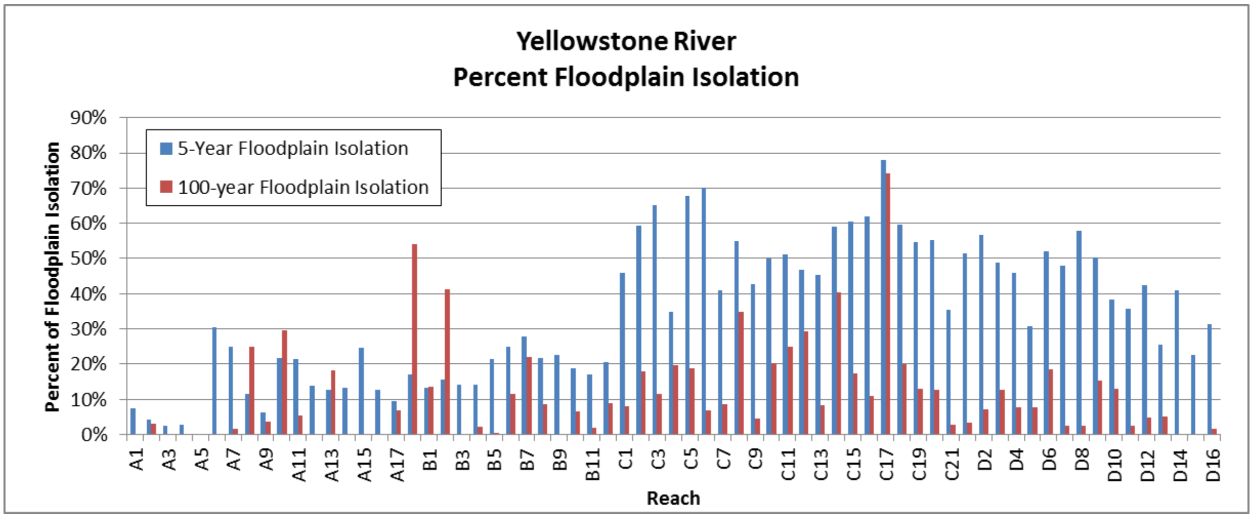

Figure 2-11 Percent of 5- and 100-year floodplain isolation by reach.

2.2.1 Land Uses in Historic and Modern 5-Year Floodplain

The 5-year floodplain on the Yellowstone River typically consists of relatively low river bottom lands that support the riparian corridor as well as irrigated and non-irrigated lands. As described above, portions of the historic 5-year floodplain are no longer inundated at a 5-year flood event. Figure 2-12 shows example output for the undeveloped condition model for the 5-year event in Reach C10 upstream of Forsyth; Figure 2-13 shows the model output at the same location for the developed condition. The comparison of the two shows substantial reduction in overall floodplain area under developed conditions; this historic floodplain isolation is due to both physical features blocking the floodplain and flow alterations.

The 5-year floodplain is an important area within the stream corridor in that it is relatively frequently inundated, such that development in these areas will be prone to flood damages. Furthermore, areas of land use conversions within the five year floodplain may provide opportunities for riparian restoration or recovery of flood channels that provide protective aquatic habitat during floods.

In order to provide some perspective on current and historic land uses in both the modern and historic 5-year floodplain, the modeled flood footprints were intersected with land use and riparian mapping polygons generated independently in support of the Cumulative Effects Analysis. This is a different dataset than that generated for the 100-year floodplain; whereas the 100-year floodplain analysis identified the cause of isolation, this dataset reflects simply the land use within the isolated floodplain area. Results indicate that there are a total of 10,990 acres of irrigated land in the isolated 5-year floodplain areas throughout the entire river corridor. The vast majority of this irrigated land is within

Region C, between the mouth of the Bighorn River and Miles City (Figure 2-14). Most of this irrigated ground is in flood irrigation, with several reaches showing pivot irrigation development in the historic 5-year floodplain footprint as well.

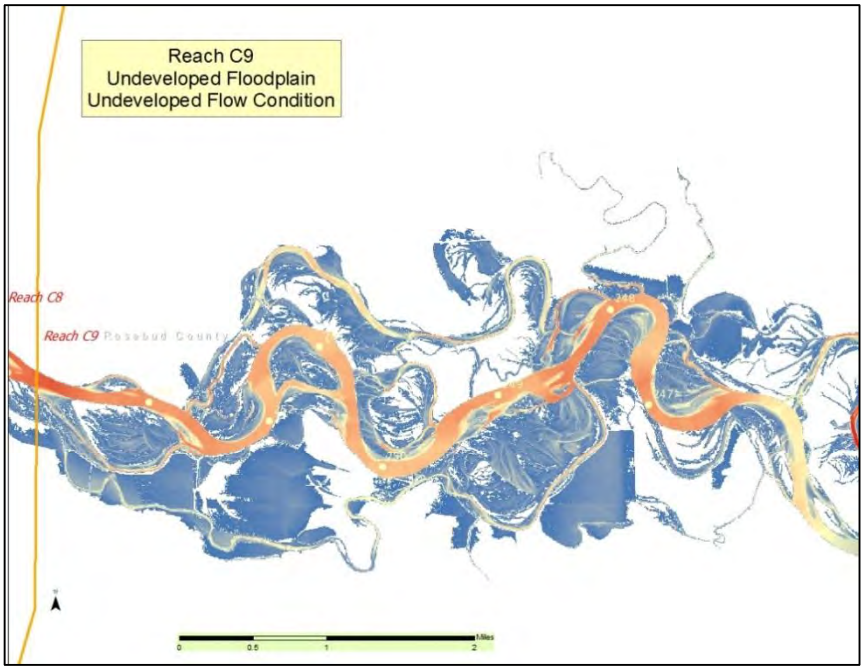

Figure 2-12 Reach C9 modeling results showing 5-year floodplain inundation and depth grids for undeveloped conditions.

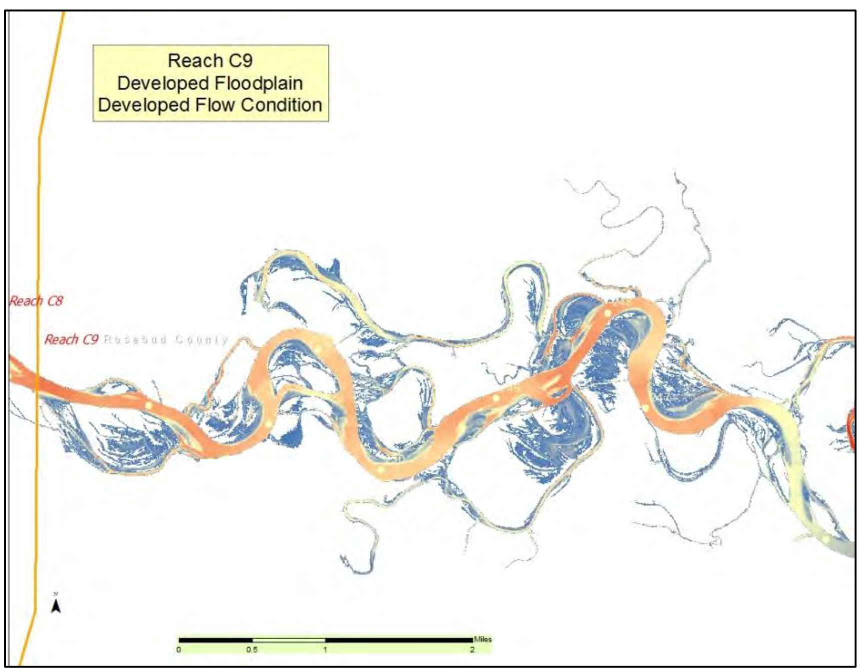

Figure 2-13 Reach C9 modeling results showing 5-year floodplain inundation and depth grids for developed conditions.

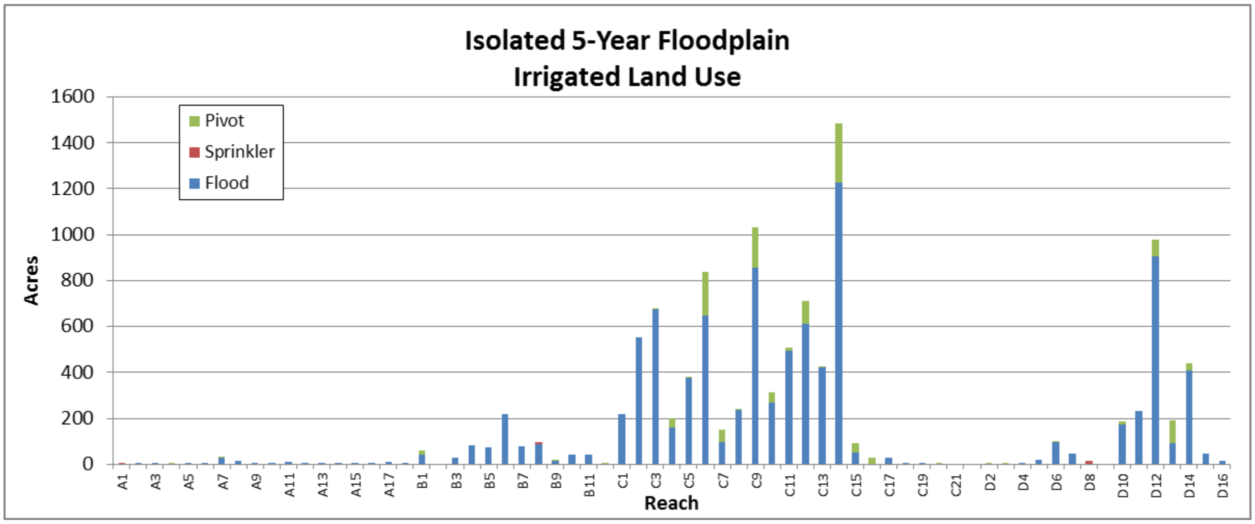

Figure 2-14 Acreage of irrigated land within the isolated 5-year floodplain footprint.

The existing 5-year floodplain is by definition more prone to flooding than the isolated areas, and this floodplain area also supports irrigated lands. Currently, there are about 6,300 acres of irrigated land within the existing 5-year floodplain footprint; 5,376 acres in flood irrigation and 871 acres under pivot irrigation (Figure 2-15 and Figure 2-16).

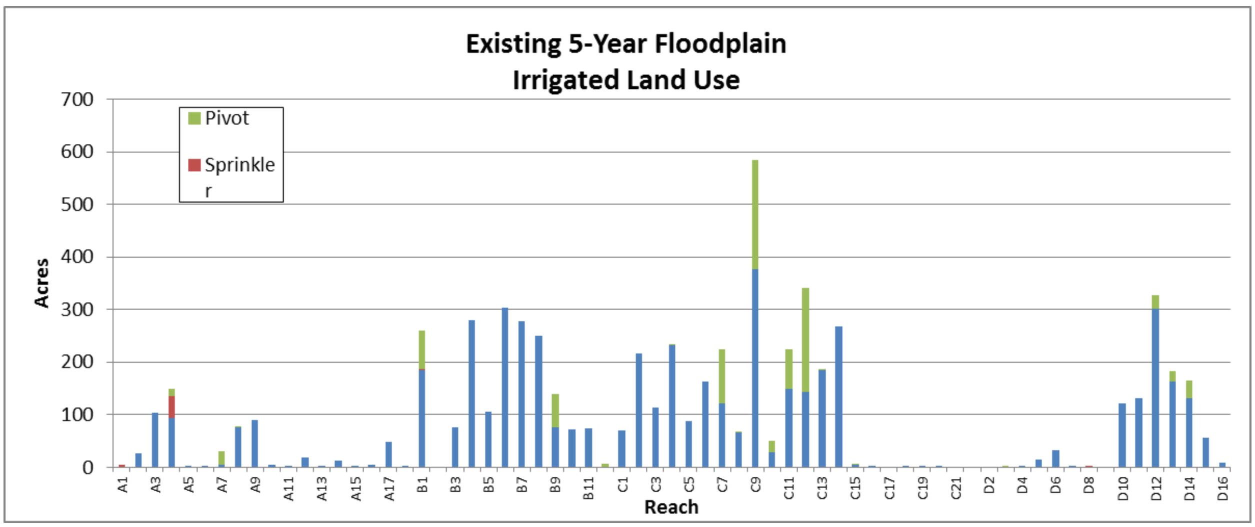

Figure 2-15 Acreage of irrigated land within the developed 5-year floodplain footprint.

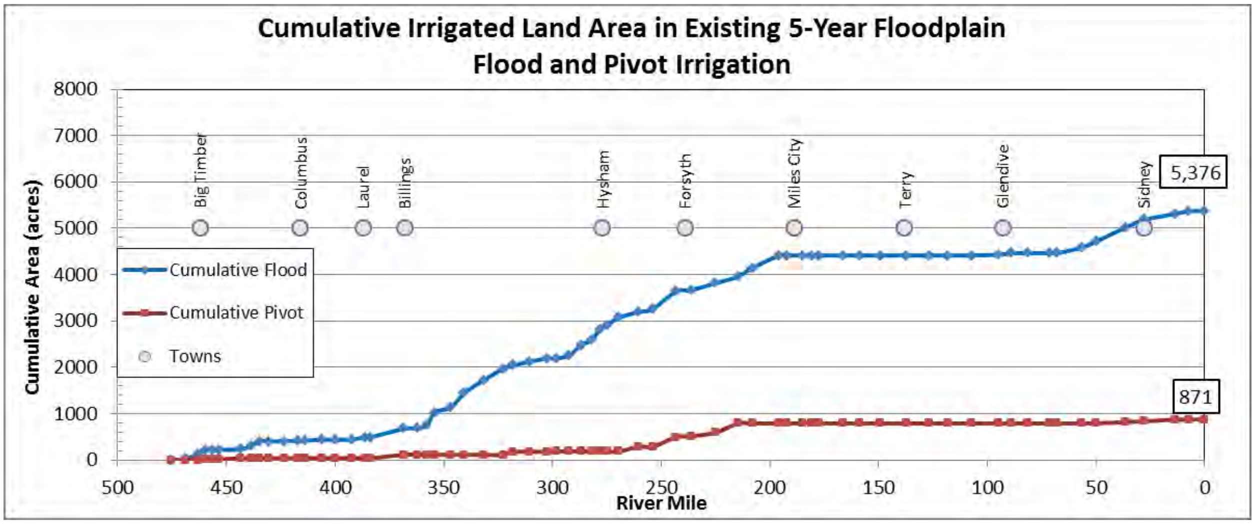

Figure 2-16 Cumulative acreage of irrigated land within existing 5-year floodplain.

Figure 2-17 shows a cumulative plot of the extent of irrigated lands in both the existing and isolated 5-year floodplain areas. The two main areas with significant downstream accumulation of irrigated acres in the floodplain is between Billings and Miles City, and just upstream of Sidney. In total, there are over 17,000 acres of irrigated land in the historic floodplain. Although about 11,000 of those acres are in isolated floodplain areas, about 6,300 acres remain in the active 5-year floodplain footprint. Those fields within the active 5-year floodplain will be especially prone to flood inundation under relatively frequent flood events, as a “5-year flood” has a 20-percent chance of occurrence in any given year.

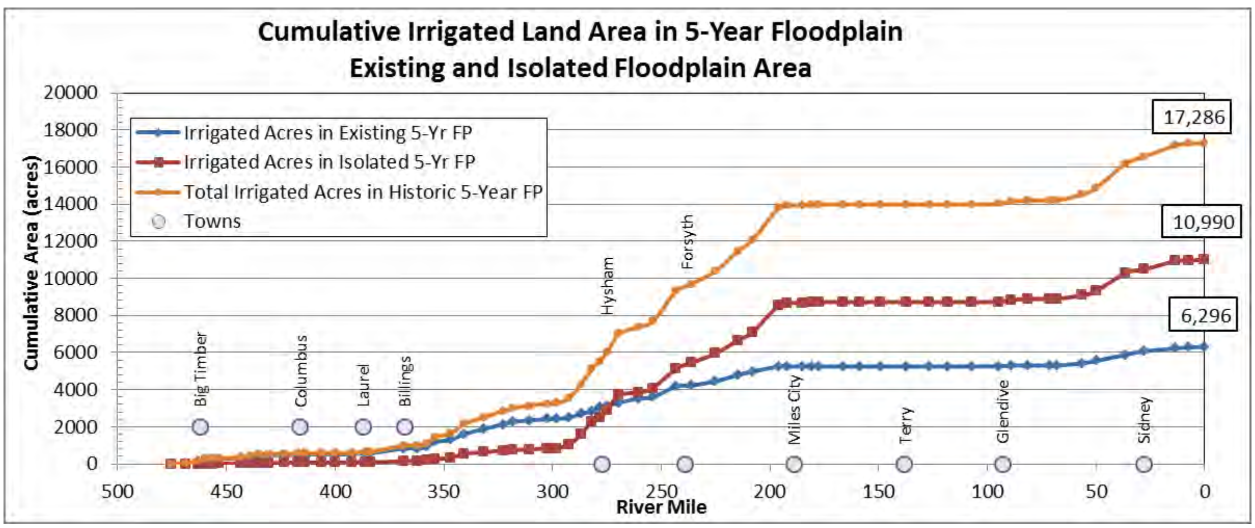

Figure 2-17 Cumulative plot showing irrigated acreage in both isolated and existing 5-year floodplain area.

2.2.2 Riparian Clearing in 5-Year Floodplain

Currently, much of the Yellowstone River woody riparian corridor lies within the historic 5-year floodplain. If the 5-year floodplain could be used to coarsely approximate the minimum extent of the Yellowstone River riparian forest, it could be estimated that at least 17,000 acres of historic riparian forest in the Yellowstone River corridor has been converted to irrigation (Figure 2-17). This translates to about 26 acres of conversion per river mile. The 1950s imagery shows that there had been extensive clearing of historic floodplain area by that time. Since 1950, however, the conversion from riparian area to irrigated lands in the floodplain can be calculated. A summary of those data indicate that between 1950 and 2001, a total of about 2,400 acres of land in the historic 5-year floodplain had transition from open or closed timber to irrigated land. Of those 2,400 acres, about 1,000 acres are in the existing 5-year floodplain, whereas 1,400 acres are in currently isolated floodplain area (Figure 2-18). In summary, these data suggest that if the historic 5-year floodplain was capable of supporting riparian vegetation, about 14,600 acres had been converted to irrigated land by 1950, and another 2,400 since then.

Figure 2-18 shows that there is a sharp increase in total conversion of riparian areas to irrigated lands in the isolated 5-year floodplain just upstream of Miles City. That area is shown in Figure 2-19 and Figure 2-20; the two figures show the conversion of open timber riparian area to flood irrigation within the historic and modern 5-year floodplain footprint.

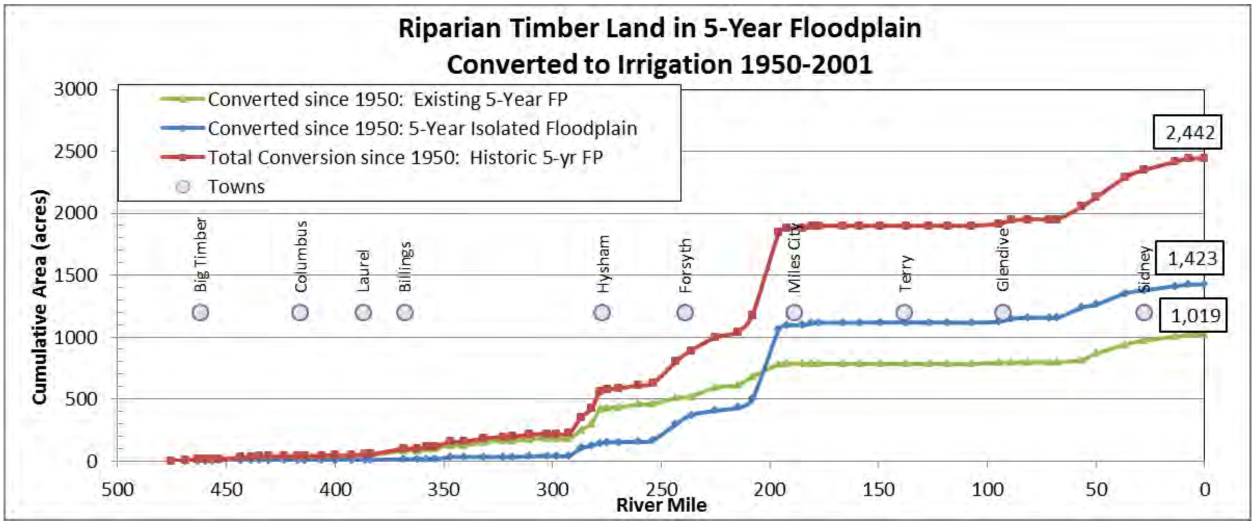

Figure 2-18 **Cumulative plot showing acreage within 5-year floodplain converted from riparian timber to irrigated lands between 1950 and 2001.**

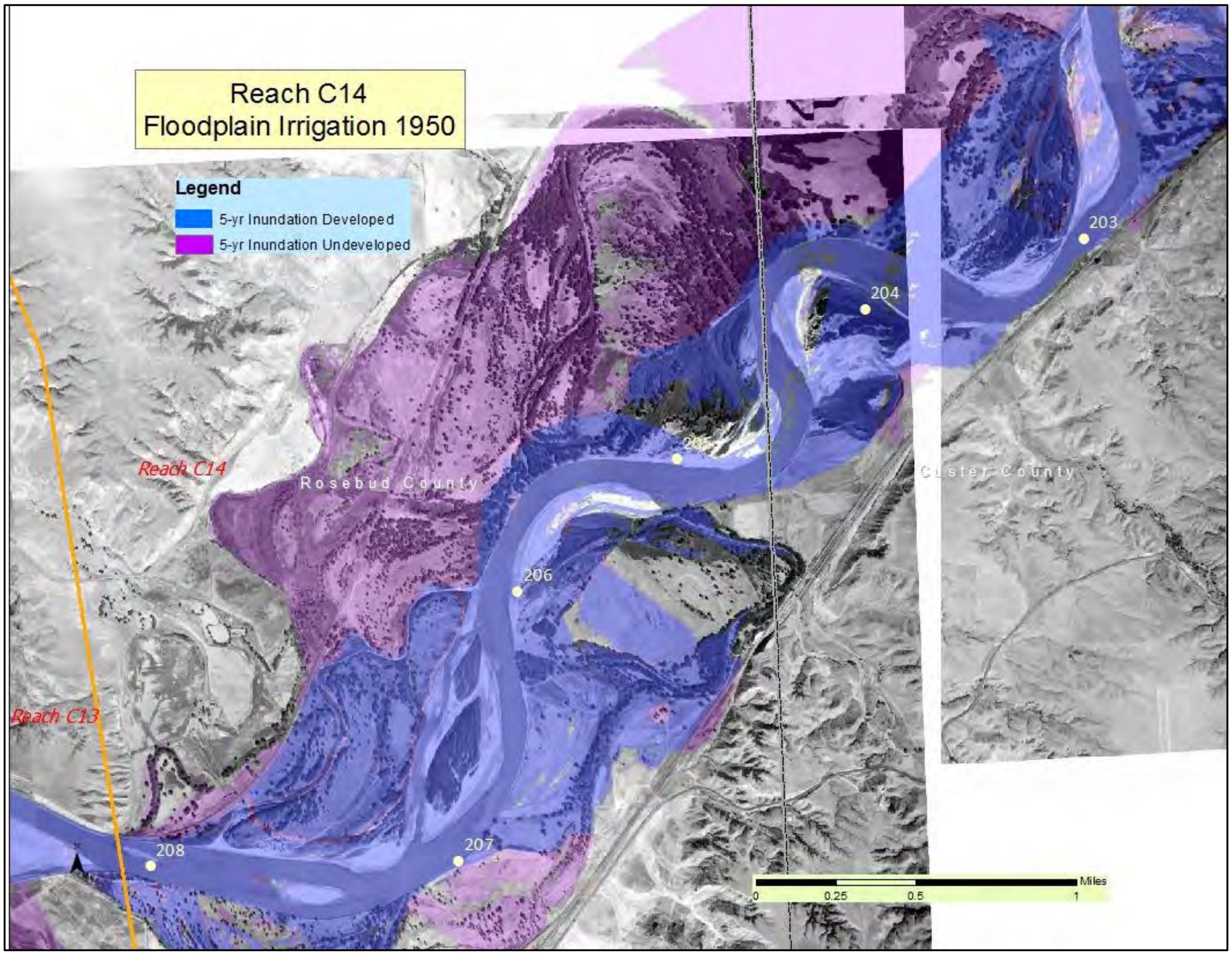

Figure 2-19 **Reach C14 showing 1950s imagery and 5-year floodplain; note open timber riparian area north of channel in historic floodplain.**

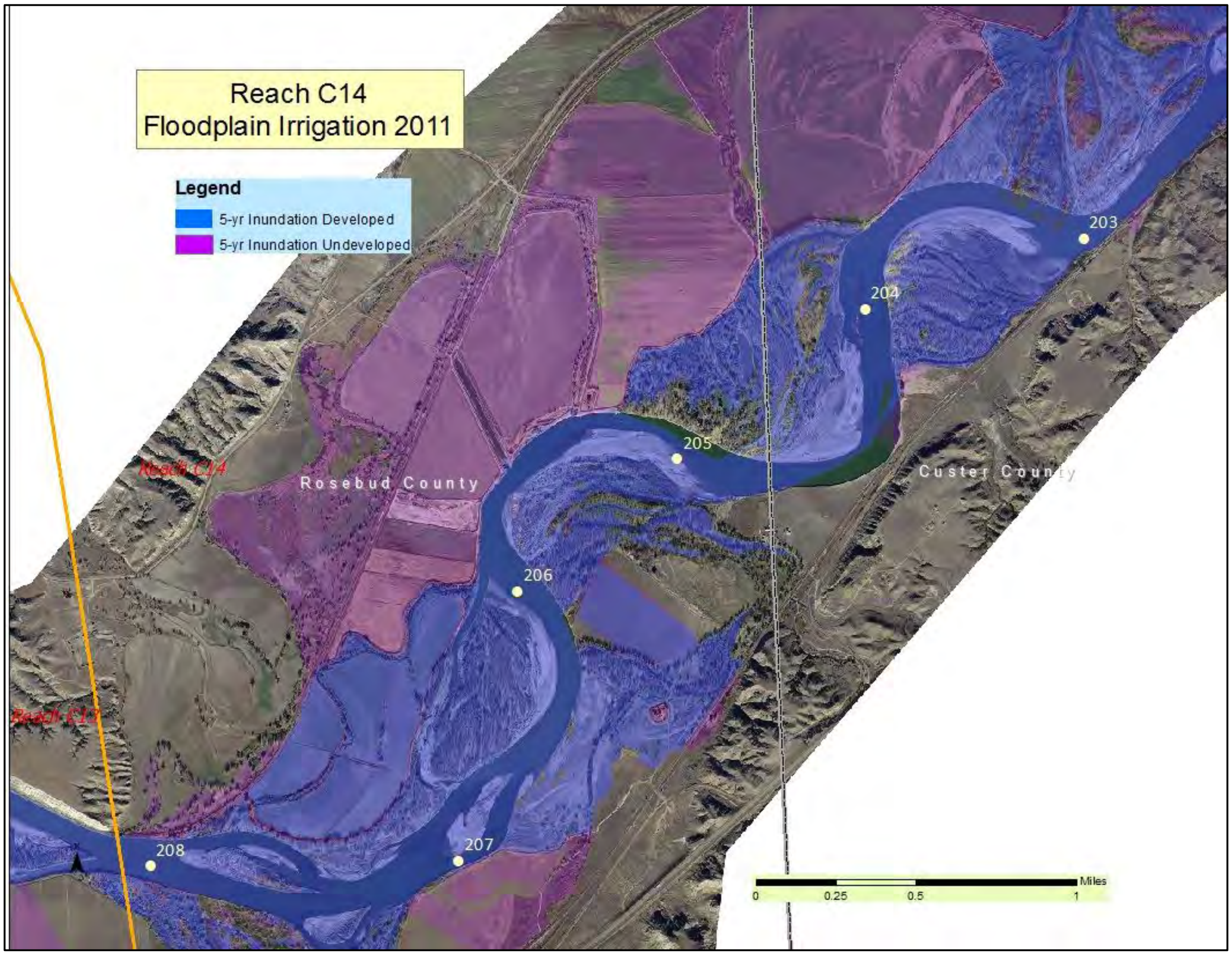

Figure 2-20 Reach C14 showing 2011 imagery and 5-year floodplain; flood irrigated lands north of channel in historic (undeveloped) and modern (developed) floodplain.

2.3 Isolation of Historic 2-Year Floodplain

Although the 2-year floodplain was modeled, the total area of floodplain isolation has not been calculated for this event. An example of the model output is shown in Figure 2-21. This lower flow condition highlights the lost channelized flow during a 2-year event in addition to overall off-channel floodplain inundation. As acreages were not available to assess the change in overall floodplain footprint, the hydraulic modeling output for the 2-year event was summarized by wetted width of the modeled cross sections. The results show that the wetted width of the modeled cross sections has narrowed throughout the river corridor under developed conditions; Figure 2-22 shows modeling output for all cross sections and Figure 2-23 displays that data as reach averages. On a reach average basis, the most impacted areas are between the mouth of the Bighorn River and the mouth of the Tongue River, where the inundated area during a 2-year flood event has been reduced on the order of 40 percent (Figure 2-24). Other areas with a relatively high level of 2-year floodplain contraction include Laurel to Billings and downstream of Intake.

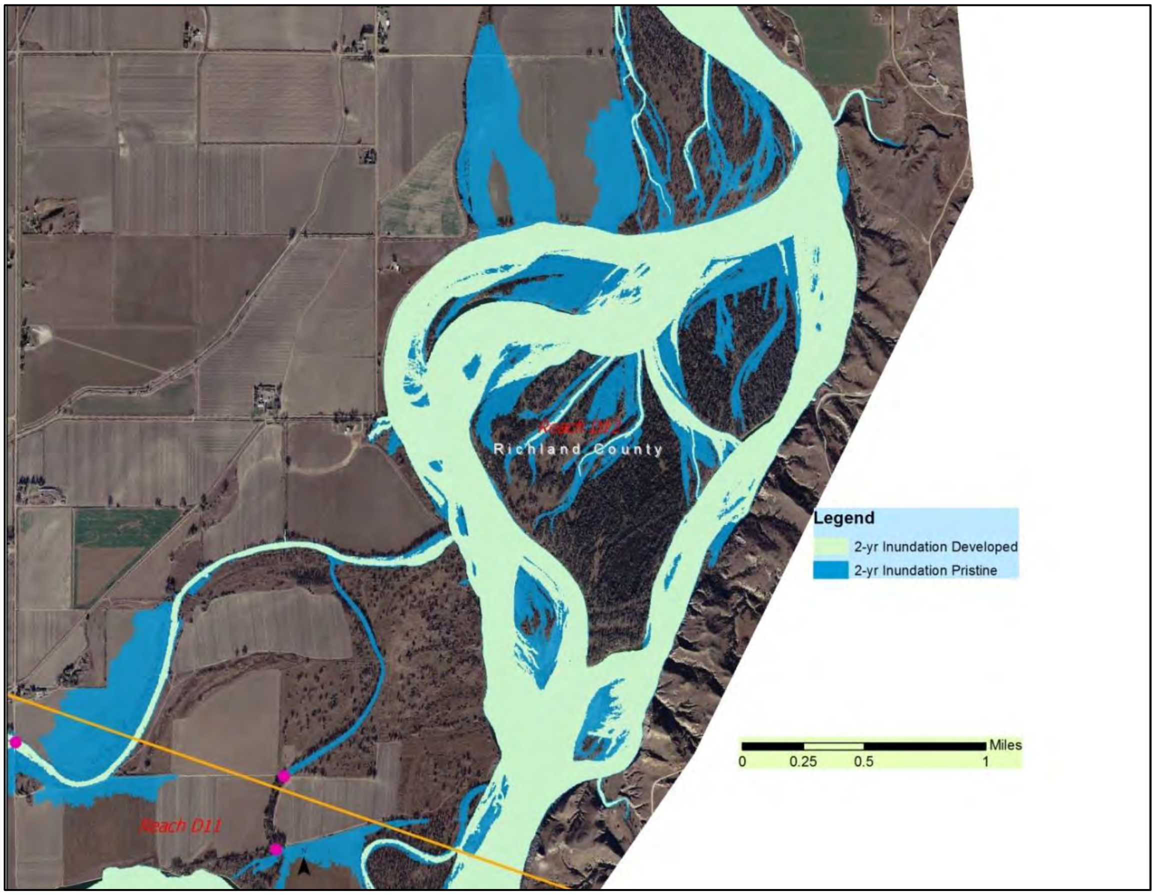

Figure 2-21 Hydraulic Modeling results showing inundated area for 2-year undeveloped and 2-year developed conditions, Reach D12.

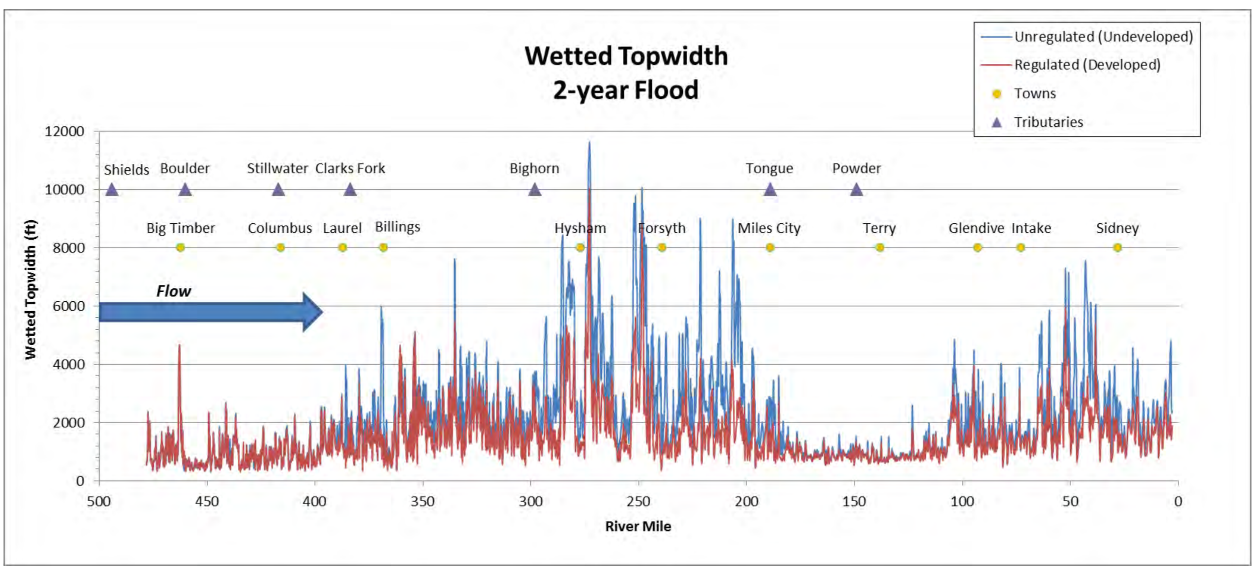

Figure 2-22 Modeled wetted topwidth at a 2-year flood event, undeveloped and developed conditions.

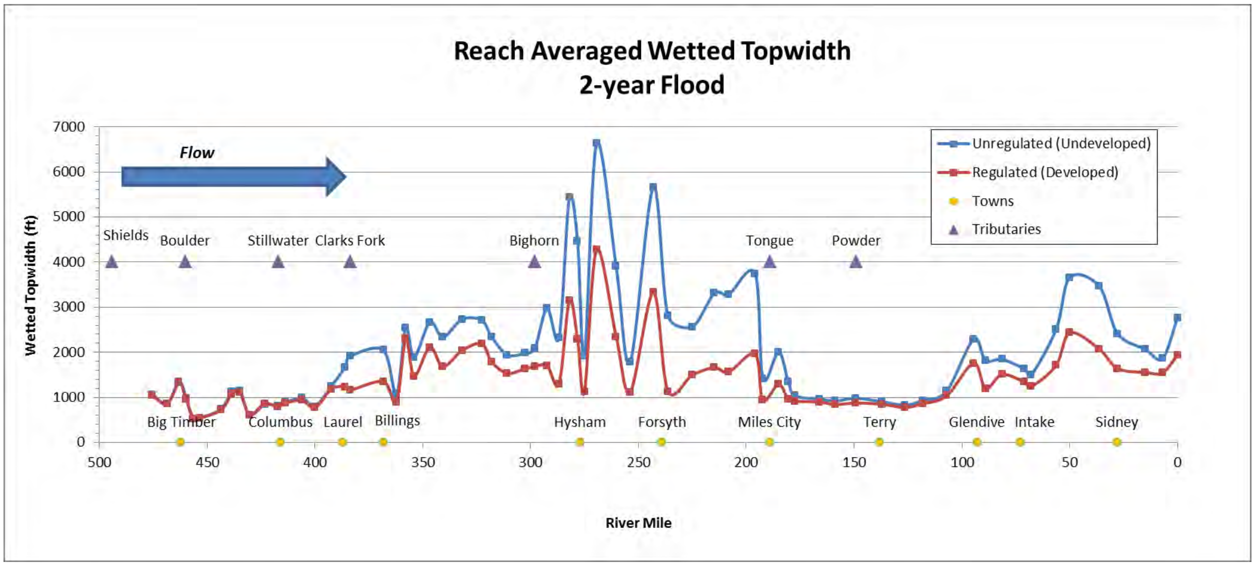

Figure 2-23 **Reach-averaged wetted topwidth for undeveloped and developed 2-year flow.**

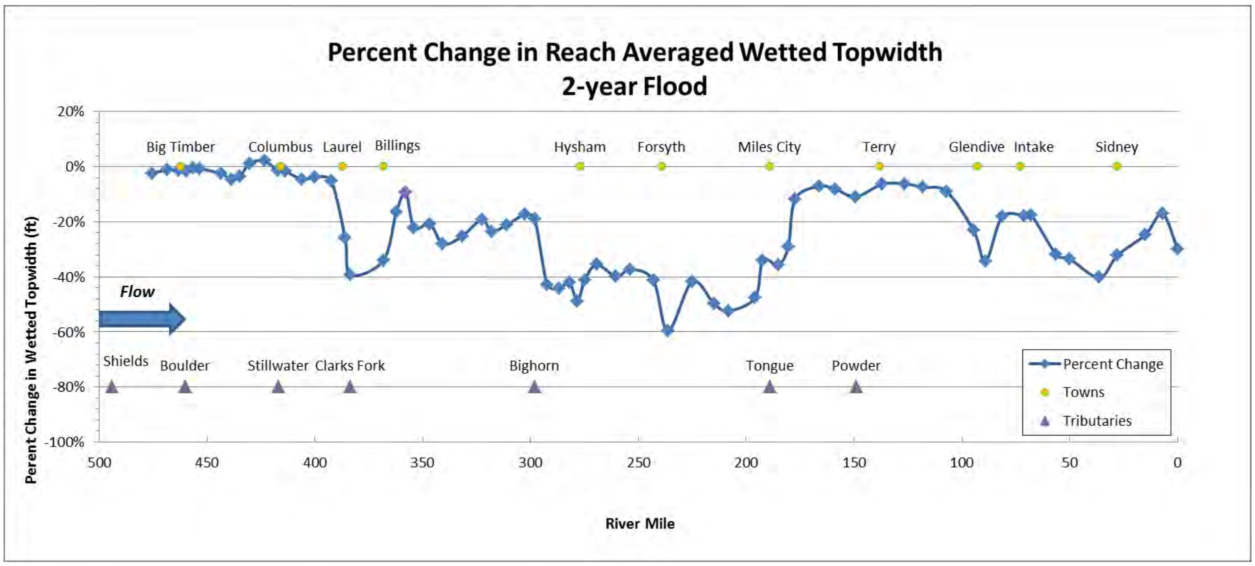

Figure 2-24 **Percent change in reach-averaged wetted topwidth between undeveloped and developed conditions.**

Figure 2-25 shows an example graphic of depth grid data developed as part of the modeling effort. The results show that although much of the contraction in inundated area consists of relatively shallow flow, the connectivity between the main channel and dominant side channels has markedly reduced under developed conditions.

When summarized by channel type (Figure 2-26), the mean wetted topwidth values show that under undeveloped conditions, the average inundated width at a 2-year flood increases from confined channel types (eg CM = “confined meandering”) to less unconfined and partially confined channel types (UA = “unconfined anabranching”). This is likely reflective of the amount of overall floodplain area characteristic of each channel type. Under developed conditions, however, that overall variability is substantially reduced so that channel type has a much lower influence on overall 2-year floodplain access. This also indicates that the most affected channel types are those that are unconfined reaches.

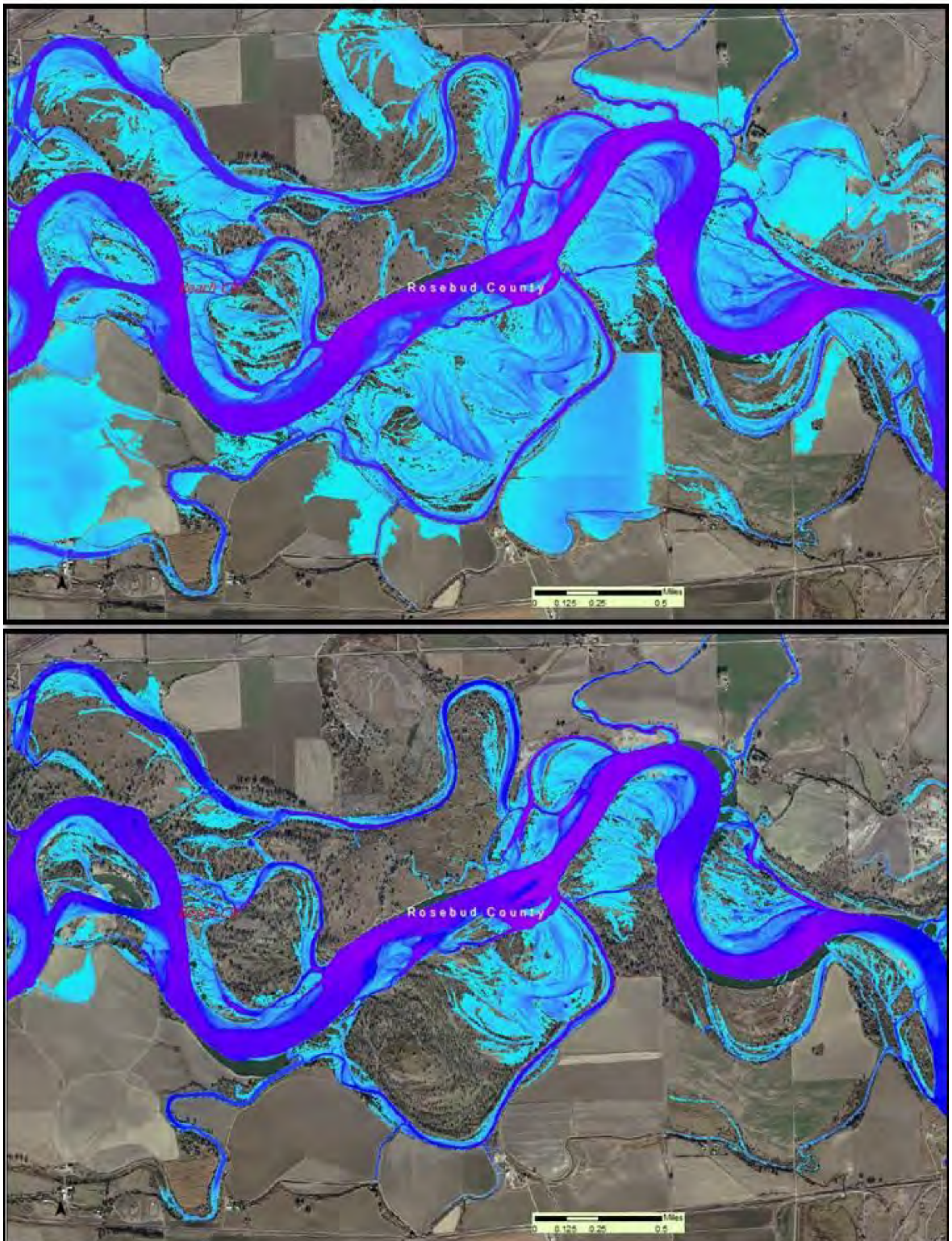

Figure 2-25 Depth grid model output showing example 2-year relative inundation depths for undeveloped (top) and developed (bottom) conditions. Example is an anabranching channel type in Rosebud County near Forsyth.

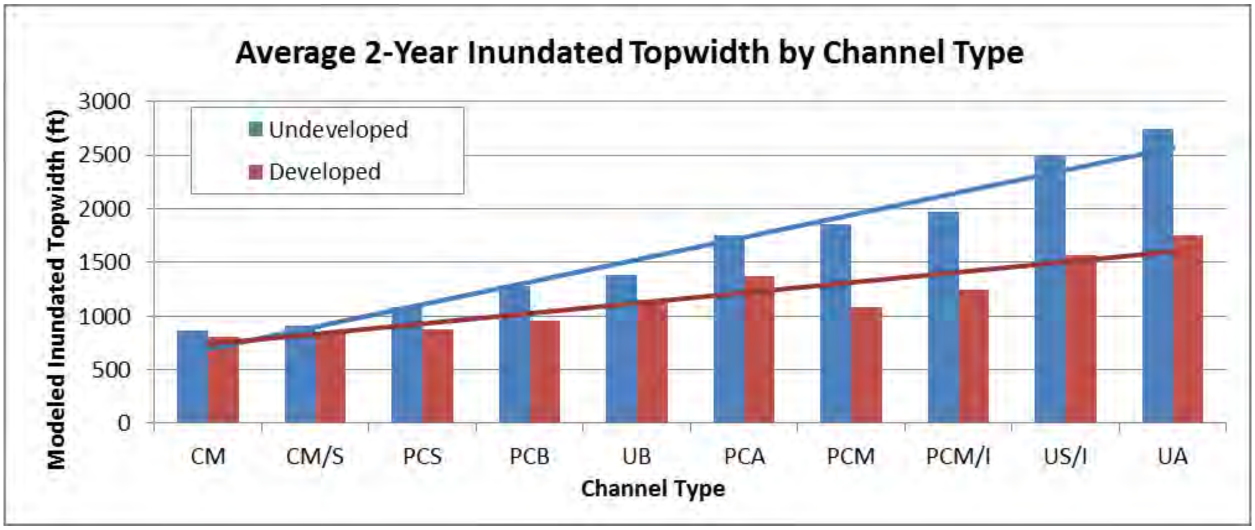

Figure 2-26 **Mean reach inundated topwidth summarized by channel type for undeveloped and developed conditions.**

3.0 REFERENCES

US Army Corps of Engineers (USACE), 2014. Yellowstone River Corridor Study Hydraulic Analysis Modeling and Mapping Report: Draft Report prepared for Yellowstone River Conservation District Council and Technical Advisory Committee, 29p.

Yellowstone River Cumulative Effects Assessment

Technical Appendix 4

Geomorphology (Channel Pattern and Channel Migration)

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1.0 INTRODUCTION

This Appendix summarizes the datasets that have been developed to describe primary geomorphic trends on the Yellowstone River from 1950 to 2001. Additional work has been performed to capture impacts that occurred prior to 1950, but pre-1950 data are generally lacking. The datasets summarized in this Appendix have been continually developed throughout the CEA process, beginning with the delineation of project reaches, application of a classification scheme to those reaches, and quantitative analysis of geomorphic datasets on a reach and regional scale. Documents that have been previously developed as part of this effort include the following:

1. **Geomorphic Reconnaissance and GIS Development, Yellowstone River Montana: Springdale to the Missouri River Confluence:** This was the initial report developed as part of the Yellowstone River CEA. Completed in 2004 by AGI and DTM (AGI and DTM, 2004), the report includes reach delineation and classification from the Park County line downstream. Park County reaches were added to the overall dataset later.

2. **Work Order #3: Geomorphic Parameters and GIS Development, Yellowstone River:** Work Order #3 was completed in 2007 and consisted of a data analysis that consisted of a GIS-based summary of the geomorphic parameters of the Yellowstone River from Park County to the confluence with the Missouri River (DTM and AGI, 2007). The parameters in that report relate to channel planform as visible on aerial photographs.

3. **Yellowstone River Human Impacts Timeline:** This report consists of an evaluation of the temporal patterns of human influences in Stillwater, Yellowstone and Dawson Counties. The focus of the timeline is a comparison of approximate construction dates for physical features such as dikes, levees, armor, and transportation encroachments. The report was completed by DTM and AGI in 2008 (DTM and AGI, 2008).

4. **Yellowstone River Channel Migration Mapping:** In 2009 DTM and AGI completed a Channel Migration Zone effort on the Yellowstone River (DTM and AGI, 2009). The report includes an analysis of river migration rates and the influence of geology on rates of movement.

Although these reports provide a foundation for the geomorphic work, this Appendix presents a re-analysis of the most recent geomorphic dataset compiled in the CEA database. The analyses focus on remote analysis of GIS data to describe the spatial distribution and temporal shifts in overall channel planform and associated complexity. Complimentary datasets such as those developed for the riparian evaluation or land-use trend analysis have been used in the geomorphic assessment as well. The main parameters described in this section include braiding parameter and side channel extent, bankfull channel area, floodplain turnover rates, land-use relationships to channel migration rates, and extents and types of bank armor mapped in the stream corridor.

As described above, the main time period covered for this geomorphic assessment is 1950 to 2001. Although the 2001 data series provides the most comprehensive information to describe recent conditions on the river, several individual datasets within that data series have been updated to 2011 conditions. Other specific datasets have been extended back in time prior to 1950. As a result, all discussion of conditions and trends prior to 1950 and after 2001 are described with regard to specific available data.

2.0 MAJOR FINDINGS IN SUPPORT OF CUMULATIVE EFFECTS ANALYSIS

Major findings of this assessment include the following:

1. Most reach types show a 1950-2001 reduction in bankfull braiding parameter, which is a reflection of the extent of side channels relative to the main channel length. The braiding parameter trends are supported by a summary of net change in side channel length; as a whole the river corridor has lost approximately 50 net miles of anabranching channel length since 1950, and this loss has affected all reach types.

2. Since 1950, about 48 miles of side channel on the Yellowstone River have been blocked by physical features, typically small dikes. Typically, the blockages account for over 80 percent of the total loss in length in any given river segment.

3. Prior to 1950, 42 miles of side channel had already been blocked. As a result at total of about 90 miles of side channel have been blocked by physical features on the river.

4. Regions C and D show a loss of about 40.2 miles of secondary channel length between 1950 and 2001. Most of this loss occurred downstream of Glendive. These changes were accompanied by a major shift in in-stream bar features in the lower river; Reaches C and D show that the total extent of mid-channel bars has dropped by about 1100 acres or 43 percent since 1950. Point bar area has also been reduced.

5. In addition to loss of side channels and mid-channel bars, Regions C and D show a reduction of bankfull area in excess of 4,000 acres between 1950 and 2001.

6. Floodplain turnover rates have dropped Regions A through D. Between Springdale and the Missouri River confluence (Park County Data were not available), the mean annual rate of total floodplain erosion dropped from 520 acres per year to 340 acres per year. Mean annual migration rates have dropped by over 20 percent in most reaches.

7. One consequence of lower floodplain turnover rates is reduced recruitment of large woody debris; the post-1976 data show a reduction in the recruitment of closed timber areas by about 50 acres per year.

8. Migration rates in the river corridor vary by land use. Over a 25-year period, banks eroded into hay ground and irrigated ground an average 40 to 50 feet further than through multi-use ground. Every region shows this fundamental trend of increased rates of migration through hay/pasture land and ground irrigated by sprinkler or flood.

9. As of 2011, there was approximately 136 miles of bank armor on the Yellowstone River below Gardiner, including rock riprap, flow deflectors, concrete riprap, car bodies, and minor extents of other techniques such as gabions and steel retaining wall. Rock riprap comprises 75 percent of the total armor. Between 2001 and 2011, about 13 miles of armor was constructed on the river; the 2011 flood also caused substantial armor failure, most of which was concrete rubble and flow deflectors.

10. The Historic Migration Zone (HMZ) of the river has been developed by agricultural, urban/exurban, and transportation infrastructure-related land uses. A total of 720 acres of the

HMZ are irrigated lands. Another 281 acres have been converted to urban/exurban and transportation land uses. These land-use conversions are all within the 1950-2001 active footprint (channels and islands) of the river corridor.

11. Areas prone to erosion on the margins of the active corridor have also been developed. As of 2011, approximately 19,500 acres of land mapped as within the Erosion Hazard Area or Avulsion Hazard Zone of the Yellowstone River were irrigated. The amount of area developed for urban/exurban and transportation infrastructure in these areas of high erosion risk increased from 1,500 acres in 1950 to 3,311 acres in 2011.

3.0 GEOMORPHIC REGIONS AND PROJECT REACHES

Between Gardiner and the Yellowstone River/Missouri River confluence, the physiography of the Yellowstone River and its tributaries transitions from steep, confined mountainous areas to plains conditions. This physiographic transition correlates to a downstream transition from a salmonid to warm-water fishery. To allow the consideration of regional physiographic and biological conditions in the assessment, the corridor was subdivided into five primary regions (Table 3-1). For more information on this regional breakdown, see the original reconnaissance report (AGI and DTM, 2004).

Table 3-1
Major geographic regions of Yellowstone River CEA study.

Region	River Miles	Location	Reaches
Region PC (Park County)	479-564	Gardiner to Springdale	PC1-PC21
Region A	384-479	Springdale to Clarks Fork River	A1-A18
Region B	298-384	Clarks Fork River to Bighorn River	B1-B12
Region C	149-298	Bighorn River to Powder River	C1-C21
Region D	0-149	Powder River to Missouri River	D1-D16

The geomorphic regions can generally be described as follows:

- ***Region PC:*** In ***Park County***, the Yellowstone River flows through major geologic controls from Gardiner to Point of Rocks, where channel migration rates are minimal, and the riparian corridor is very narrow. Below Emigrant, the channel is more dynamic, although locally confined by both low and high terraces. Spring creeks in the Paradise Valley occur on both sides of the main channel. This area is prone to major sediment loading from the terraces during flood events. Through Livingston, the river is confined by extensive armor and dikes. Downstream of Livingston near Mission Creek, wooded islands and open bars are common. There are a total of 21 reaches in Park County. All of the reaches are at least partially confined, indicating that bedrock and terraces strongly influence the river corridor.

- ***Region A: From Springdale to the Clarks Fork*** confluence near Laurel, the river contains a total of 18 reaches. These reaches are typically anabranching (supporting long side channels separated by the main channel by wooded islands), as well as braided (supporting split flow channels around open gravel bars). Similar to Park County, the reaches are typically partially confined, indicating that a bedrock valley wall or an alluvial terrace commonly affects one bank of the river. The low terrace commonly follows the channel edge, and a few exposures of high terrace locally bound the modern river corridor.

- ***Region B: Between the Clarks Fork confluence and the Bighorn River confluenc***e, the river contains 12 reaches. Reach types are variable, ranging from straight to braided. Similar to Region A, bedrock valley wall controls are intermittent. Both low terrace and high terrace features locally form the channel bankline. Region B includes the area around Billings which is densely armored and highly impacted.

- ***Region C: Between the Bighorn River and the Powder River***, Region C consists of a lower gradient system that supports a wide range of reach types. A total of 21 reaches have been identified in Region C, and these reaches range from unconfined, multi-thread channels in the

Mission and Hammond Valleys, to highly confined areas downstream of Miles City. Region C marks the first river section that is impacted by hydrologic alterations associated with Yellowtail Dam operations on the Bighorn River.

- ***Region D: Below the Powder River confluence***, Region D contains 16 reaches. The uppermost segments of this region, from the Powder River to Fallon, are closely confined by bedrock valley walls. Downstream of Fallon, confinement is reduced, and broad islands are common. Region D supports a warm water fishery and tends to be relatively fine grained and low gradient.

As part of the initial Reconnaissance Study (AGI and DTM, 2004), the river was segmented into reaches based on geomorphic conditions observable in the 2001 color infrared dataset. Ultimately, the river was divided into 88 reaches between Gardiner and the mouth (Figure 3-1). The reach classification is based on general river pattern as well as the relative influence of the valley wall on the active channel morphology. Thus, the classification describes confinement (confined, partially confined, unconfined), and pattern (straight, meandering, braided, and anabranching). Table 3-2 lists the reach types assigned to the corridor segments. The first column of the table also shows the “Primary Channel Type”, which is a collapsed version of the reach types used in some of the data analysis and presentation. As shown in Table 3-1, the reach names refer first to region and then to a sequential number from upstream to downstream within that region (e.g., Region A contains reaches A1 through A18, with Reach A1 at the upper end of the region). Table 10-1 at the end of this Appendix contains a list of reach locations and classifications. For a more detailed discussion of the reach classification, see the 2004 Reconnaissance Report (AGI and DTM, 2004). The 2004 Reconnaissance Report also contains more extensive descriptions of broad scale geomorphic controls on Yellowstone River geomorphology such as geologic influences and associated valley bottom configurations.

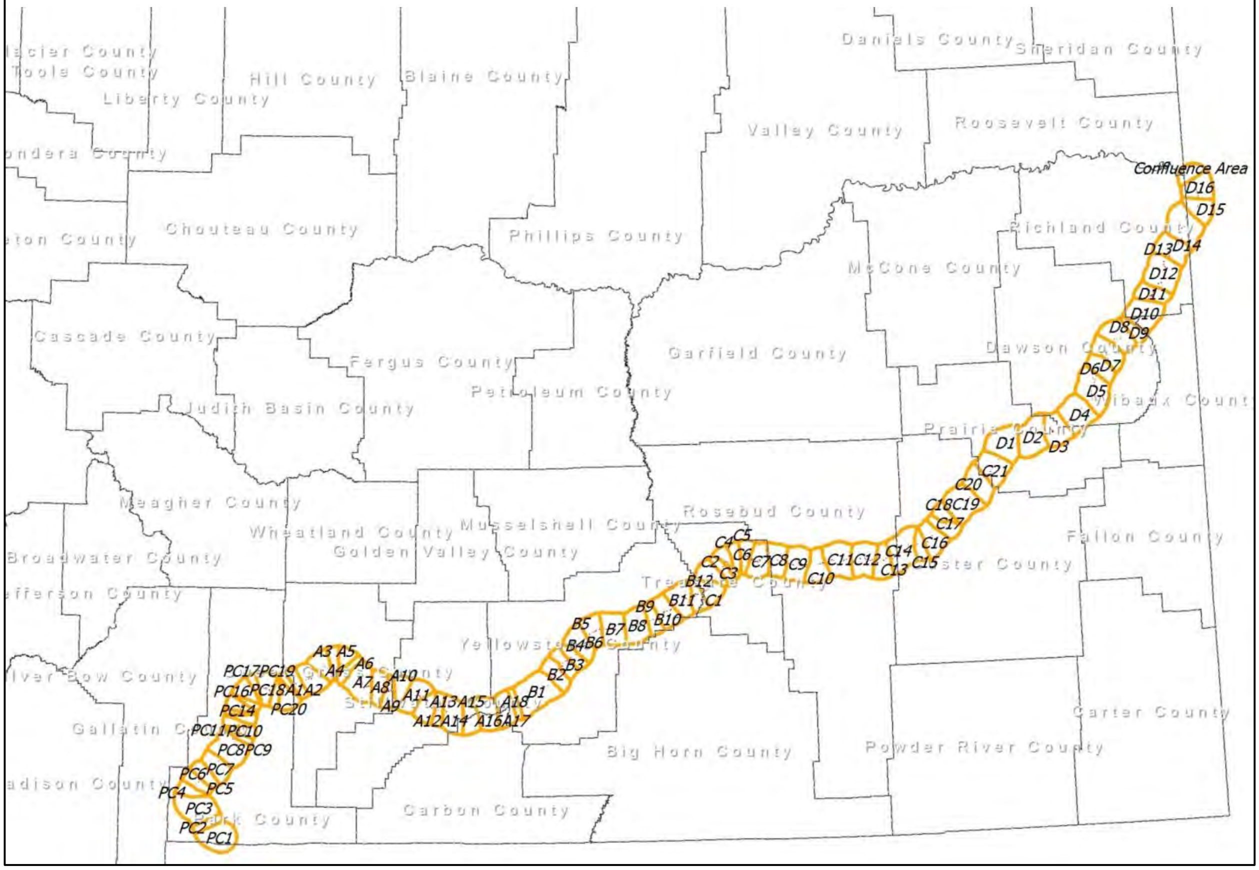


Figure 3-1 Yellowstone River subreach delineation.

Many of the plots in this Appendix include the locations of major communities and tributary confluences. These are intended to help readers put the trend data into a spatial context. For further reference, Table 3-3 lists the reach locations of major towns, confluences, and counties on the Yellowstone.

Table 3-2
Summary parameters for reach classification (AGI and DTM, 2004).

General Channel Type	Detailed Channel Type	Detailed Channel Type Reference	Number of Reaches	Natural Confinement	Gravel Bar Frequency	Side Channel Frequency
Anabranching	Unconfined anabranching	UA	12	Low	Moderate	**High**
	Partially confined anabranching	PCA	18	Moderate	Moderate	**High**
Braided	Unconfined braided	UB	6	Low	High	**High**
	Partially confined braided	PCB	13	Moderate	High	**High**
Meandering	Partially confined meandering	PCM	4	Moderate	Low/Moderate	**Moderate**
	Partially confined meandering/islands	PCM/I	11	Moderate	Low/Moderate	**Moderate**
Straight/ Confined	Partially confined straight	PCS	11	Moderate	Low/Moderate	**Low**
	Confined straight	CS	5	High	Low	**Low**
	Confined meandering	CM	7	High	Low	**Low**
Straight/ Unconfined	Unconfined straight/islands	US/I	1	Low	Low/Moderate	**Moderate**

Table 3-3
Reach locations of major towns, confluences and counties.

Town	River Mile	Valley Mile	Reach
Gardiner	564	466	PC1
Livingston	501	413	PC15
Big Timber	461	377	A4
Reed Point	434	353	A10
Columbus	416	337	A13
Laurel	386	311	A18
Billings	365	293	B2
Hysham	277	220	C5
Forsyth	239	193	C10
Miles City	185	150	C17
Terry	139	111	D1
Glendive	94	171	D6
Intake	73	56	D8
Sidney	29	22	D13
Fairview	12	10	D15

Confluence	River Mile	Valley Mile	Reach
Mill Creek	526	431	PC8
Shields River	494	406.5	PC17
Boulder River	460	376	A4
Stillwater	417.5	338.5	A12
Clarks Fork	383.5	309	A18
Pryor Creek	354	283	B5
Bighorn	298	236	B12
Tongue	185	150	C17
Powder	150	119	C21

County	Reaches
Park	PC1-PC20
Sweet Grass	A1-A9
Stillwater	A10-A16
Yellowstone	A17-B12
Treasure	C1-C7
Rosebud	C8-C13
Custer	C14-C20
Prairie	C21-D3
Dawson	D4-D9
Richland	D10-D14
McKenzie	D15-D16

4.0 SINUOSITY

Sinuosity, which is defined as the ratio of channel length to valley length, depicts how tortuous a stream channel is for a given valley distance. In general, the sinuosity of the Yellowstone River increases in the downstream direction with the most sinuous segment in Region C, where mean reach-scale sinuosity exceeds 1.2 (Figure 4-1). The sinuosity of the Yellowstone River is inversely related to overall channel slope; high sinuosity areas in the lower river tend to support lower gradient channels, whereas in upper reaches, the channel is both relatively steep and relatively straight (Figure 4-2).

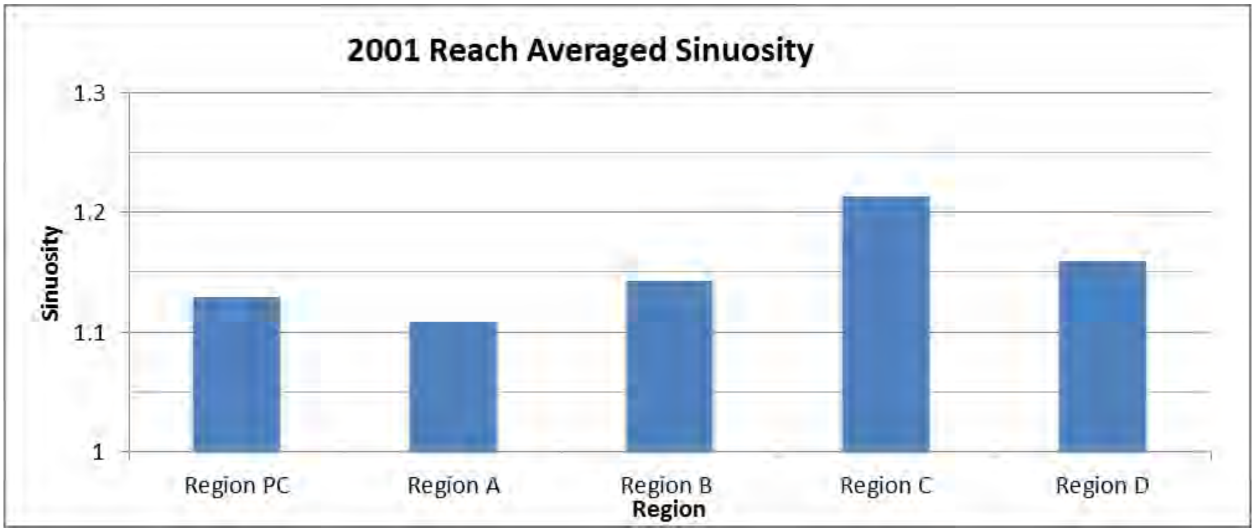


Figure 4-1 Yellowstone River reach -average sinuosity by Region.

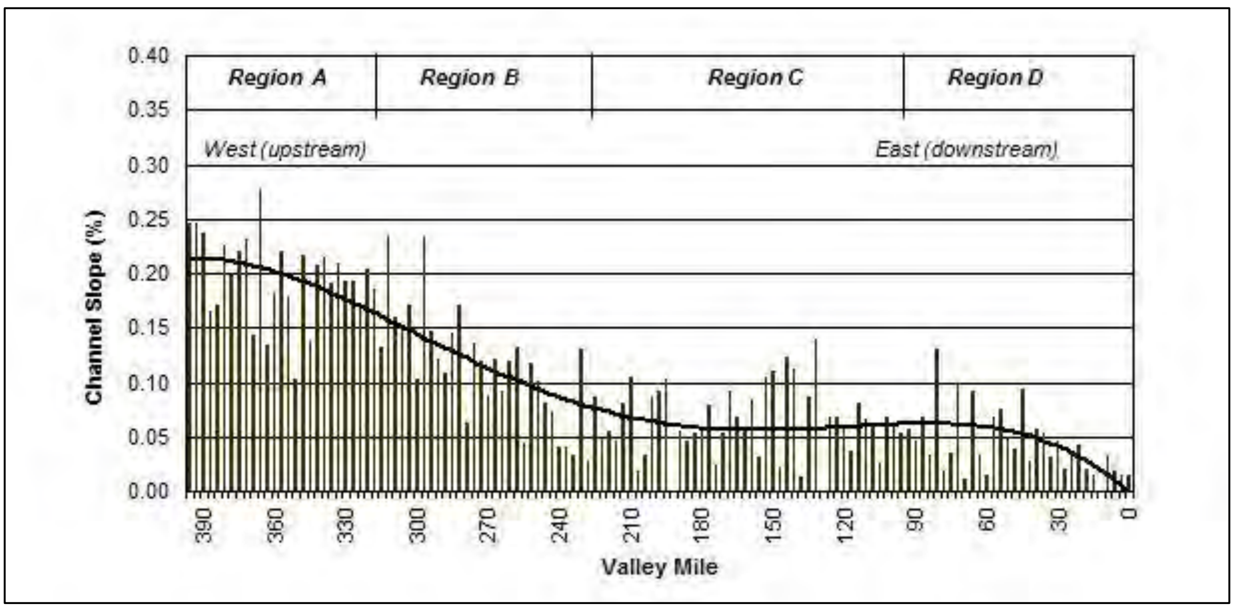


Figure 4-2 Channel slope measured with DEM data on 3-mile increments, Regions A-D (AGI and DTM, 2004); note that the plot is not a profile, but slope values for individual river segments.

When broken down on a reach scale, 2001 sinuosity values show that the majority of the reaches have a sinuosity of less than 1.15 (Figure 4-3). The most striking exception to that value is in the upper portions of Region C, where sinuosity exceeds 1.4 in five reaches between C3 and C9. These reaches are located just below Myers Bridge, as well as in the Mission and Hammond Valleys near Hysham and Forsyth, respectively. The Mission and Hammond valleys are geologically controlled by Bearpaw Shale, which can be correlated to valley floor widening (AGI and DTM, 2004). Anabranching channel types tend to be the most sinuous channel type, and they are also prevalent in these wide broad valleys. Anabranching channel types are those that have extensive side channels that are separated from the main channel by vegetated islands. These channels are continuous and active under bankfull flow conditions.

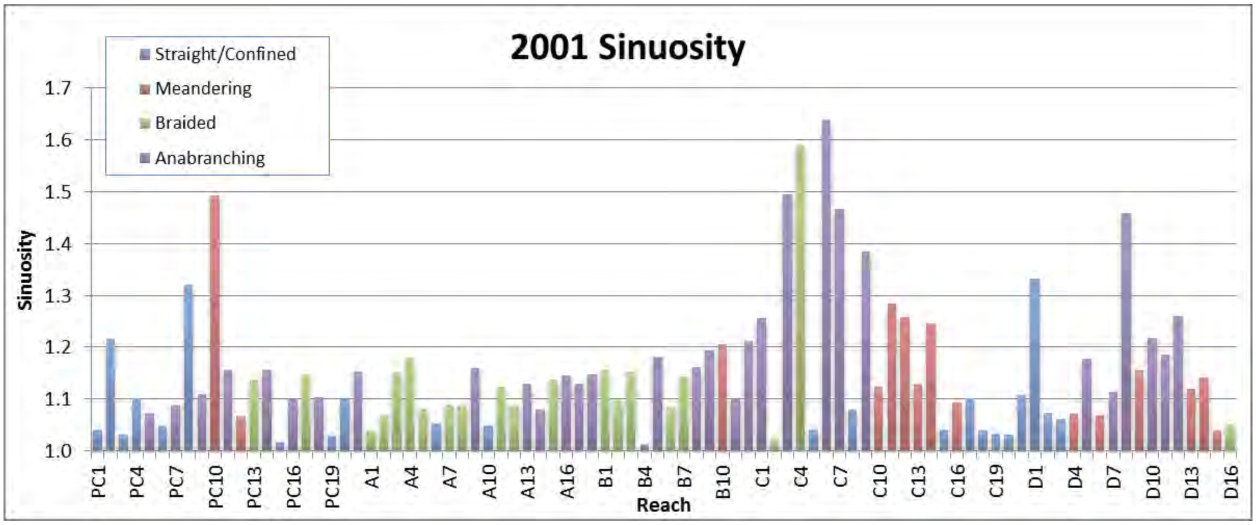


Figure 4-3 Ratio of 2001 channel length to valley distance (sinuosity).

As anabranching channel types tend to be the most sinuous, it is not surprising that they show the greatest net change in overall channel length through time. On the Yellowstone River, the changes in primary channel length since 1950 on anabranching channels has been dominated by shortening or reduction in sinuosity (Figure 4-4). Several anabranching reach types on the Yellowstone have lost over 500 feet of primary channel length per valley mile since 1950, and these reaches can be found in all regions.

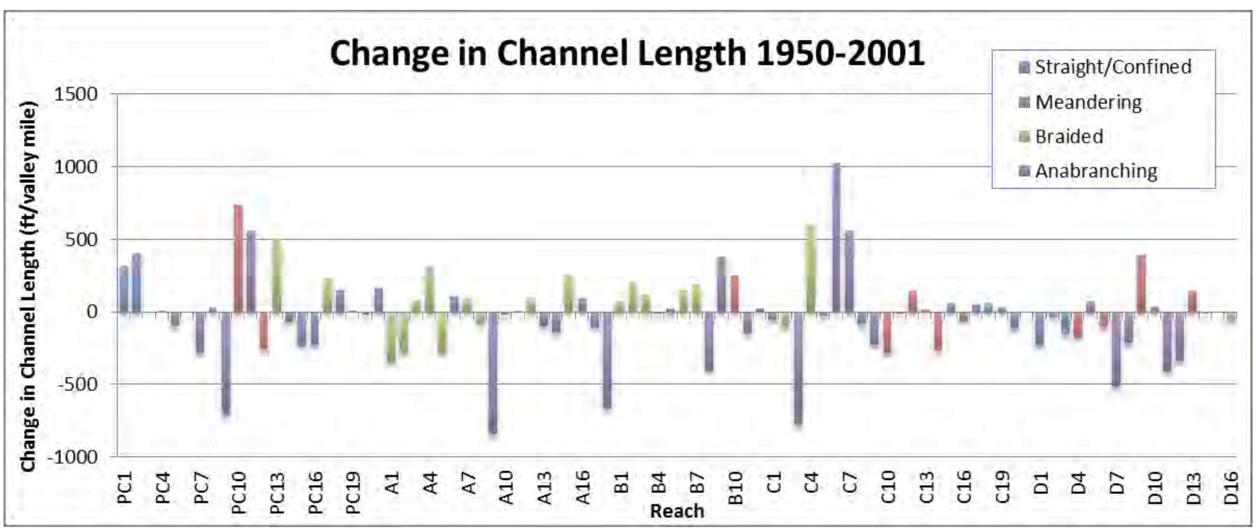


Figure 4-4 Change in channel length by reach normalized to valley distance

5.0 BANKFULL BRAIDING PARAMETER AND SIDE CHANNEL LENGTH

Braiding parameter is an effective metric used to describe the extent of side channels in alluvial rivers. This is an important component of the CEA due to the recognized importance of side channels to fisheries (Appendix 8: Fisheries).

Bank full braiding parameter reflects the following ratio:

$$BP = \frac{(\text{Primary Channel Length} + \text{Anabranching Channel Length})}{\text{Primary Channel Length}}$$

As anabranching channels active under bankfull flow conditions and are separated from the main channel by vegetated islands, they provide an effective means of describing bankfull channel planform metrics. A reach with no anabranching channels has a braiding parameter of 1.0, and a braiding parameter of 2 means that the total length of the anabranching channels equals that of the main channel.

Figure 5-1 shows the 2001 braiding parameter for each reach. The spatial distribution of braiding parameter indicates relatively low side channel extents in confined channels in upper Park County (PC1-PC4) and from Miles City to Fallon (C17-D3). The highest braiding parameters tend to be in lower Yellowstone County down to Forsyth (B5 to C7), which includes the anabranching channel types of the very broad Mission and Hammond Valley areas, and in reaches D5 through D12 near and below Glendive.

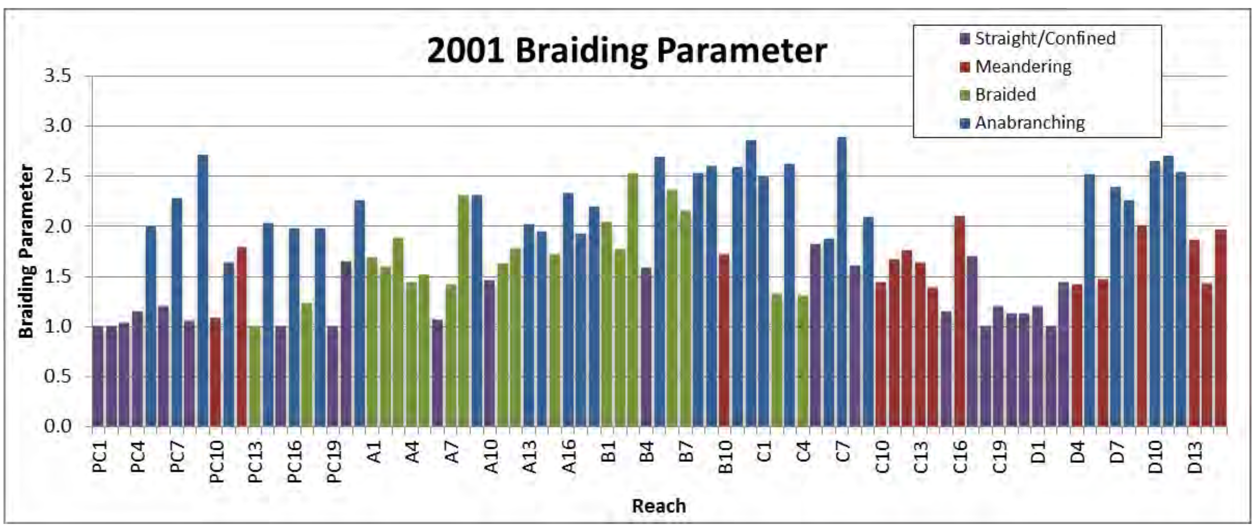


Figure 5-1 **2001 braiding parameter by reach.**

As the reach classification is in part a function of channel pattern, braiding parameter values stratify based on that classification (Figure 5-2). Braiding parameter, which reflects the cumulative length of bankfull side channels relative to the primary channel, increases consistently from the confined reach types (CM and CS) to the anabranching reach types (PCA and UA). Anabranching channel types reach braiding parameters in excess of 2.5, which means that the total length of side channels is over 150 percent that of the main channel. Although there are consistent patterns in braiding parameter as a function of reach type, Figure 5-2 also shows that there has been a distinct reduction in braiding parameter from 1950 to 2001 within most reach types. This reduction is an important, consistent trend with respect to the Cumulative Effects Analysis. The consistent change in braiding parameter may be due to an increase in main channel length, loss of side channel length, or both. However, as the main channel shows net shortening since 1950 (Figure 4-4), the loss of braiding parameter clearly reflects a loss of side channel length throughout the river corridor. This loss is described in greater detail in later sections.

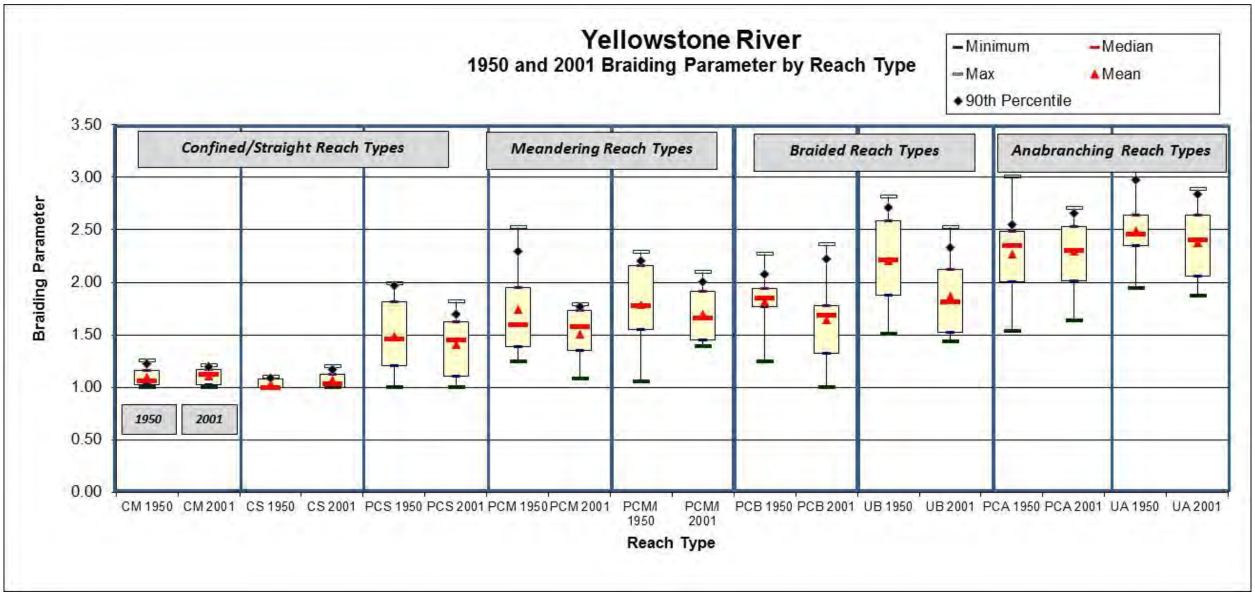


Figure 5-2 **Box and Whisker plots showing bankfull braiding parameter by reach type; each reach type has 1950 and 2001 data summarized.**

5.1 Change in Bankfull Braiding Parameter: 1950 to 2001

As described above, there has been an overall loss of braiding parameter on the Yellowstone River since the 1950s. Figure 5-3 shows the change in braiding parameter from 1950 to 2001 by reach. The results show that most reaches of all channel types show a reduction in braiding parameter. Notable exceptions to this trend include anabranching reaches in Park County (Reaches PC5-PC9), and meandering channel types downstream of Sidney (Reaches D15-D16).

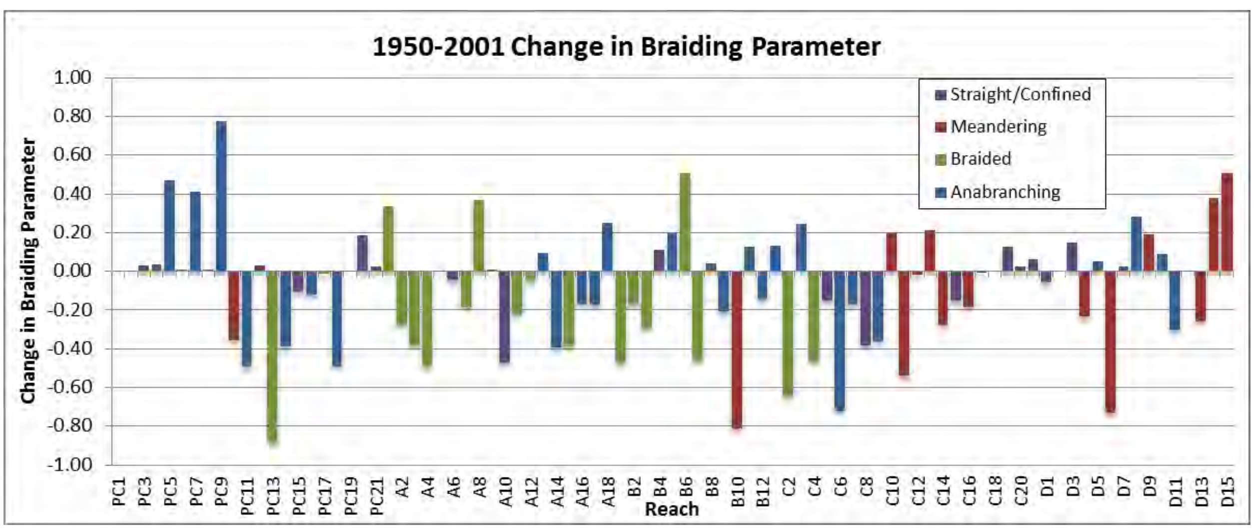


Figure 5-3 **Total change in braiding parameter by reach, 1950-2001.**

The gain in bankfull braiding parameter in the downstream-most sections of the river (Reaches D14-D16) reflects riparian coloinization of bars that were unvegetated in 1950 (Figure 5-4). This shows the role of riparian vegetation in affecting overall channel classification. In Reach D16 for example, the conversion of open bars to islands transitioned those side channels from secondary channels (braided planform) to anabranching channels (anabranching planform).

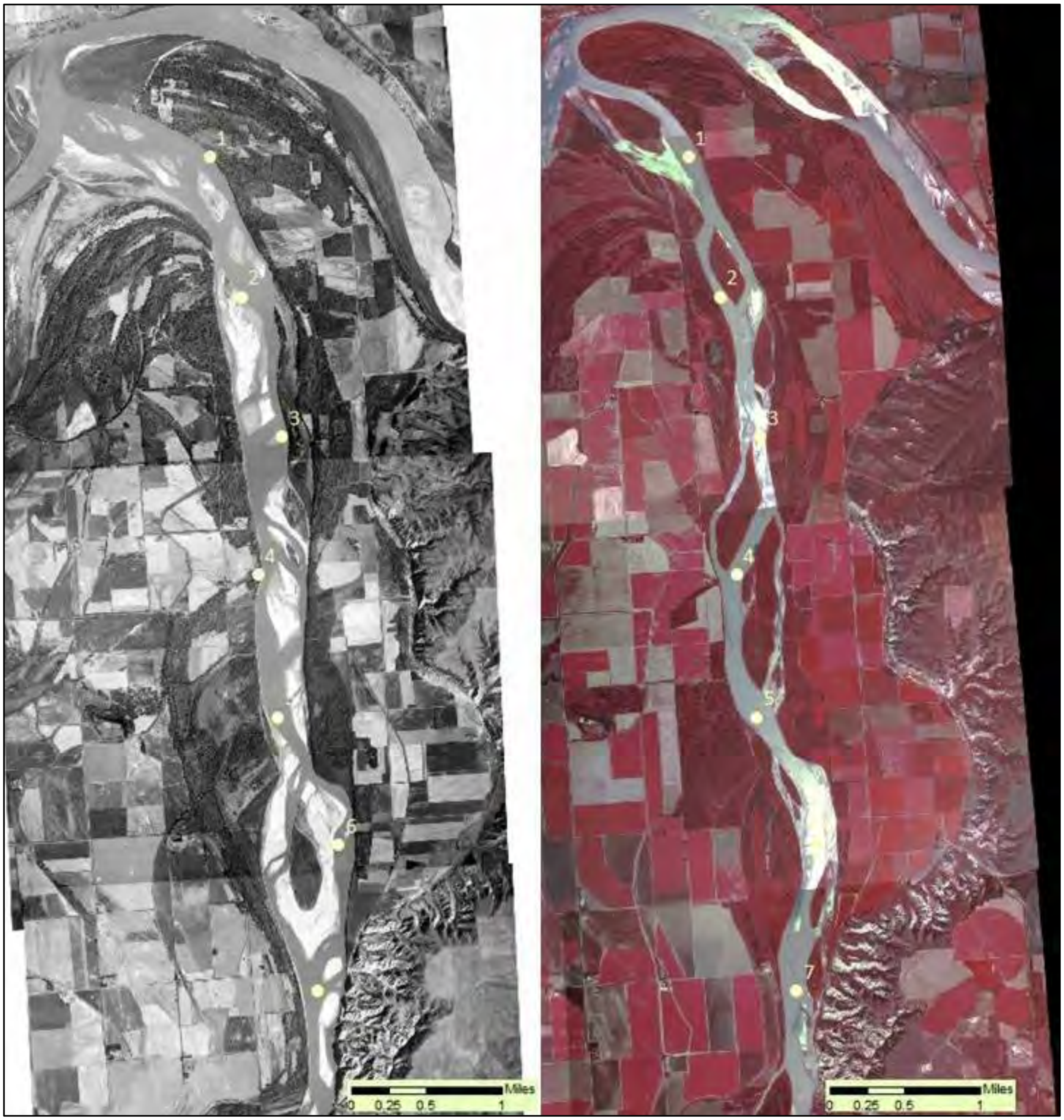


Figure 5-4 Reach D16 at mouth of Yellowstone River showing conversion from open bar secondary channels in 1955 (left) to forested anabranching channels in 2001 (right).

5.2 Total Change in Anabranching Channel Length: 1950-2001

The braiding parameter data indicate that the length of anabranching channels on the Yellowstone River has dropped since 1950. This section summarizes the total extent of that loss. In the 1950s, there were approximately 508 miles of anabranching channels on the Yellowstone River below Gardiner. By 2001, there were a total of 463 miles of anabranching channel. When summarized as a cumulative plot in the downstream direction, the anabranching channel datasets indicated that since 1950, more than 50 miles of anabranching channel length has been lost between Livingston and Miles City (Figure 5-5 and Figure 5-6). Between Miles City and Sidney, the cumulative rate of loss has been much slower, and downstream of Sidney the length of anabranching channel has increased over 10 miles. This increase in anabranching channel length below Sidney reflects vegetation encroachment onto mid-channel bar deposits since 1950 (Figure 5-4).

When individual time frames are plotted for the cumulative change in anabranching channel length, it is apparent that the majority of the side channel loss occurred in the 1976-1995 timeframe (Figure 5-7).

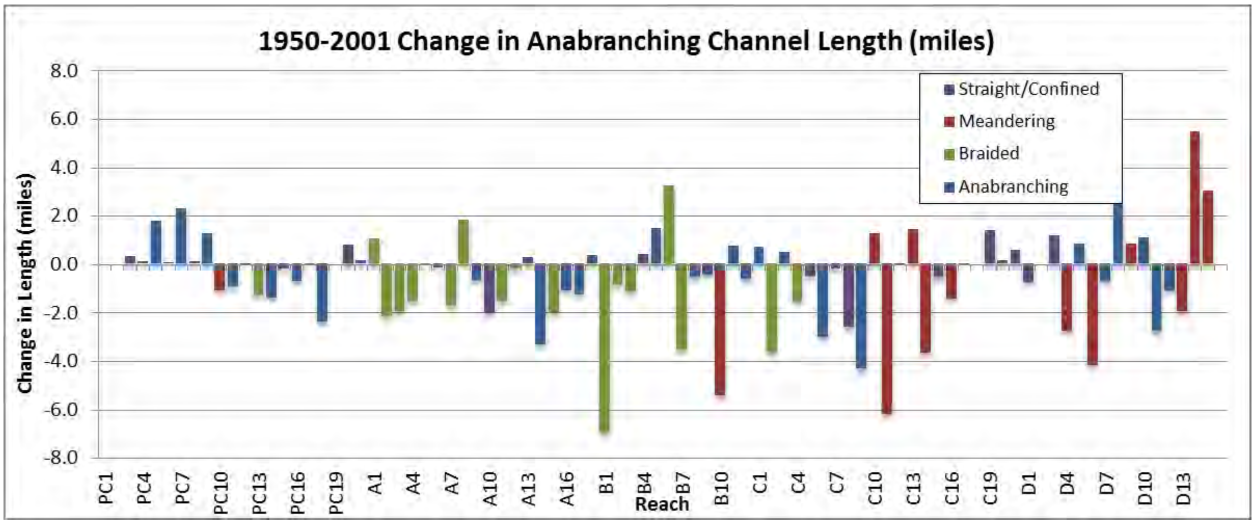


Figure 5-5 Total loss of anabranching channel length by reach.

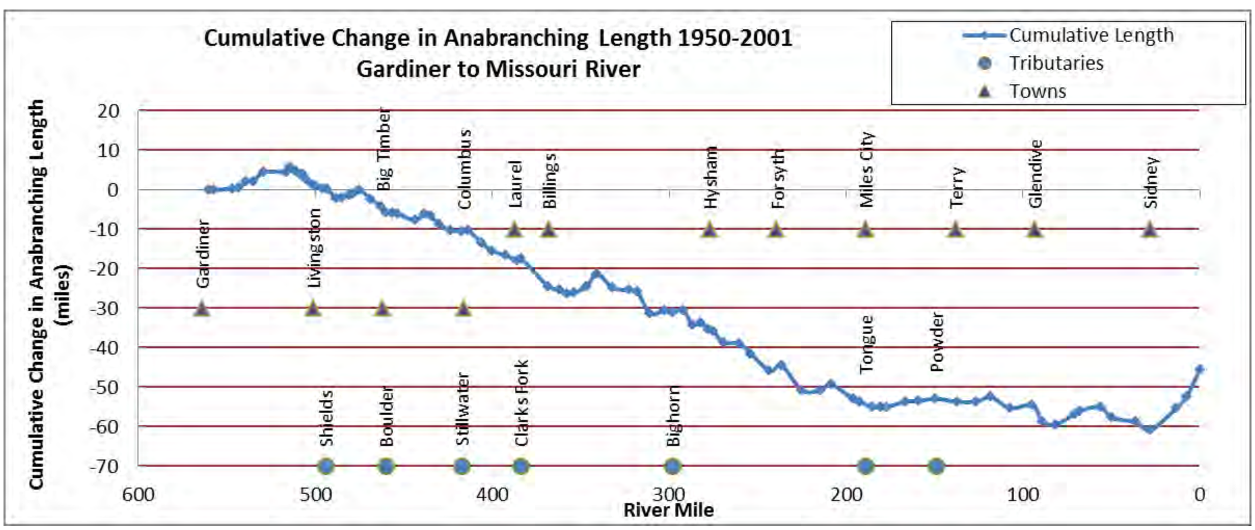


Figure 5-6 Cumulative change in anabranching channel length, 1950-2001.

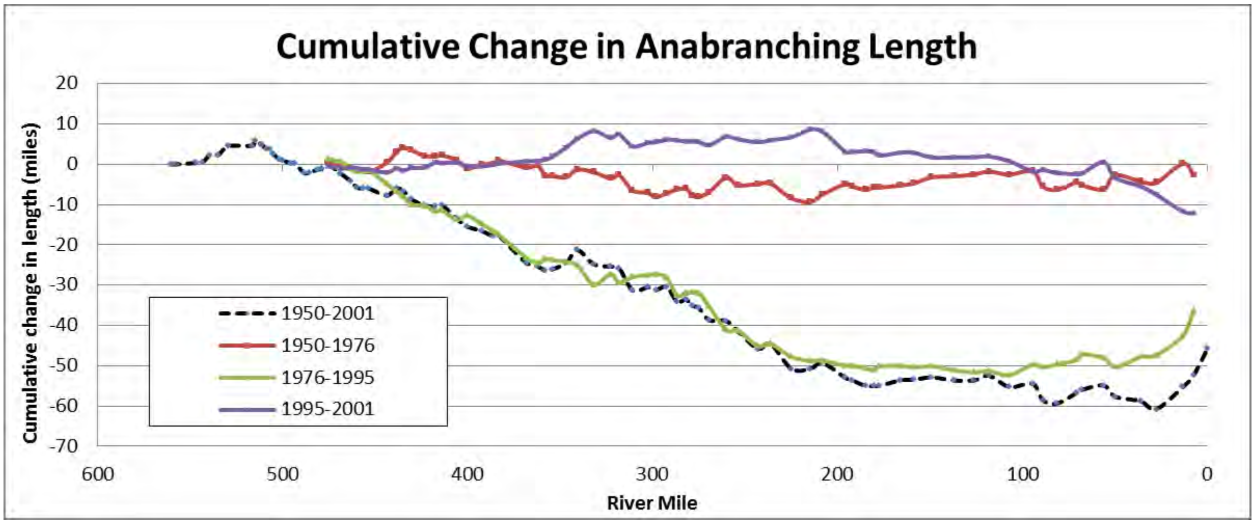


Figure 5-7 Cumulative change in anabranching channel length for multiple timeframes.

5.2.1 Cause of Side Channel Loss

The loss of side channels could relate to factors such as physical blockages or hydrologic change. One dataset generated on the Yellowstone River is the attribution of side channels that have been lost due to blockages by physical features. Physical features typically consist of small dikes that have been built within side channels to block the channels and commonly provide road access to islands (Figure 5-8). Figure 5-9 shows that several reaches have lost miles of side channels due to such blockages. A total of 47 miles of side channel have been mapped as isolated by physical features between 1950 and 2001. The most concentrated areas of side channel loss are near Billings (Reaches B1-B3) and between Hysham and Forsyth (Reaches C6-C10). Figure 5-10 shows that between Gardiner and the Missouri River confluence, almost 50 miles of anabranching channel has been isolated by physical features. Physical features typically account for about 80 percent of the total side channel loss in reaches with a net loss. However, it is important to note that some reaches show a net gain in side channel length; side channels are dynamic and the results here are intended to show total, cumulative change for an inherently dynamic geomorphic parameter.

5.3 Pre-1950s Loss of Side Channels

A total of 42 miles of side channel were mapped as blocked by physical features at the time the 1950s imagery was taken (Figure 5-11). These features were mapped both to recognize that impacts to the river had occurred prior to 1950, and also to help identify restoration opportunities in the river corridor. The most impacted reaches with regard to total side channel loss are downstream of Billings (B1-B3) and at Glendive (D6) (Figure 5-12).

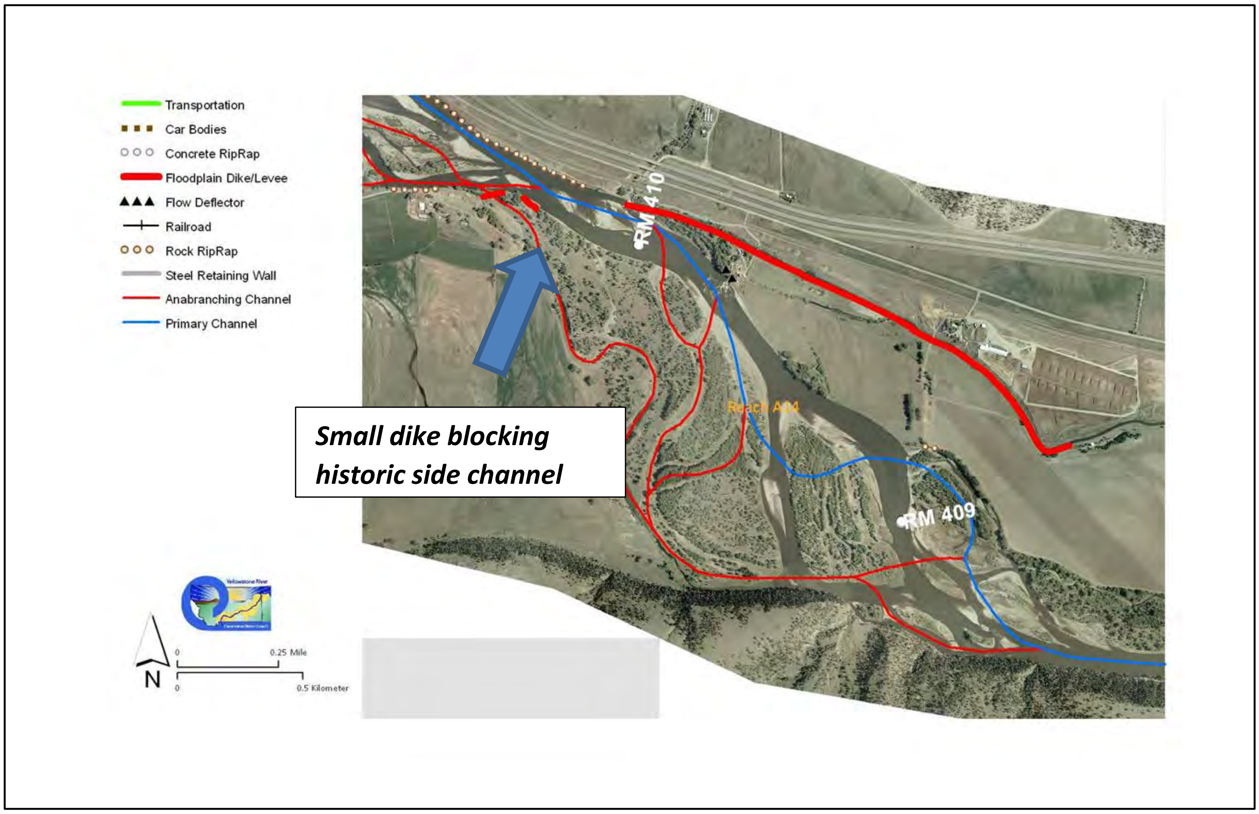


Figure 5-8 **Portion of Reach A14 showing 2011 air photo overlain by 1950 channel centerlines and physical features; an anabranching channel on south side of river has been abandoned due to a short floodplain dike in the upper left portion of photo; flow is left to right.**

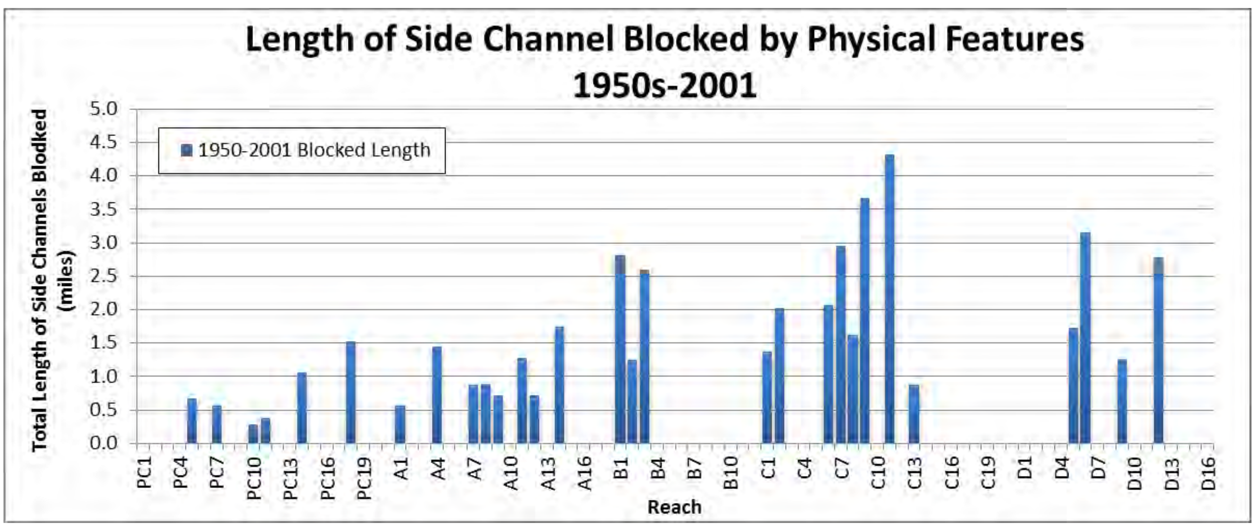


Figure 5-9 **Length of side channel blocked by physical features by reach.**

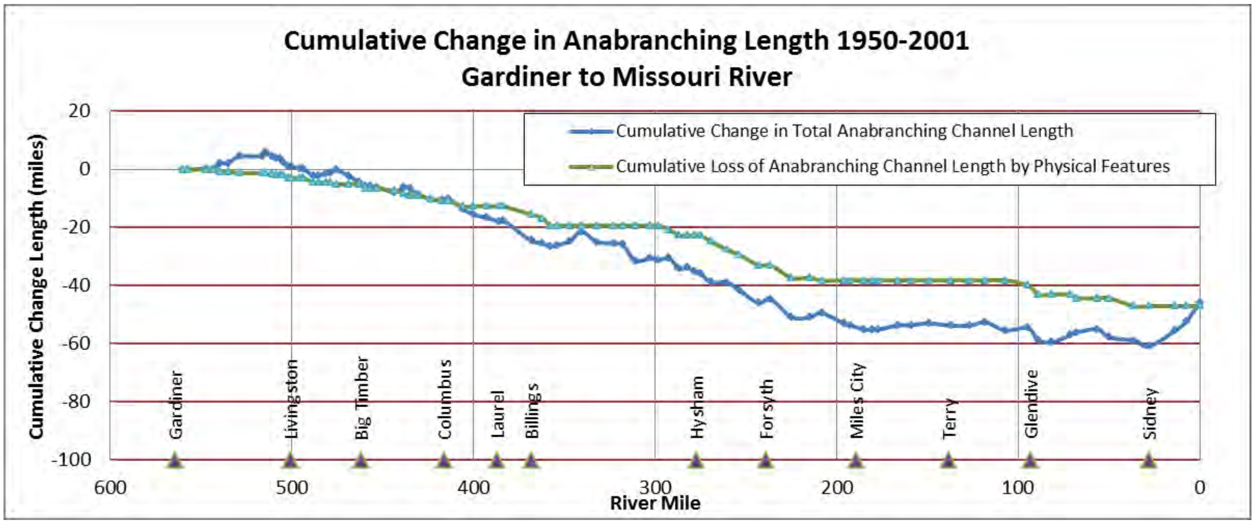


Figure 5-10 **Cumulative 1950-2001 loss of anabranching channel length and cumulative isolation of side channels by physical features.**

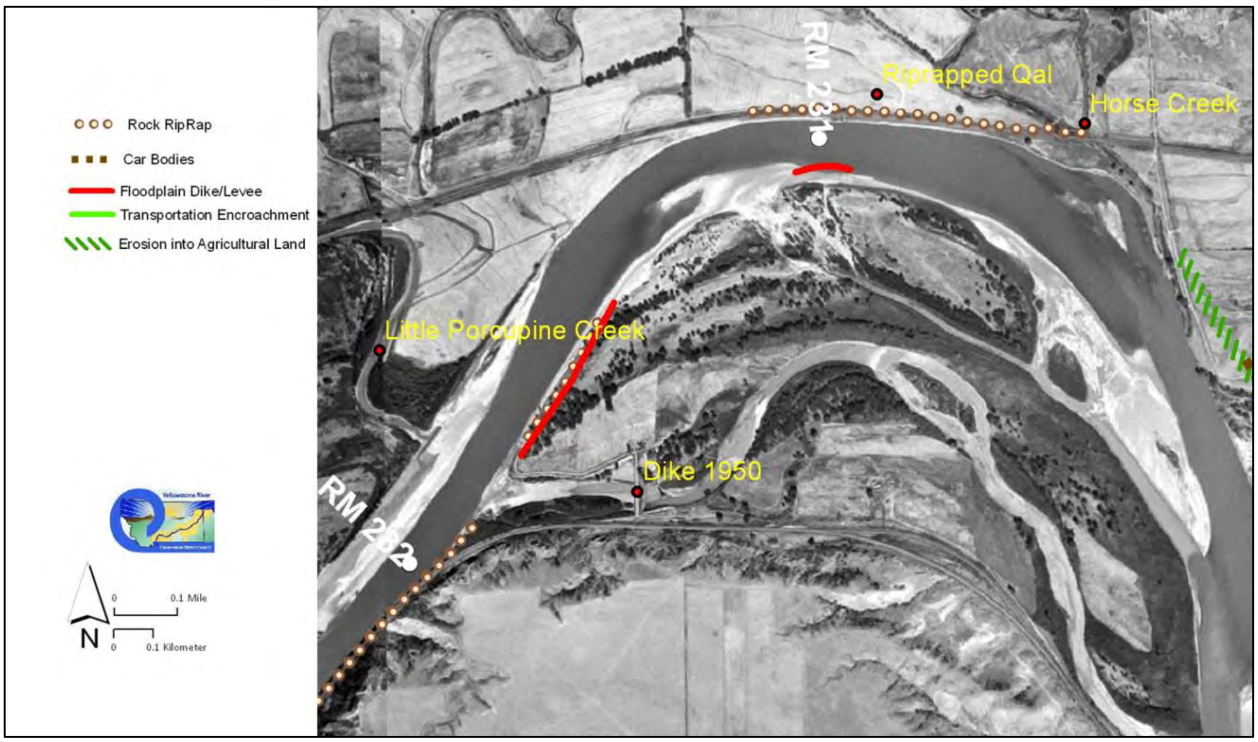


Figure 5-11 **Air photo from 1950s of Reach C11 near Cartersville Bridge showing a small dike blocking a side channel in meander core by 1950; flow is left to right.**

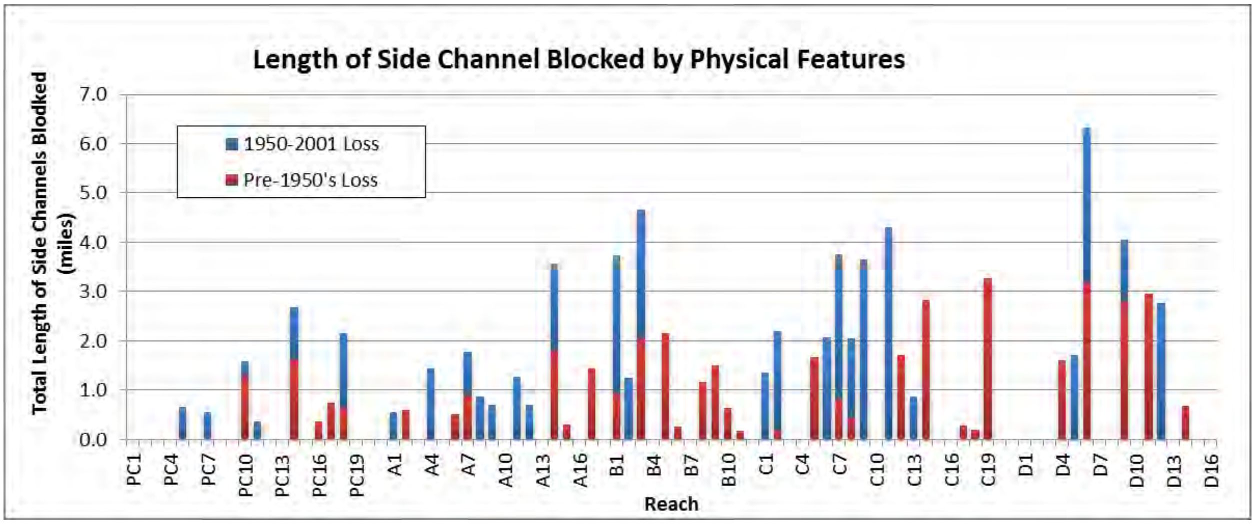


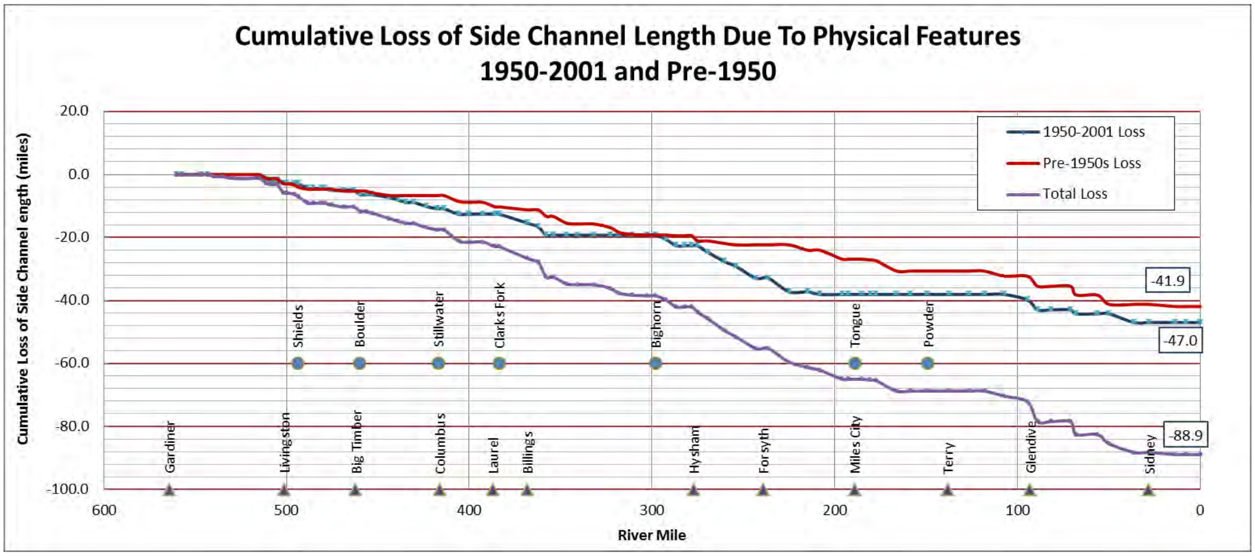
Figure 5-12 Total side channel loss due to blockages, pre- and post-1950s.

5.4 Example Side Channel Loss: Reach B1 (Billings)

Side channel loss on the Yellowstone River is clearly in part due to the construction of discreet dikes intended to focus flow into a single thread. Most of these features are relatively small agricultural dikes that provide access to historic islands and increase the overall extent of agricultural land in the stream corridor. However, additional factors may also affect the connectivity and length of side channels. These main impacts include hydrologic alterations (Appendix 2 Hydrology) as well as bank armor.

In 2011, a total of 57,836 feet or 12 miles of bank armor were mapped in Reach B1 at Billings. The total amount of bank length created by both the main and anabranching channels is about 62 miles, indicating that about 19 percent of the banks were armored in 2011. Hydrologic analysis indicates that the mean monthly June flows have dropped by about 3,000cfs or 10 percent under developed conditions. Both of these impacts have the potential to drive abandonment of side channels.

Between 1950 and 2001, Reach B1 lost 7.0 miles of anabranching channel length. A total of 2.8 miles of side channels were blocked by physical features. This indicates that at most, about 40 percent of the loss in side channel length can be attributed to those blockages (Figure 5-13).



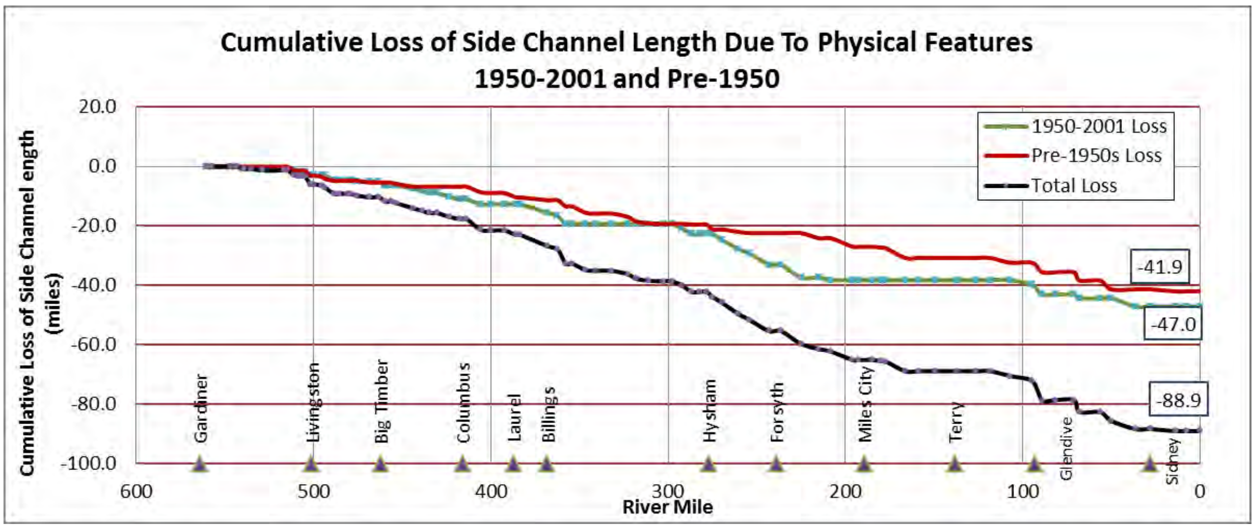


Figure 5-13 Cumulative loss of side channel length, pre-1950 and 1950-2001.

Figure 5-14 shows 1955 and 2001 air photos of a portion of Reach B1. The photos, which are of the same location, show a dramatic change from a true anabranching channel in 1955 with a “split main” thread, to a largely single thread channel in 2001. No physical features were mapped in this reach as blocking side channels. As such, these channels were “passively” lost, in that the loss cannot be directly attributed to a physical blockage. This is further exemplified in Figure 5-15 which is also from Reach B1; South Billings Blvd can be seen in the center of the photo. This example shows a 1955 multithread condition converting to a highly dominant main channel thread in 2011.

The loss of side (anabranching) channels in Reach B1 shows a cumulative geomorphic impact that is only partially explained by features such as dikes that were constructed to intentionally block channels. This depicts the complexity of cumulative impacts on geomorphic parameters, as contributing factors to side channel loss include flow alterations which have the potential to dry out side channels, and bank armoring, which can drive channel downcutting and physical perching of side channels.

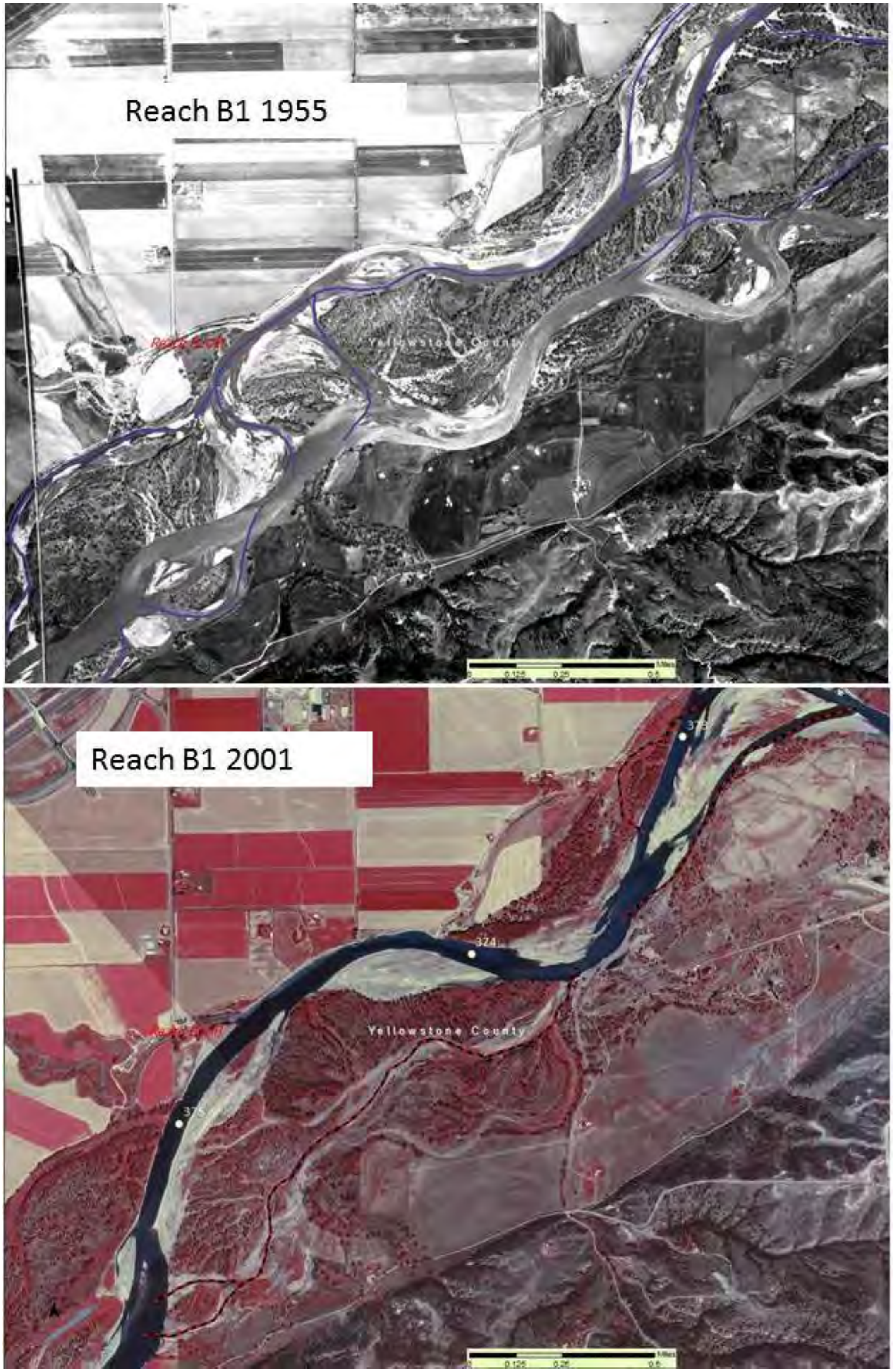


Figure 5-14 Air photos of Reach B1 showing passive loss of anabranching channels.

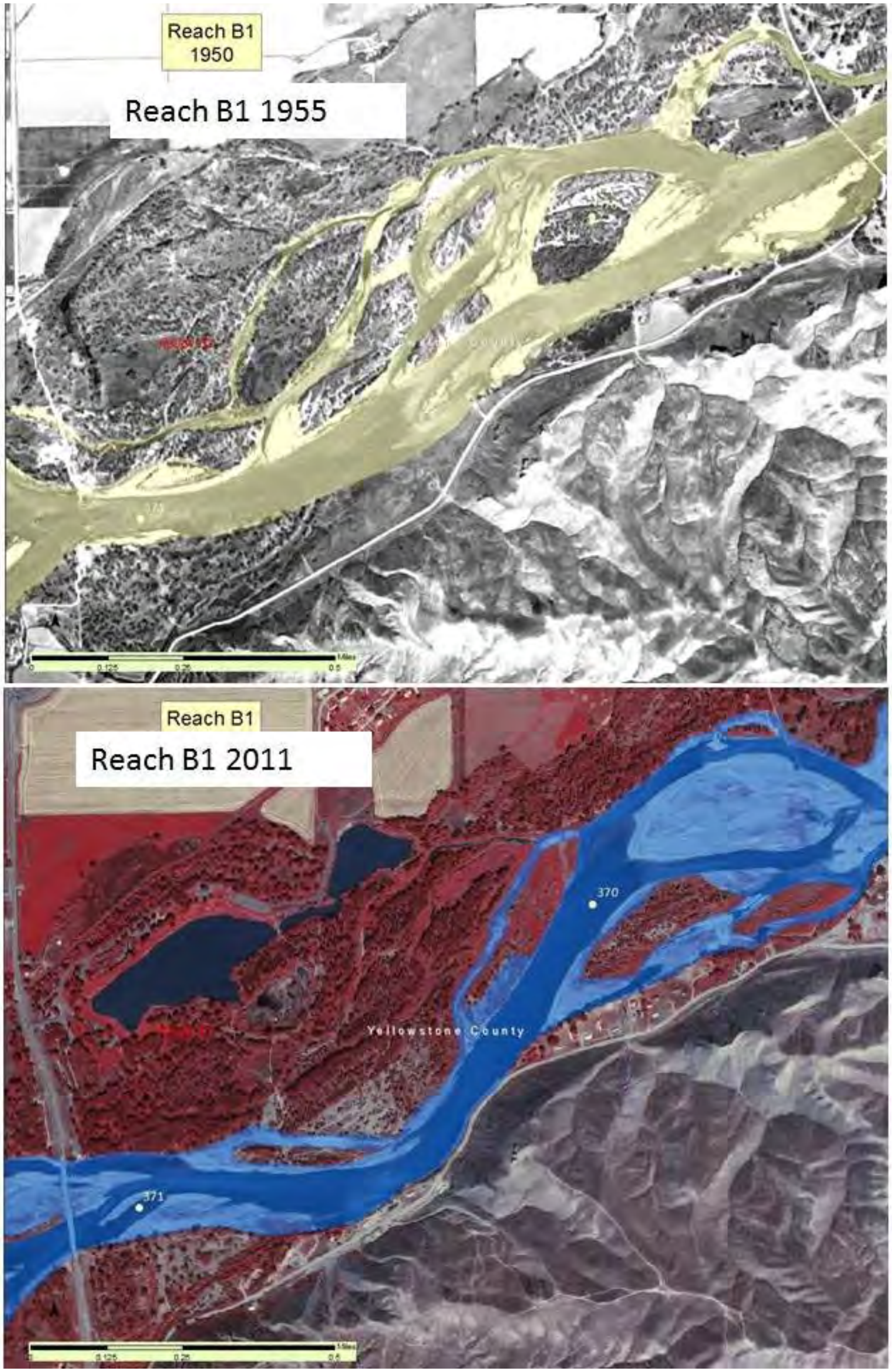


Figure 5-15 Air photos of Reach B1 showing evidence of flow consolidation between 1955 and 2011.

6.0 CHANGE IN LOW FLOW IN-STREAM GEOMORPHIC FEATURES

Low-flow geomorphic features are those located within the bankfull channel polygons. These features include mapped secondary channels and low-flow fish habitat. The comparison of these features through time requires consideration of the flow conditions at the time the imagery was collected. To that end, the imagery suites have been evaluated to assign an estimated flow condition on the day of the photo. The day the imagery was collected was recorded for each frame, and then the frame was assigned a discharge based on the flow recorded at a representative gaging station. Although the discharges assigned to each reach are approximate, however the results do provide an indication of flow comparability for each reach. Figure 6-1 shows estimated flows for the 1950 and 2001 imagery suites by reach for Regions A through D. The results show that upstream of the Bighorn River confluence (Reach C1), the 1950s imagery captured flows that were over twice that of the 2001 imagery. The differences are greatest below Billings in Reaches B6 through B12. These differences are what prompted the evaluation of most geomorphic parameters under bankfull flow conditions.

Although there are differences in flow conditions above the Bighorn River, all of the reaches in Regions C and D show very similar flow conditions for the 1950 and 2011 imagery. This allows a realistic comparison of low flow features for these Reaches (C1 through D16). These reaches are all affected by hydrologic alterations caused by both irrigation and Yellowtail Dam operations, so the analysis provides additional insight as to the potential river response to these impacts.

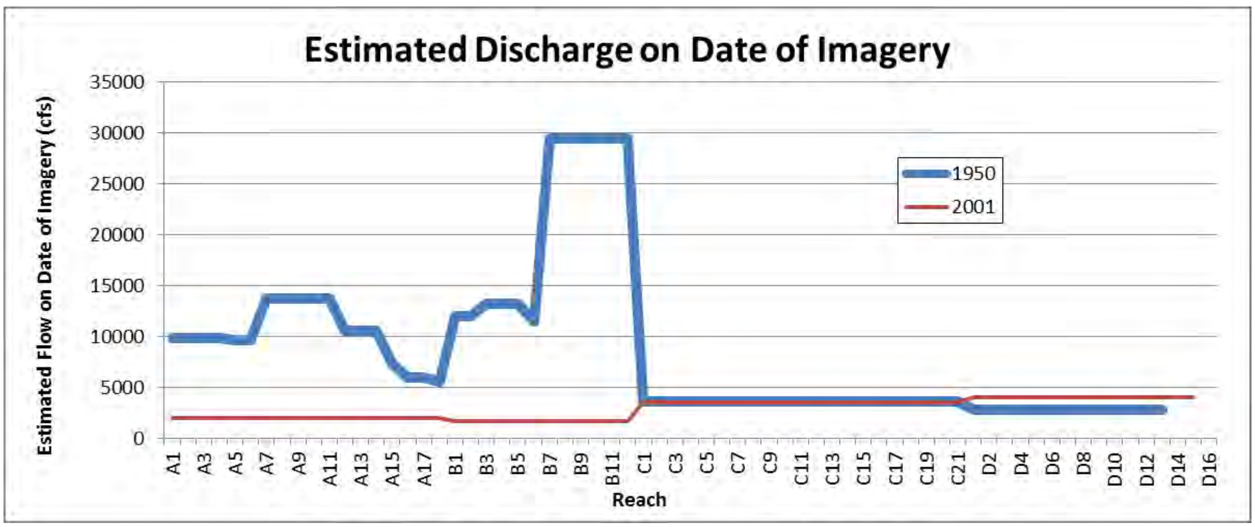


Figure 6-1 Estimated flow condition on date 1950 and 2001 aerial imagery frames were collected by reach.

6.1 Secondary Channels

Secondary channels were mapped as those that are separated from the main channel centerline by open gravel bars or minimally vegetated islands. These types of side channels are inundated at bankfull flow, but visible under low flow conditions. Secondary channels were mapped as line features in the GIS and summarized for Regions C and D where flows were similar for the suites of air photos. Results show that from 1950 to 2001, secondary channel lengths tend to largely decreased in Regions C and D. The most pronounced reductions in secondary channel length were downstream of Glendive in reaches D8 through D16 (Figure 6-2). In total, there was a reduction in secondary channel length of about 40.2 miles between 1950 and 2001 (Figure 6-3).

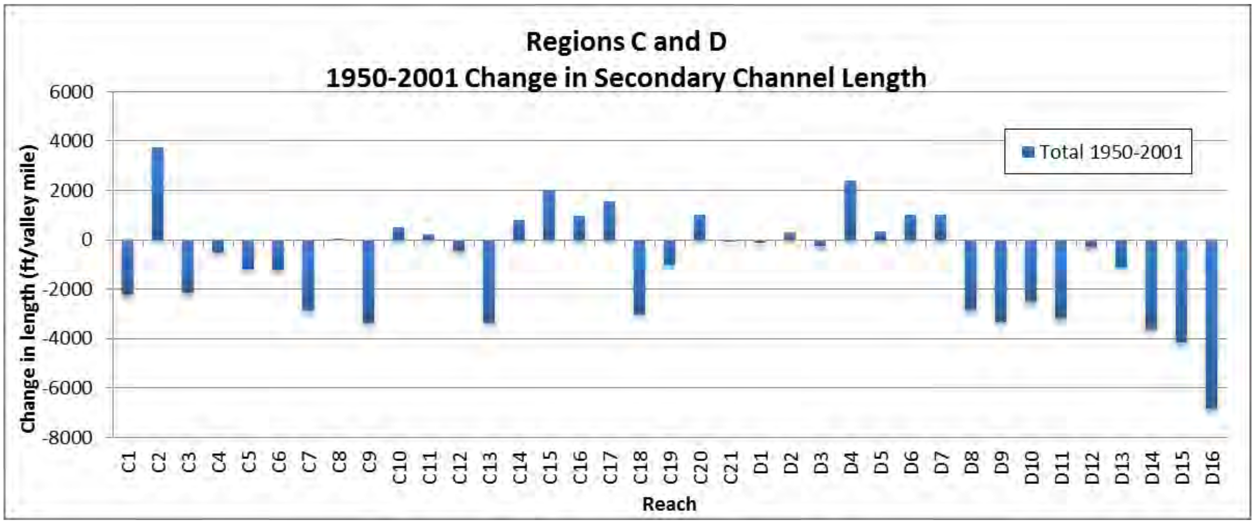


Figure 6-2 Mapped 1950-2001 total change in secondary channel length normalized to Valley Mile

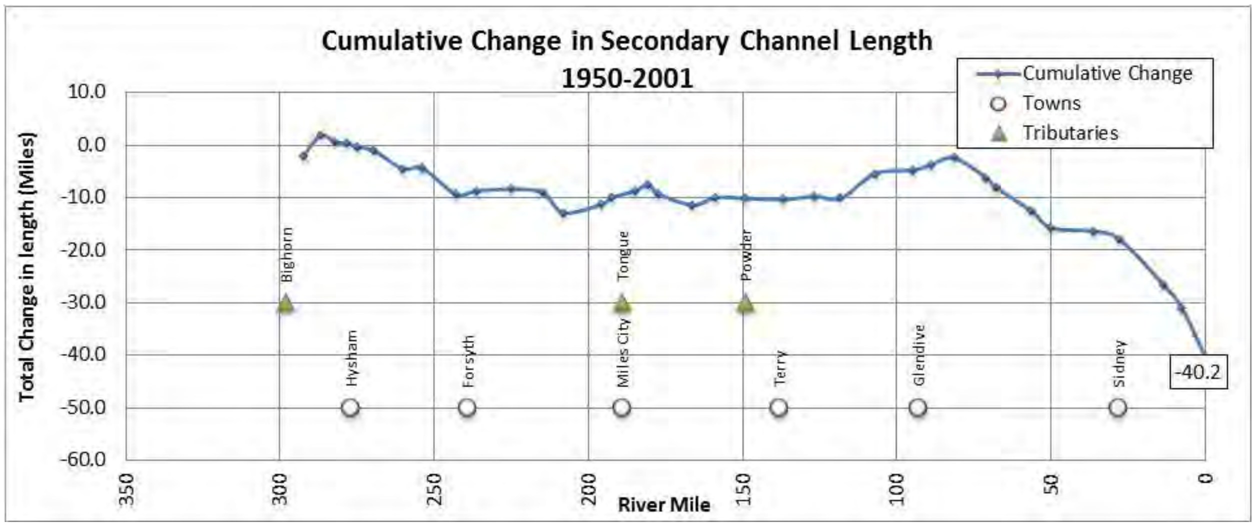


Figure 6-3 Change in secondary channel length summarized by individual time frame.

6.2 Open Bar Area

Open bars were mapped as low-flow habitat features on the 1950 and 2001 imagery and summarized for Regions C and D. Results show that reaches have both gained and lost open bar area, typically on the order of 10 acres per valley mile or less. The biggest changes were in the lowermost river below Sidney, where open bar area was reduced by over 30 acres per valley mile in Reach D14 (Figure 6-4). As open bars were mapped specifically in terms of bar type (point bars, mid-channel bars, and bank-attached bars), it is possible to compare these features through time in more detail. These results show that there has been a major loss of both point bar and mid-channel bar area, with a lesser increase in bank-attached bars (Figure 6-5 through Figure 6-7). Between the mouth of the Bighorn River and the Missouri River confluence, there was a net loss of 543 acres of open bar area, which translates to about 2.1 acres per valley mile of net reduction in area. Perhaps more importantly however, the bar types have changed fairly dramatically. The total extent of mid-channel bars has dropped by 43 percent since 1950, or by a total of 1,100 acres. Point bar area has been reduced ty 28 percent or 868 acres. In contrast, bank attached bar area has increased about 1,400 acres during the same timeframe, which is over a 200-percent increase. This shift has major ramifications for instream habitat environments.

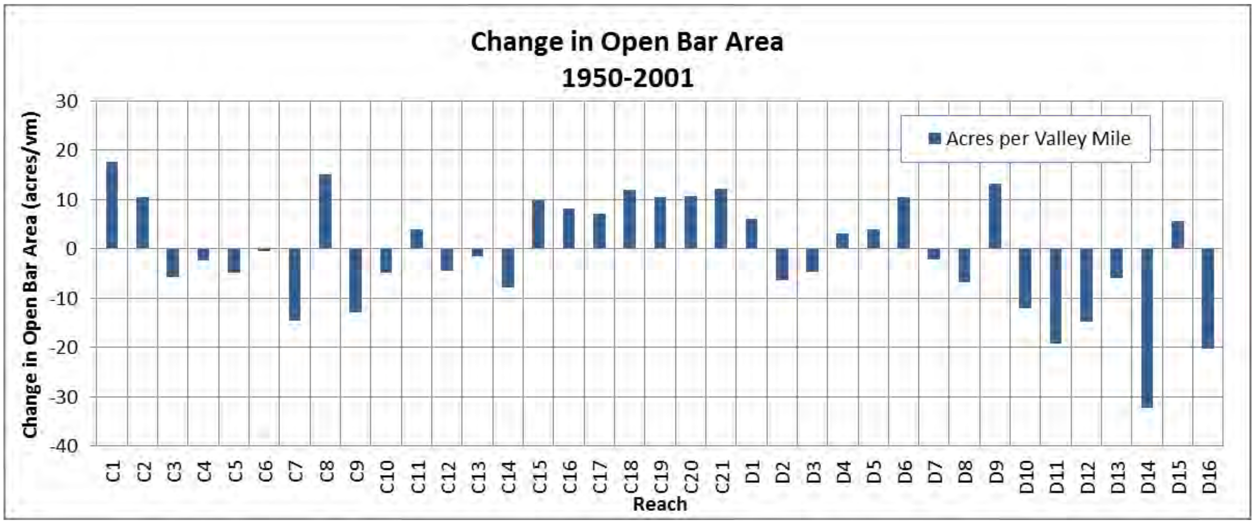


Figure 6-4 **Change in mapped open bar area, Regions C and D.**

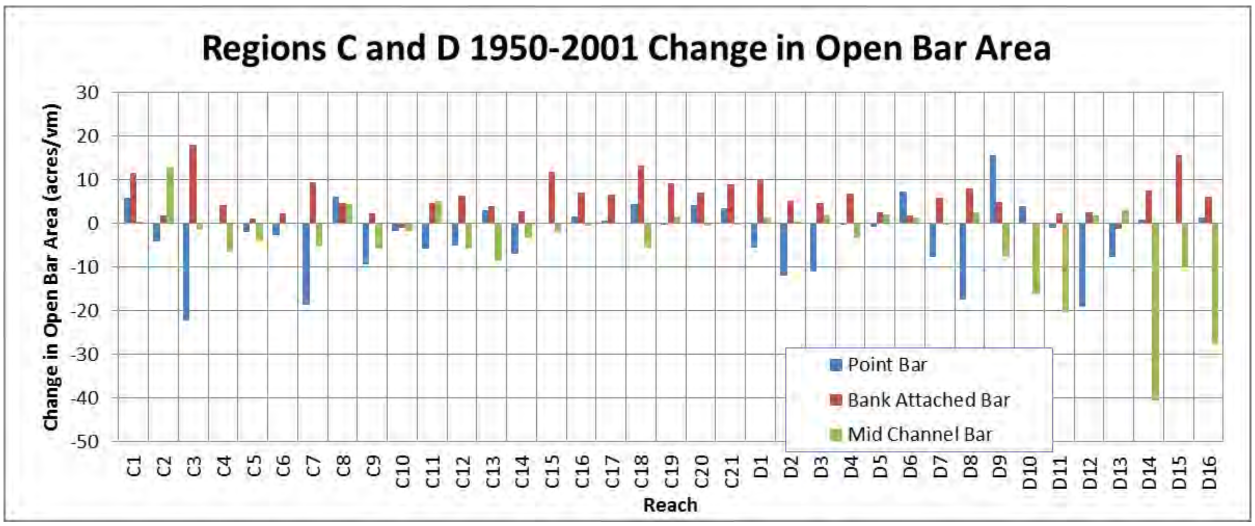


Figure 6-5 **Change in spatial extent of several types of open bar features.**

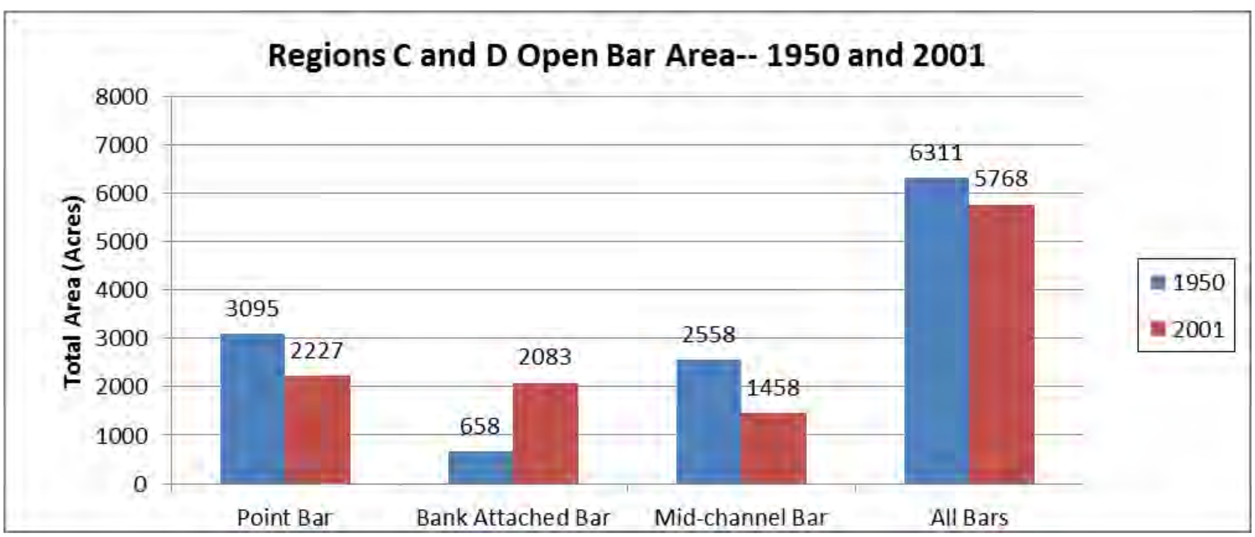


Figure 6-6 **Total acreage of open bar types, 1950 and 2001.**

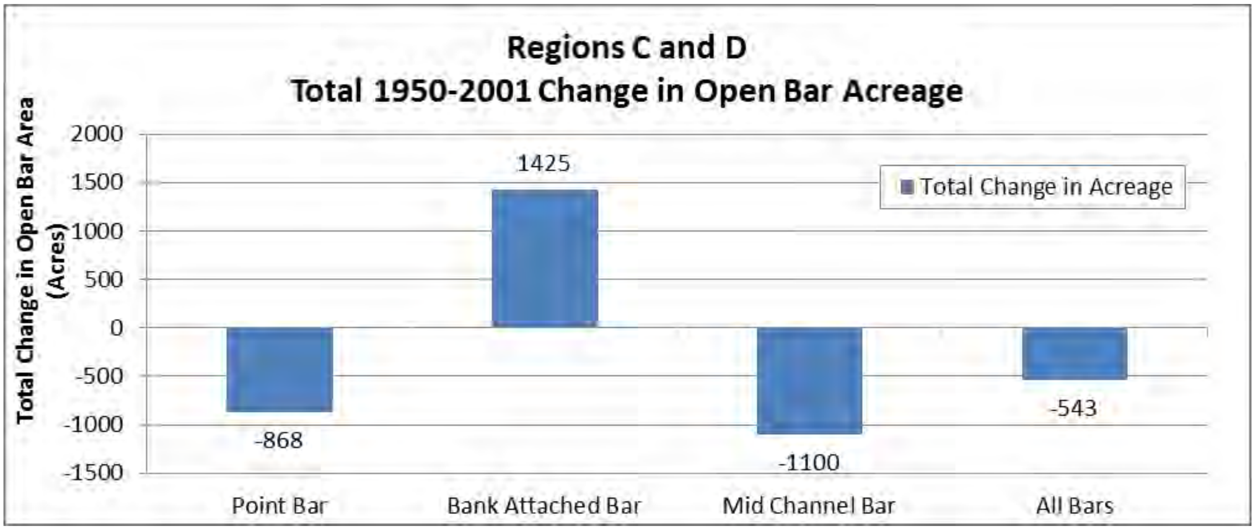


Figure 6-7 Total change in extent of open bar types, 1950-2001.

7.0 CHANGE IN BANKFULL CHANNEL AREA

Bankfull channel area was measured as the entire channel footprint within bankfull channel lines. Figure 7-1 shows that although many reaches show fairly minor shifts in total bankful area (±20 acres per valley mile), some reaches show reductions in bankfull channel area of over 40 acres per valley mile. Whereas, upstream of the Bighorn River confluence there was been a net gain in bankfull channel area of 1,760 acres between 1950 and 2011, there was a net loss of 4,460 acres downstream of the Bighorn. When plotted by individual timeframe for Regions A-D (Park County data were not available), the continual loss of bankfull area below the Bighorn River is evident (Regions C and D; Figure 7-2). Figure 7-3 and Figure 7-4 show an example from Reach D13 showing the net loss of bankfull channel area between 1950 and 2001.

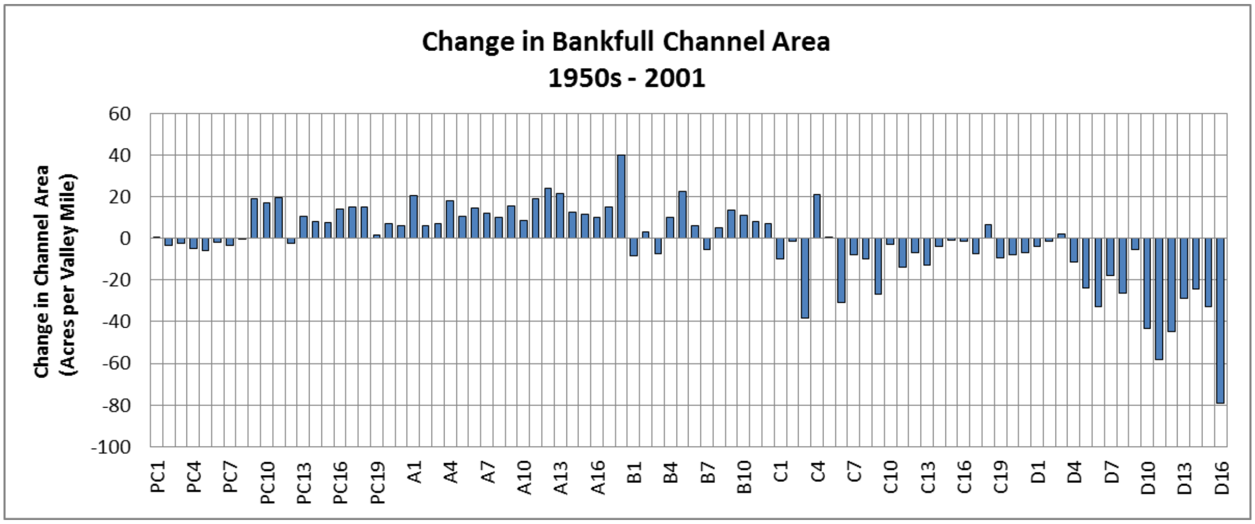


Figure 7-1 Total change in bankfull channel area by reach, 1950s-2001.

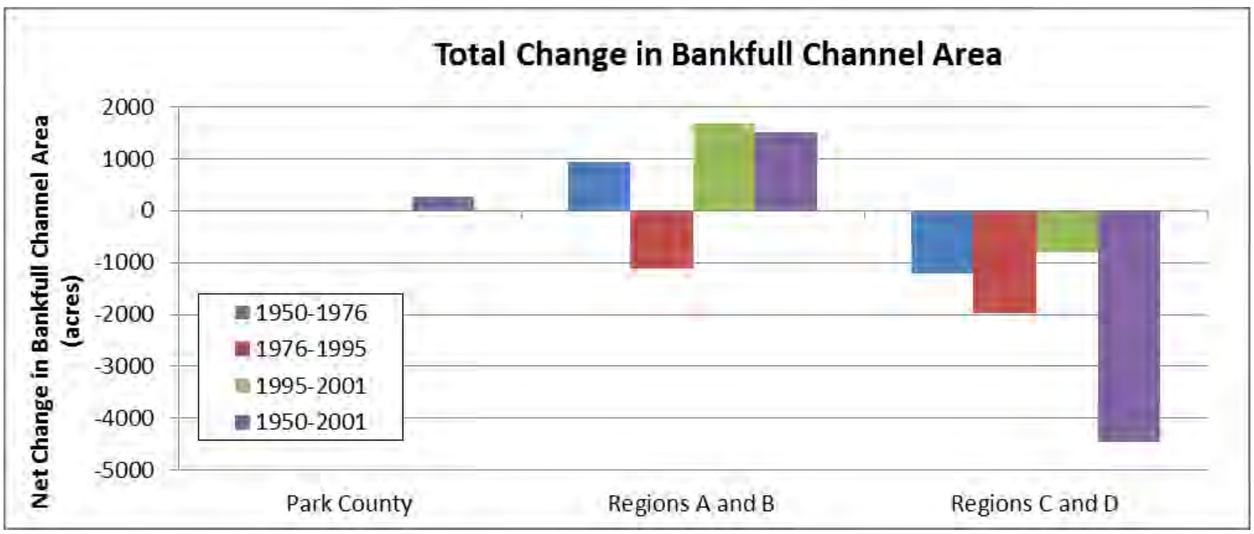


Figure 7-2 Total change bankfull channel area by timeframe (only 1950-2001 data available for Park County).

Figure 7-3 1950 image of Reach D13 showing extensive open bar habitat and large bankfull area.

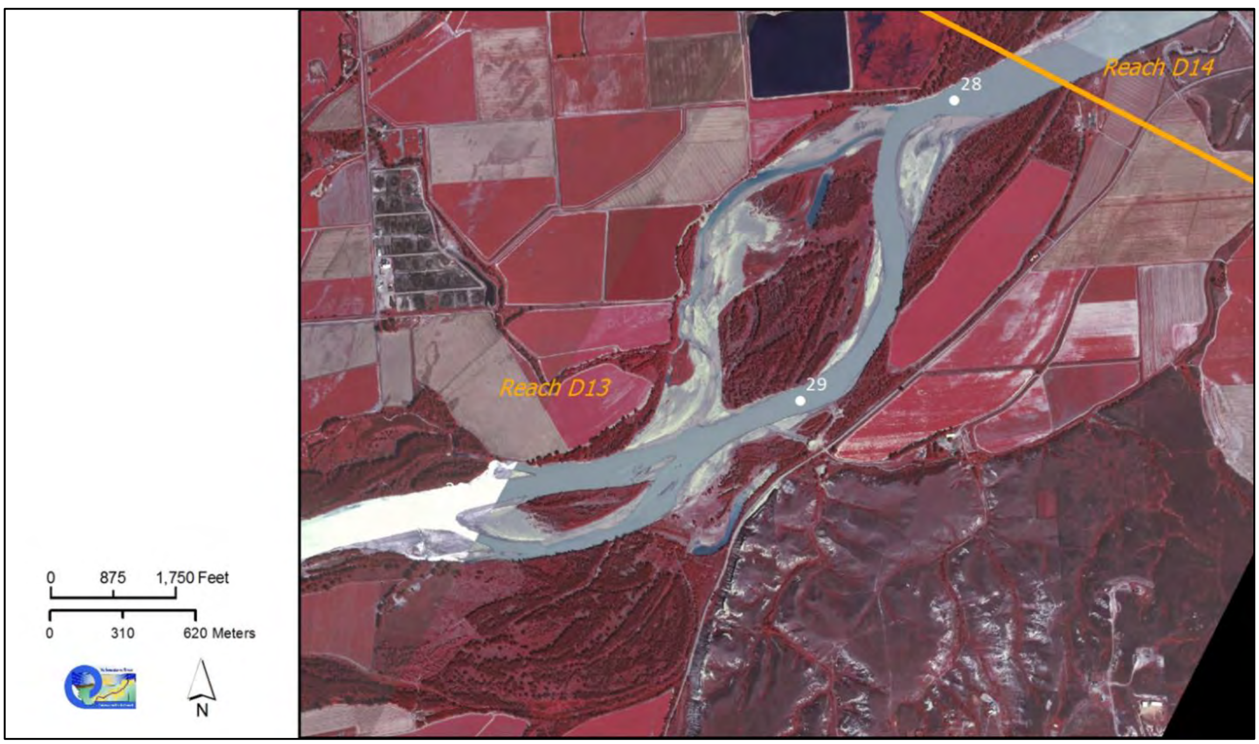


Figure 7-4 2001 image of Reach D13 showing small open bar habitat area and relatively small bankfull area.

8.0 FLOODPLAIN TURNOVER RATES

Floodplain turnover extents were measured as the amount of land that was eroded by the river in any given timeframe. This can then be annualized to a reach-scale acre per year value of floodplain turnover. These values were not calculated in Park County due to data limitations. For the entire river however, these trends were analyzed independently in terms of mean measured rates of channel migration.

8.1 Area of Floodplain Turnover

By intersecting bankfull channel lines, those areas that were eroded over a given timeframe can be identified and summarized by area. Since banklines are available for multiple timeframes, these values can be similarly segmented. The approach taken here was to evaluate turnover rates for two time frames: 1950-1976 and 1976-2001. The results indicate that from Springdale to the mouth, floodplain turnover rates have dropped in 54 of 66 total reaches (Figure 8-1 and Figure 8-2). During the 1950-1976 timeframe, about 11,800 acres of floodplain were eroded by the river below Springdale. Over the next 25 years, that extent of turnover dropped to 8,300 acres (Figure 8-3). Between Springdale and the Missouri River confluence (Park County Data were not available), the mean annual rate of total floodplain erosion dropped from 520 acres per year to 340 acres per year (Figure 8-4).

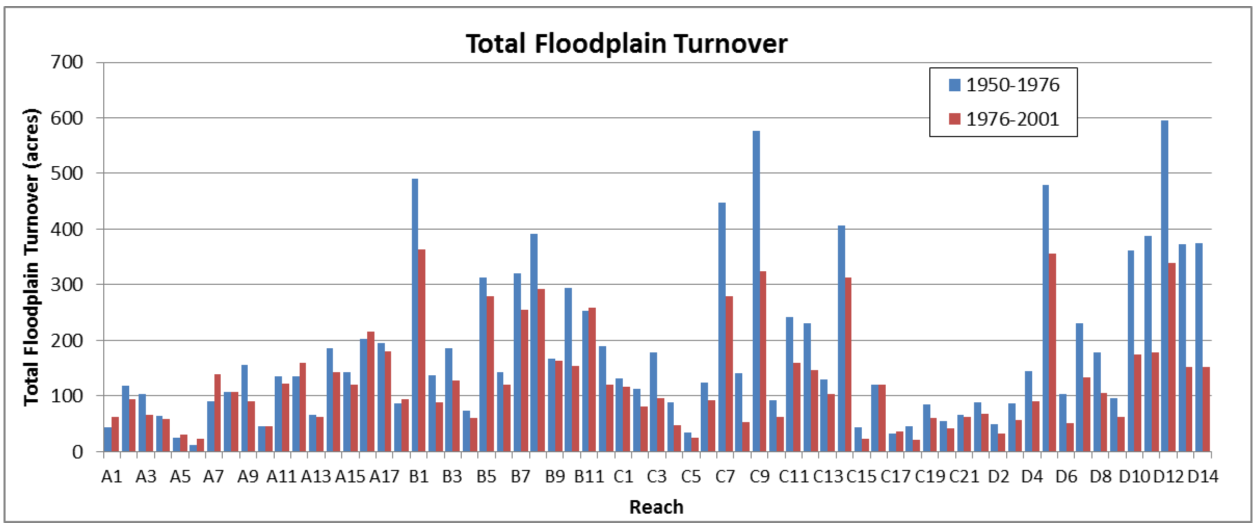


Figure 8-1 Total floodplain turnover from 1950-1976 and 1976-2001 by reach.

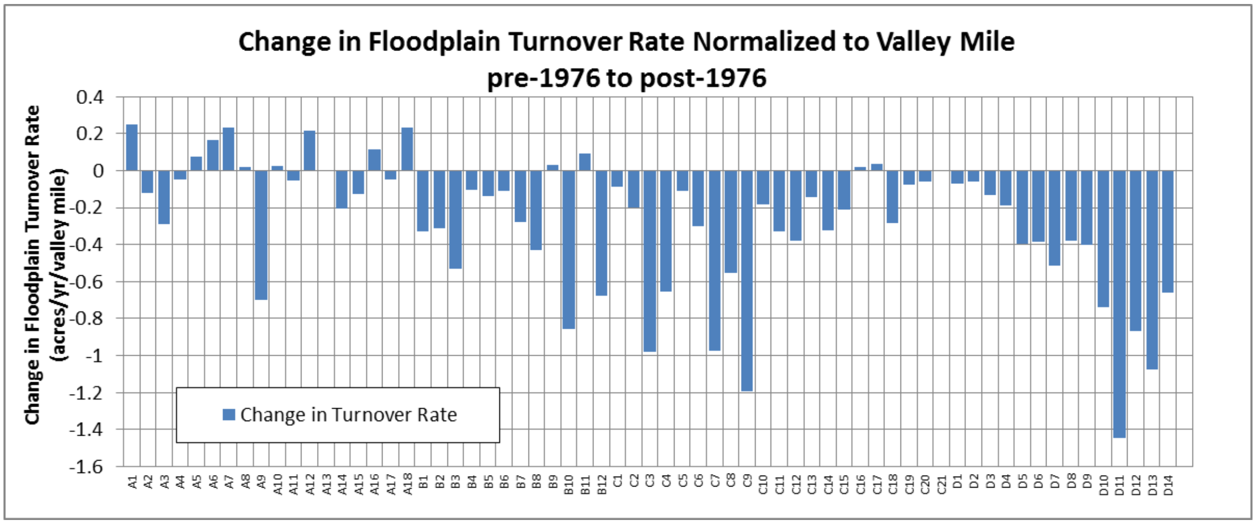


Figure 8-2 **Pre- and post- 1976 change in floodplain turnover rates (acres per year) normalized by valley distance.**

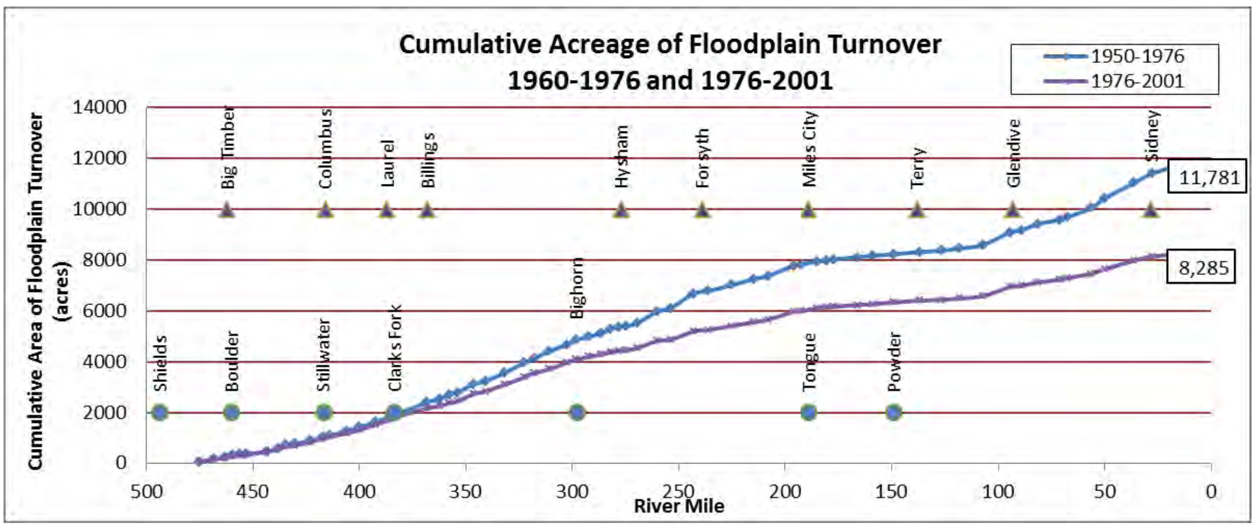


Figure 8-3 **Cumulative acreage of floodplain turnover by timeframe.**

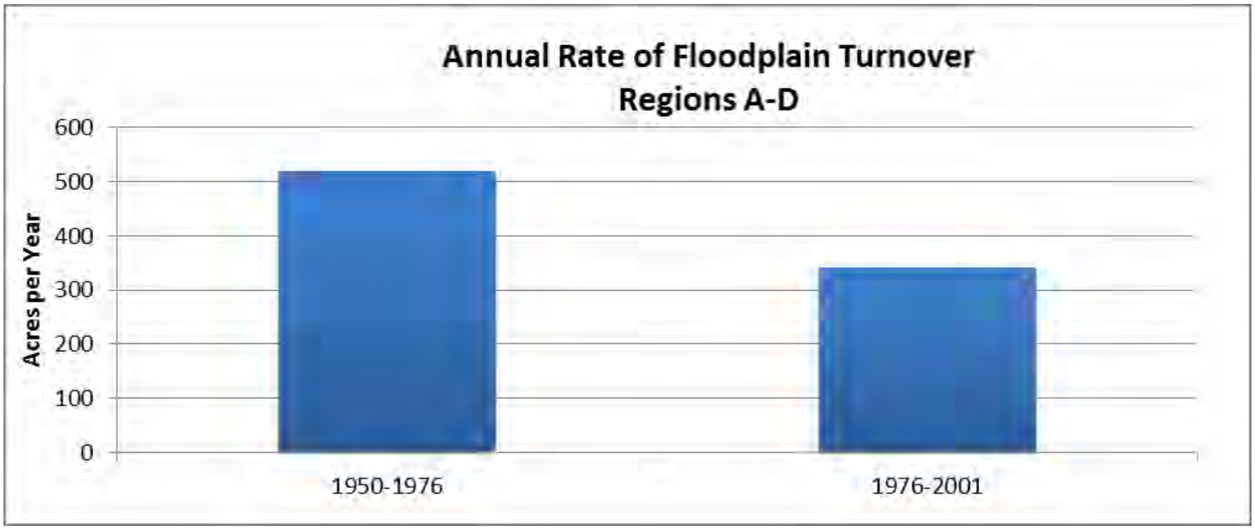


Figure 8-4 Annualized rate of floodplain turnover by timeframe.

These data indicate that the river corridor is less dynamic than it has been historically. Figure 8-5 and Figure 8-6 show the net and percent change in annual migration rates for the 1950-1976 to 1976-2002 timeframes, respectively. On a regional basis, Park County shows little change in mean rates, whereas all other reaches show a marked lowering of mean reach-averaged migration rate (Figure 8-7).

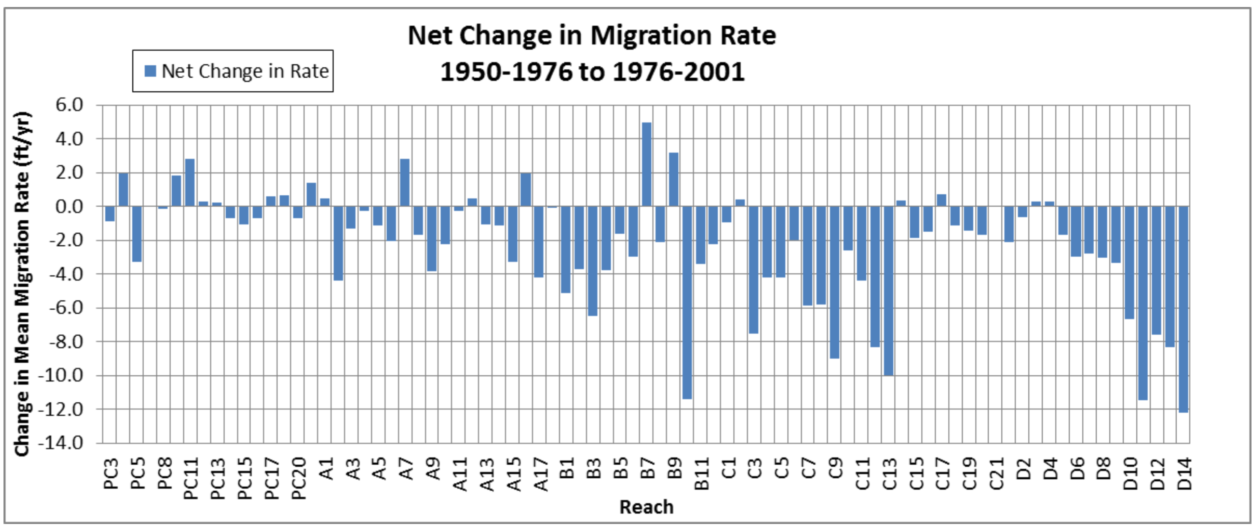


Figure 8-5 Net change in average annual migration rate pre- and post- 1976.

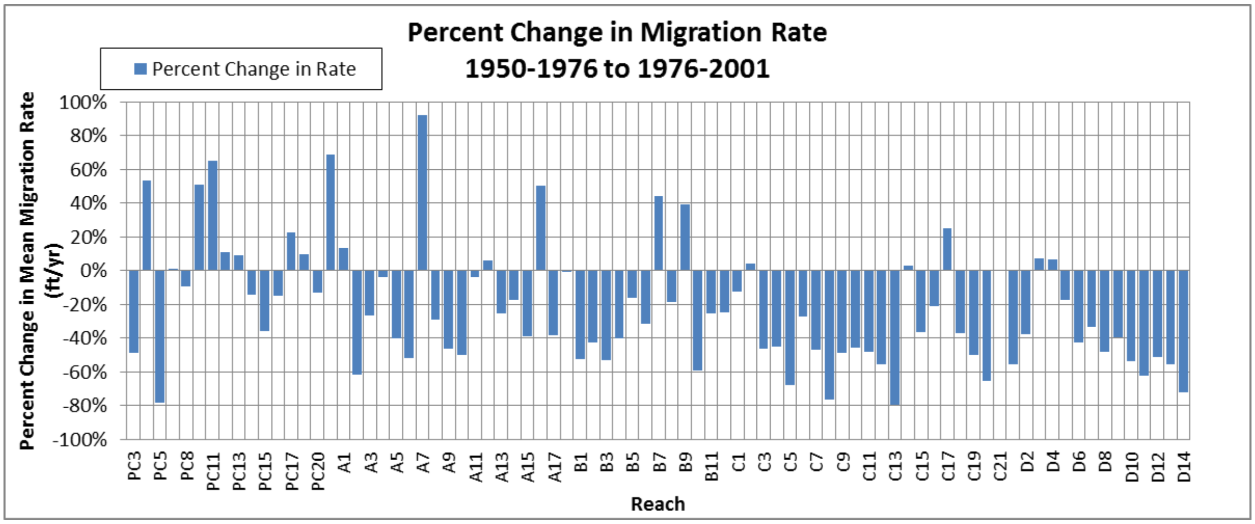


Figure 8-6 **Percent change in average annual migration rate pre- and post- 1976.**

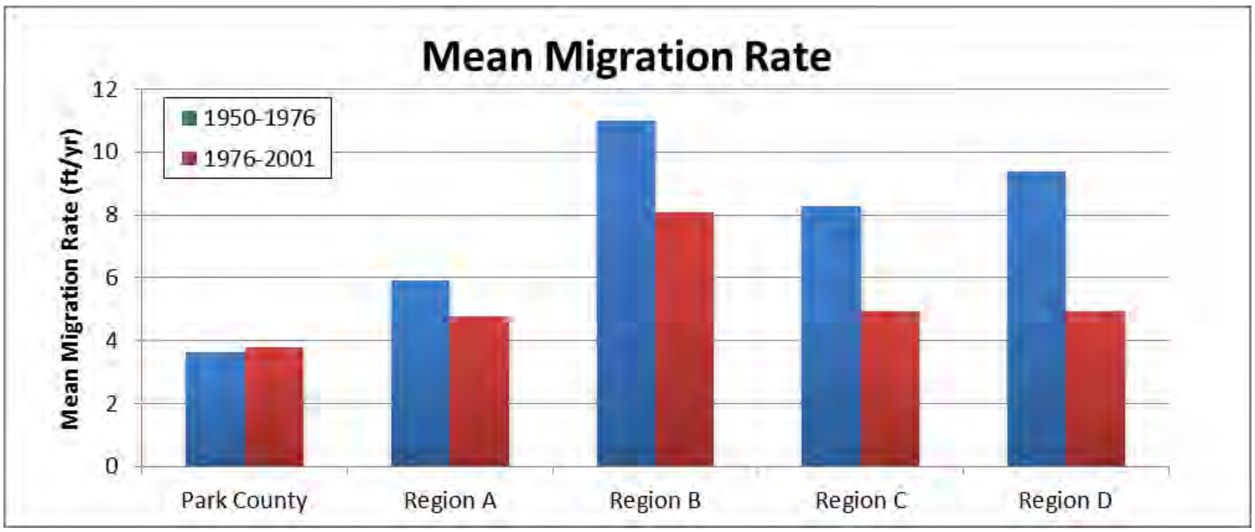


Figure 8-7 **Mean annual migration rate.**

8.1.1 Large Wood Recruitment

In order to identify any changes in rates of large wood recruitment into the river, the mapping datasets were used to quantify the conversion of areas from closed timber to channel. These acreages were then normalized to valley mile. The results show that the erosion rate of floodplain areas mapped as closed timber has dropped in the majority of reaches since the mid- 1970s (Figure 8-8 through Figure 8-10). The total river-wide recruitment rate pre-1976 was 182 acres per year, and from 1976 to 2001 the rate was 132 acres per year, a reduction of 50 acres per year. If the closed timber areas had one tree per every 1,000 square feet, that would translate to 2,500 fewer trees being incorporated into the river channel every year. The most pronounced reduction is in Region C. In Reach C9 the recruitment rates dropped from over 14 acres per year on average to less than 5 acres per year since 1976. Reach C9 is located between Hysham and Forsyth, in the broad Hammond Valley. Figure 8-11 and Figure 8-12 show the recruitment locations and extents during each of these two timeframes. Between 1950 and 1976, broad areas of riparian forest were eroded out by the river, and these areas are highlighted in the polygons shown on each air photo (Figure 8-11). From 1976 to 2001, the total amount of floodplain turnover (area eroded) was smaller, and more of that erosion extended into cleared agricultural fields rather than riparian forest (Figure 8-12). This suggests that the reduction in LWD recruitment rates is related to both reductions in overall floodplain turnover rates and riparian clearing.

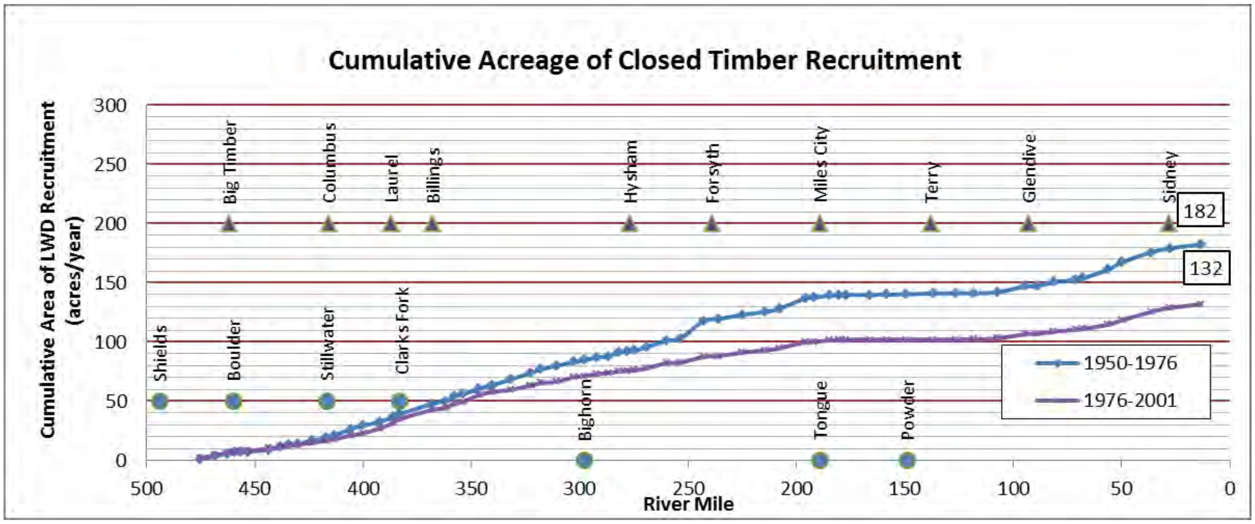


Figure 8-8 **Cumulative acreage of eroded closed timber riparian polygons, 1950-1976 and 1976-2001.**

Figure 8-9 **Rates of closed timber riparian polygon erosion by reach.**

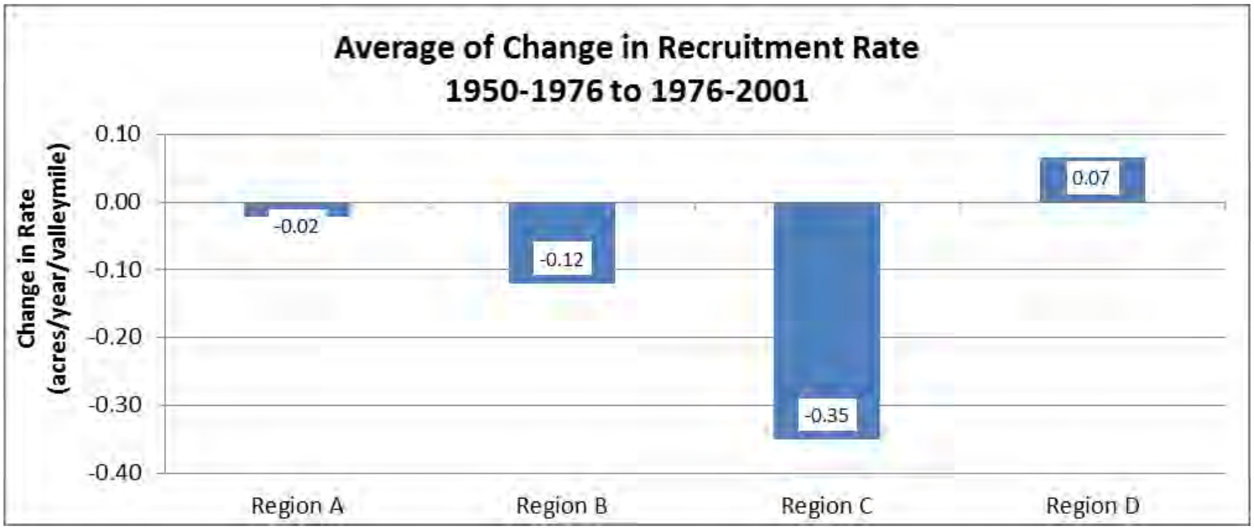


Figure 8-10 Pre- and post- 1976 average change in closed timber recruitment rates by region.

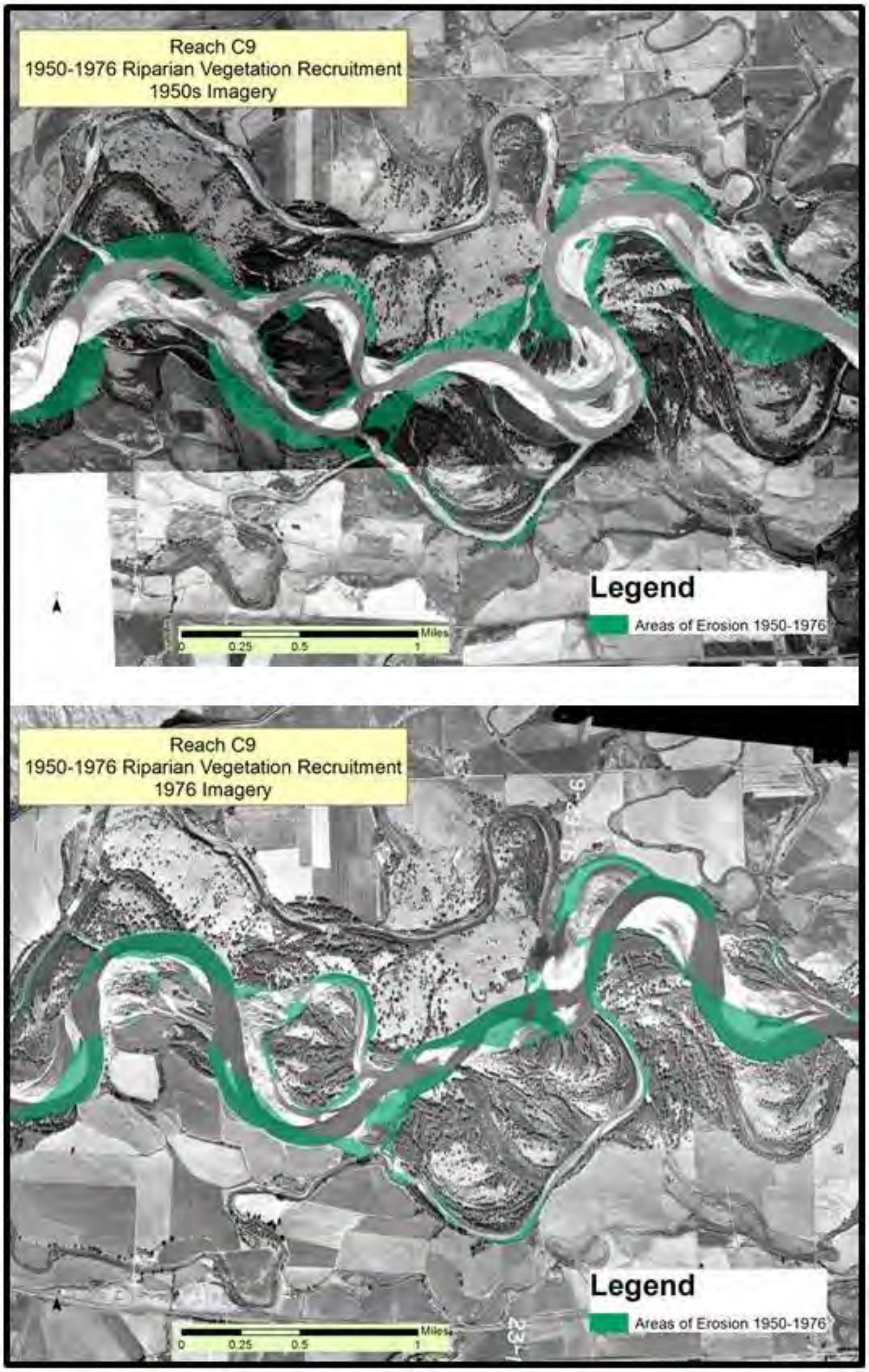


Figure 8-11 Reach C9 areas of 1950-1976 floodplain erosion and LWD recruitment showing 1950 image, (top), 1976 image (bottom), and areas eroded between 1950 and 1976 (green).

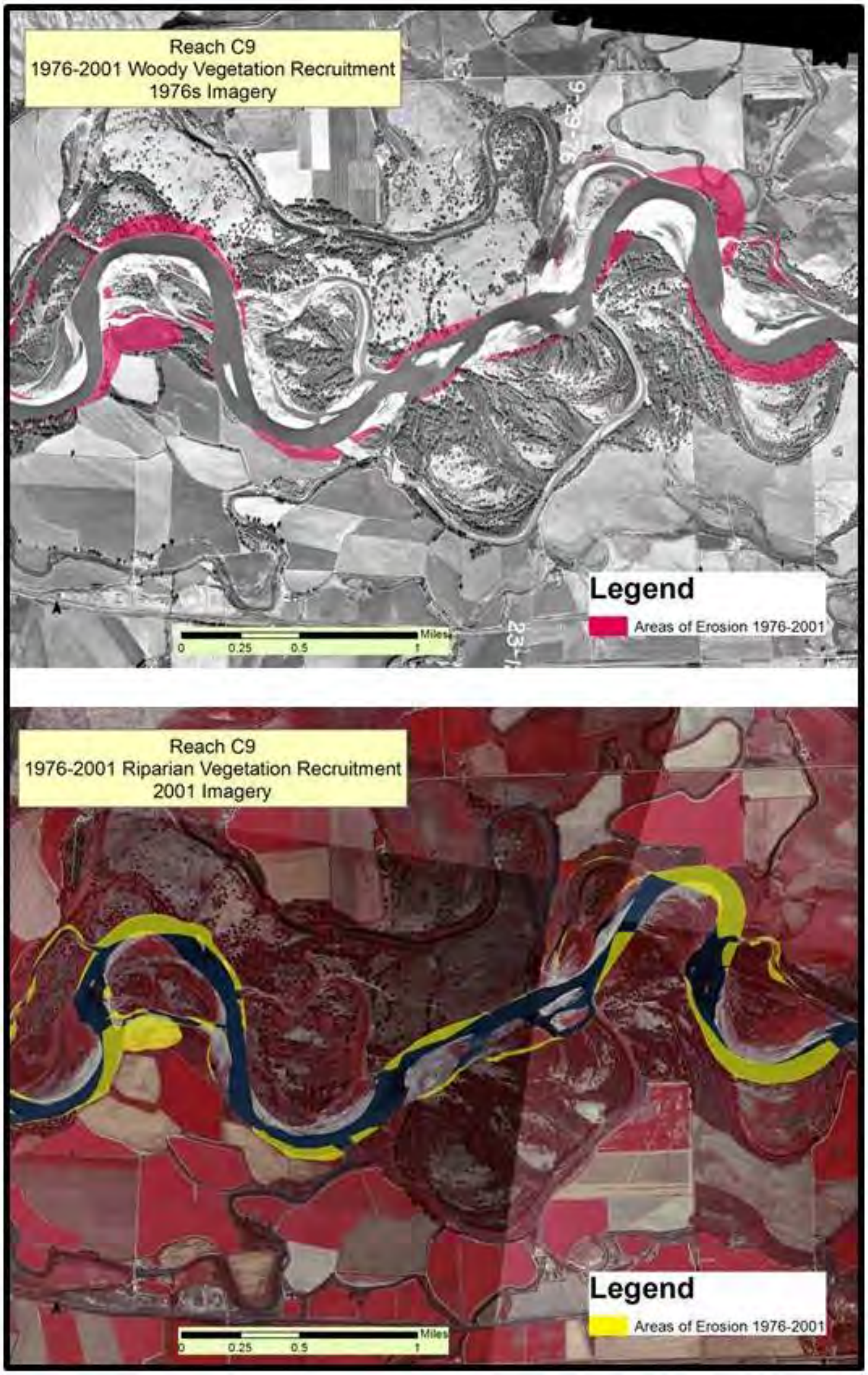


Figure 8-12 Reach C9 areas of 76-2001 floodplain erosion and LWD recruitment showing 1976 image, (top), 2001 image (bottom), and areas eroded between 1950 and 1976 (pink/yellow)

8.2 Migration Rates and Land Use

Bank erosion rates can be influenced by several factors, but it is fundamentally a reflection of the relationship between flow energy and erosion resistance of the bankline. Flow energy can be influenced by streamflow and local hydraulic conditions such as geomorphic location or local scour elements. The erosion resistance of the bankline can be affected by bank materials, bank height, vegetation density, and geotechnical parameter such as bank saturation. As a result, land use has the potential to affect erosion rates due to removal of deep binding woody vegetation or bank saturation through irrigation. To assess any such relationship on the Yellowstone River, the migration vectors generated as part of the Channel Migration Zone (CMZ) mapping effort were intersected with underlying land-use mapping to associate migration rates with land use. The analysis was only performed for unarmored banks, as natural rates are confounded by erosion control measures. The resulting dataset included 66 measurements of migration rates through hay/pasture ground, 64 measurements through area under sprinkler/flood irrigation, and 164 measurements through "multi-use" ground, which includes riparian bottoms and grazing land. The vectors include both the 1950-1976 and 1967-2001 timeframes. When averaged on a system-wide basis, the results indicate that average erosion rates are higher in both hay ground and irrigated lands relative to multi-use land (Figure 8-13 through Figure 8-15). Over a 25-year period, banks eroded into hay ground and irrigated ground an average 40 to 50 feet further than through multi-use ground. When summarized by region, the results show that every region shows this fundamental trend (Figure 8-16).

Figure 8-13 Rapid bankline migration through agricultural fields in Reach C7; light blue is 1950s banklines, red vectors are 1950-2001 migration distance labeled in feet, and air photo is 2011.

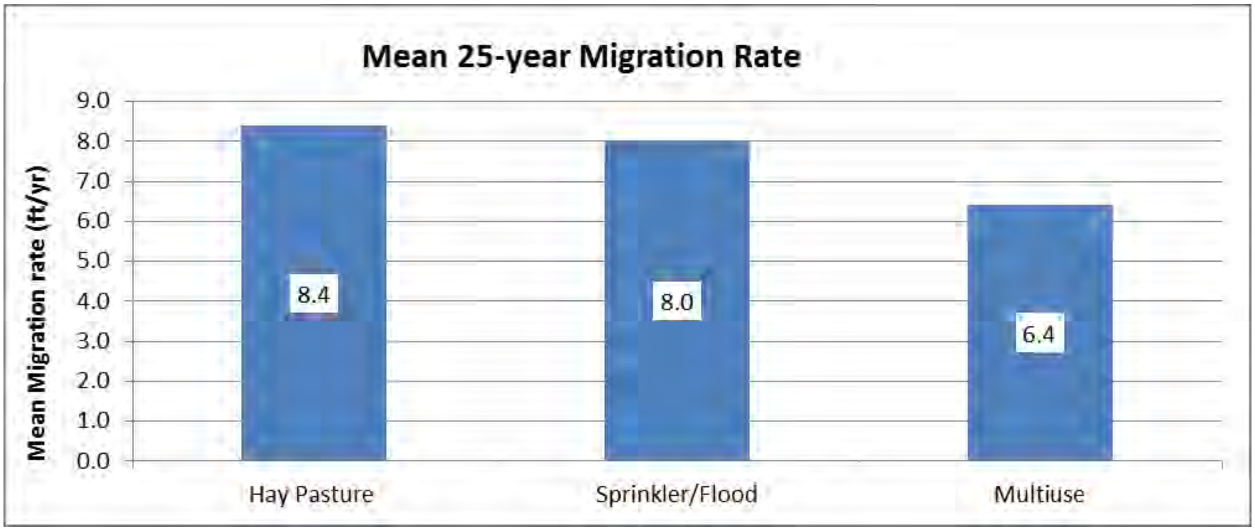


Figure 8-14 Mean migration rate summarized by land use; "multiuse" consists of riparian bottoms and grazing land.

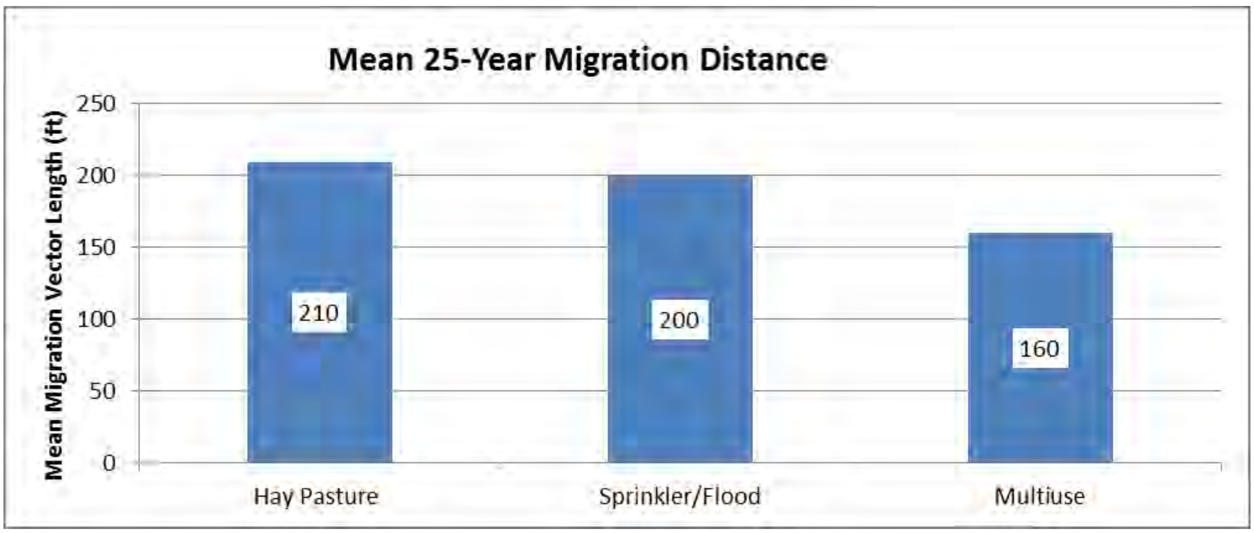


Figure 8-15 Mean 25-year migration distance by land use.

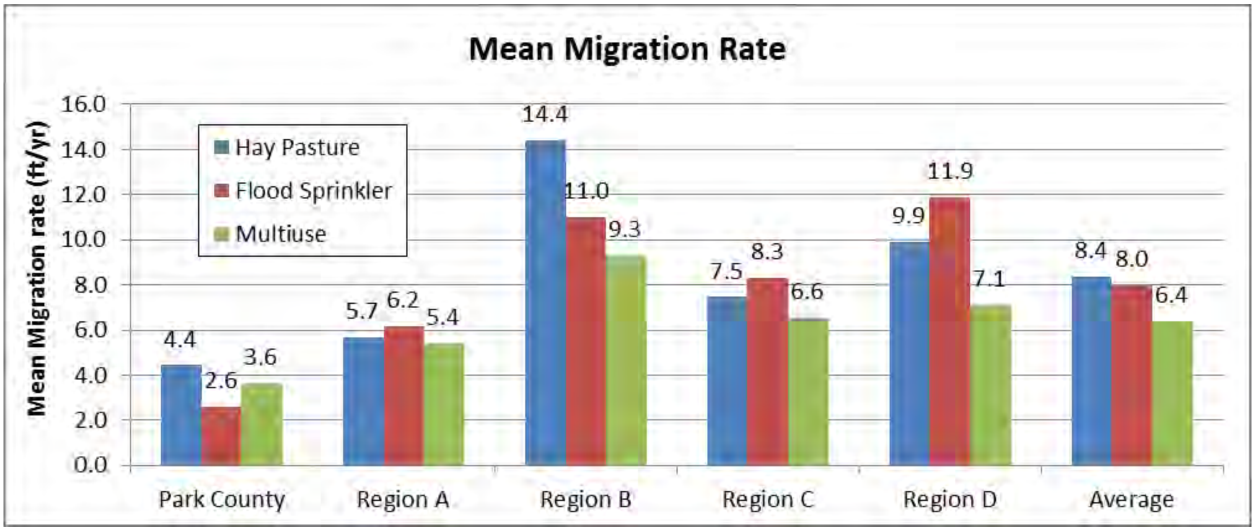


Figure 8-16 Mean migration rate summarized by region.

9.0 BANK ARMOR AND GEOMORPHOLOGY

The following section describes the mapped extents of bank armor within the Yellowstone River corridor.

9.1 Extent of Bank Armor: County

When summarized by County, mapped physical features data indicate that Yellowstone and Park Counties host the greatest extent of bank armor; collectively these two counties contain almost one half of all of the bank armor on the river (Figure 9-1 and Table 9-1). Although in terms of total extent, Park and Yellowstone County contain over 60 miles of bank armor (Figure 9-2), the extent of bank armor in these counties is only moderately higher than other counties of the upper river when normalized to channel length (Figure 9-3).

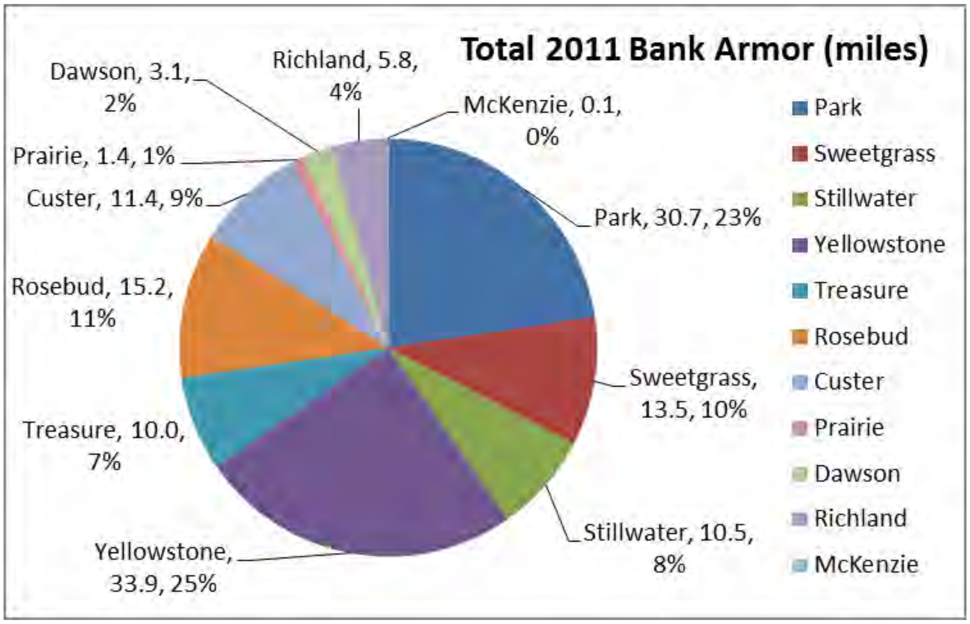


Figure 9-1 Distribution of total 2011 bank armor by county.

Table 9-1
Summary of total bank armor lengths by county.

County	Total Length of Armor (miles)	River Length (miles)	Miles of Armor / Miles of River
Park	30.7	85.2	0.36
Sweetgrass	13.5	44.1	0.31
Stillwater	10.5	42.3	0.25
Yellowstone	33.9	94.3	0.36
Treasure	10.0	37.8	0.26
Rosebud	15.2	52.2	0.29
Custer	11.4	49.4	0.23
Prairie	1.4	40.6	0.03
Dawson	3.1	50.3	0.06
Richland	5.8	54.3	0.11
McKenzie	0.1	13.5	0.00

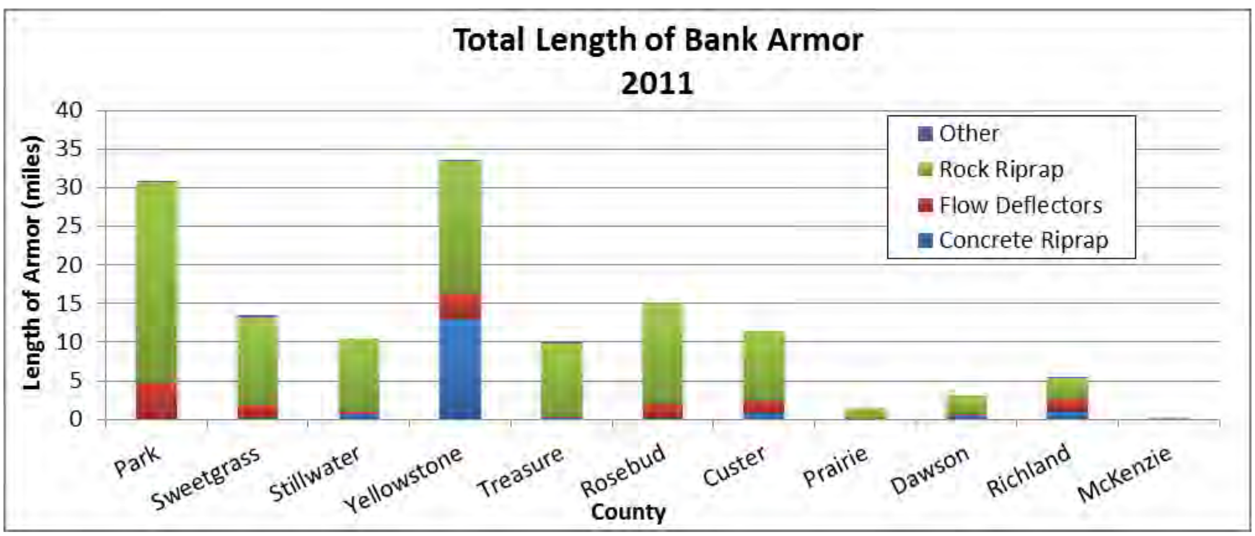


Figure 9-2 Total length of bank armor by county, 2011 physical features inventory.

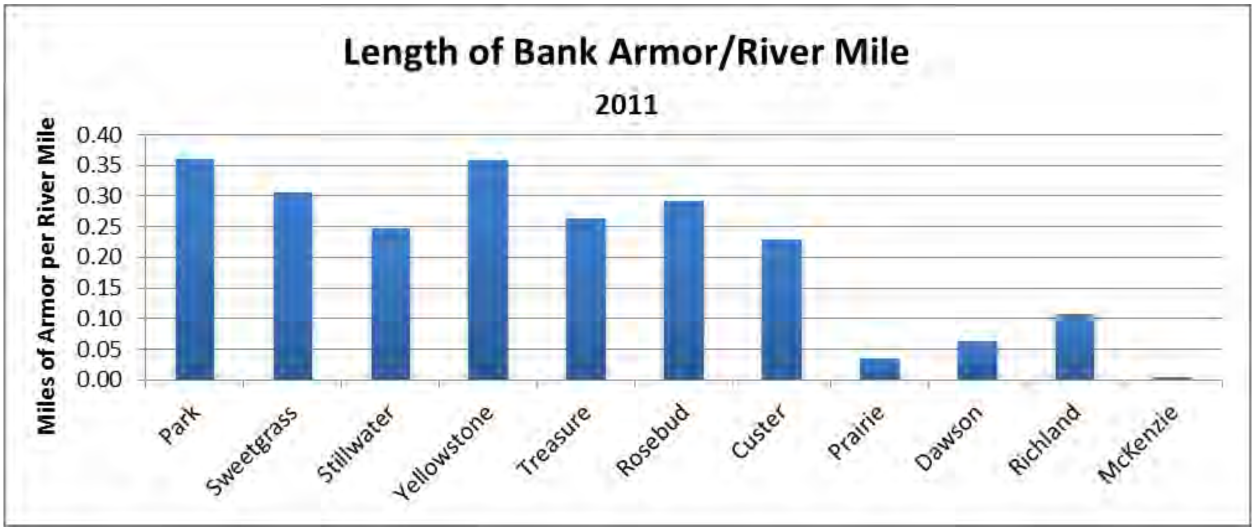


Figure 9-3 Miles of armor normalized to main channel length by county, 2011 physical features inventory.

9.2 Extent and Types of Bank Armor by Reach

As of 2011, there was approximately 136 miles of bank armor on the Yellowstone River below Gardiner, consisting of rock riprap, flow deflectors, concrete riprap, car bodies, and minor extents of other techniques such as gabions and steel retaining walls (Table 9-2). The most prevalent type of bank armor is rock riprap, which comprises about 75 percent of the total armor. Concrete riprap and flow deflectors make up most of the remaining armor (27 percent; Figure 9-4). About 12% of the banks of the Yellowstone River below Gardiner are armored. On a reach scale, an average of 9 percent of the bankline is protected in any given reach, and that number varies from 0 to 47 percent in Reach B4 downstream of Billings (Figure 9-5). Concrete riprap is most densely concentrated near Billings (Reaches B1-B5, Figure 9-5).

Table 9-2
Total extent of major armor types.

	2011 Armor Extents: Gardiner to Mouth					
	Rock Riprap	Flow Deflectors	Concrete Riprap	Car Bodies	Other	Total
Length (mi)	102.0	15.2	16.5	1.3	0.6	135.6
Percent of Bankline	9.1%	1.4%	1.5%	0.1%	0.1%	12.1%

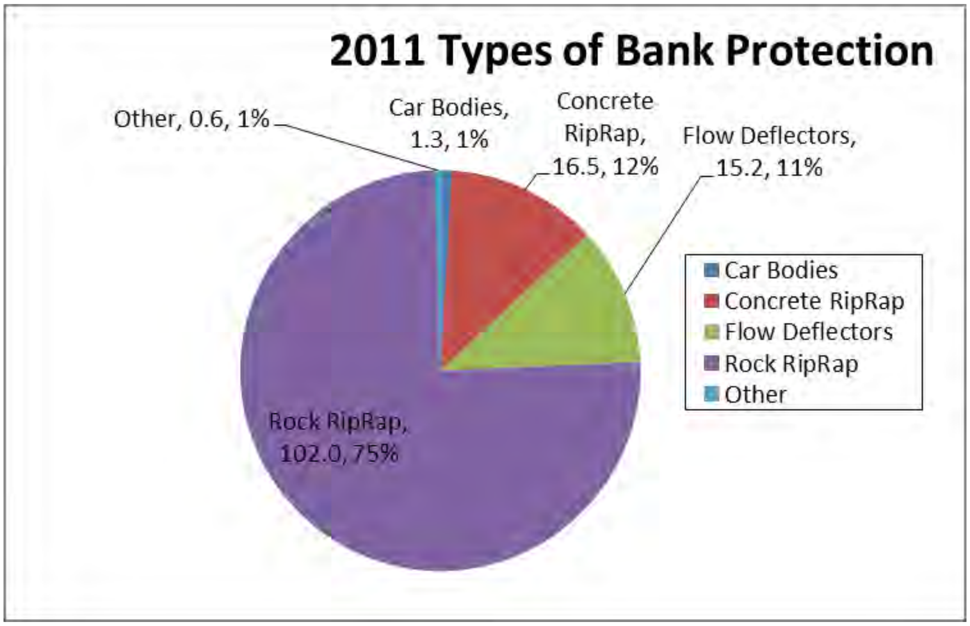


Figure 9-4 **Pie chart showing relative extents of bank armor types.**

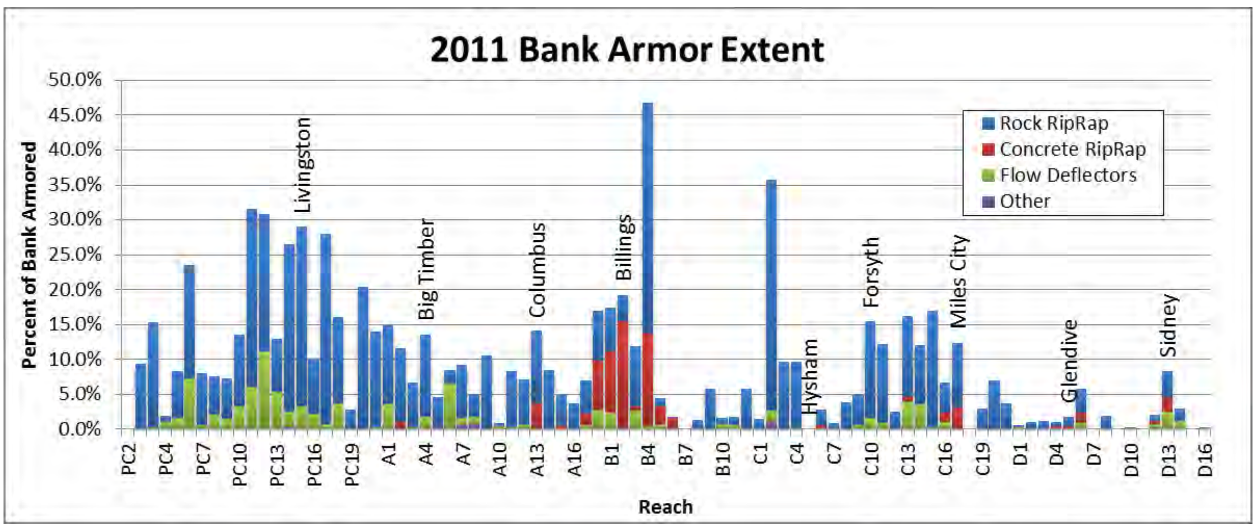


Figure 9-5 **Percent of total bankline armored by reach, 2011 conditions.**

When plotted cumulatively, the prominence of concrete armor near Billings is evident as an abrupt increase in the downstream accumulation of bank armor length (Figure 9-6). Rock riprap shows a fairly consistent rate of accumulation from Livingston to Miles City, after which the rate of bank protection decreases substantially. This trend is supported by a plot of bank protection extent (reach-scale percent armored bank) summarized by region (Figure 9-7). In terms of extent of bank protection in any given reach, Park County shows the highest density of armor. Much of this armoring density is located in the lower Paradise Valley (Reach PC11) downstream to below the Shields River confluence (Reach PC17).

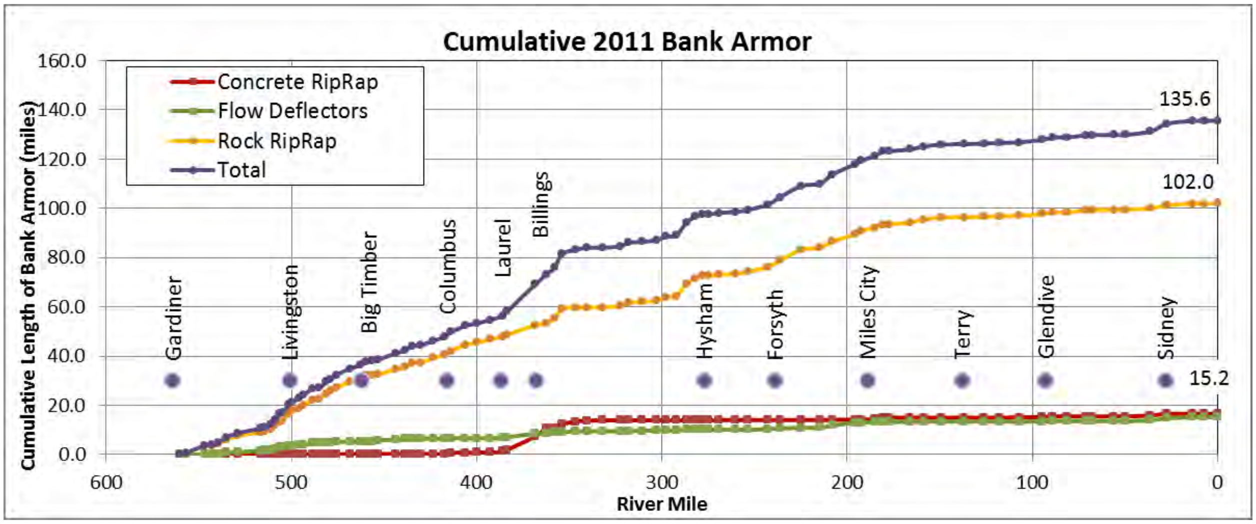


Figure 9-6 **Cumulative upstream to downstream plot showing bank armor trends for rock riprap, concrete riprap, and flow deflectors.**

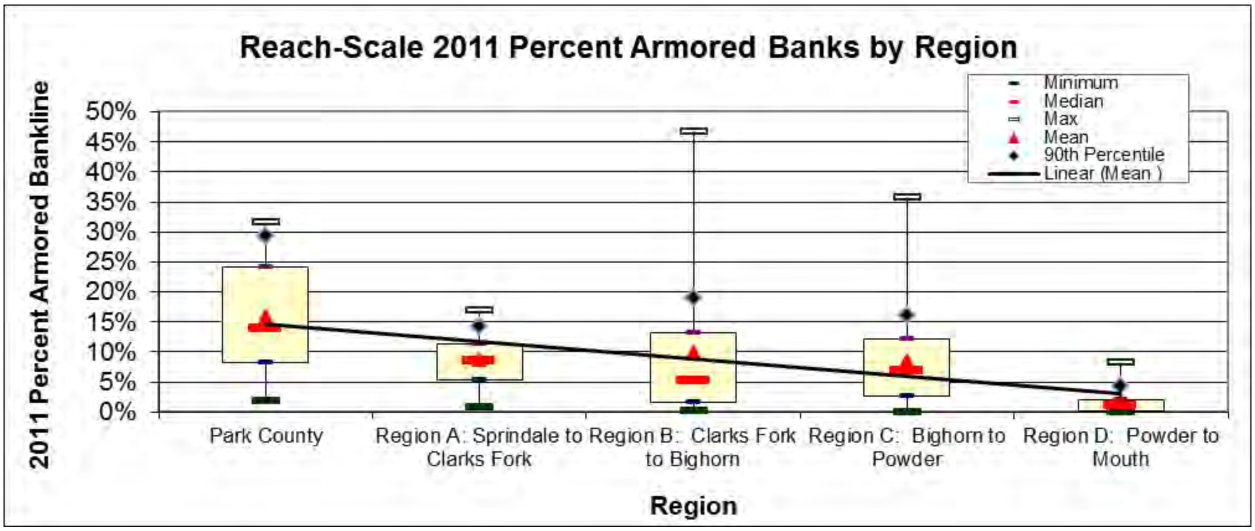


Figure 9-7 **Reach-scale percent armored bankline values statistically summarized by region.**

9.3 Change in Bank Armor Extent: 2001-2011

From 2001 to late fall 2011, about 13 miles of bank armor was constructed on the Yellowstone River. The majority of this new construction was rock riprap. In several reaches near Billings (Reaches A18-B6), concrete armor failed or was otherwise removed from the bank (Figure 9-8). There was a net loss of about one mile of concrete riprap between 2001 and 2011 (Figure 9-9). Between Forsyth and Miles City, over a mile of flow deflectors were lost. Figure 9-10 and Figure 9-11 show examples of flow deflectors that were flanked in spring 2011 and now sit in the main river channel.

The total gain in armor length from 2001-2011 represents about a 10-percent increase in overall armor length on the river.

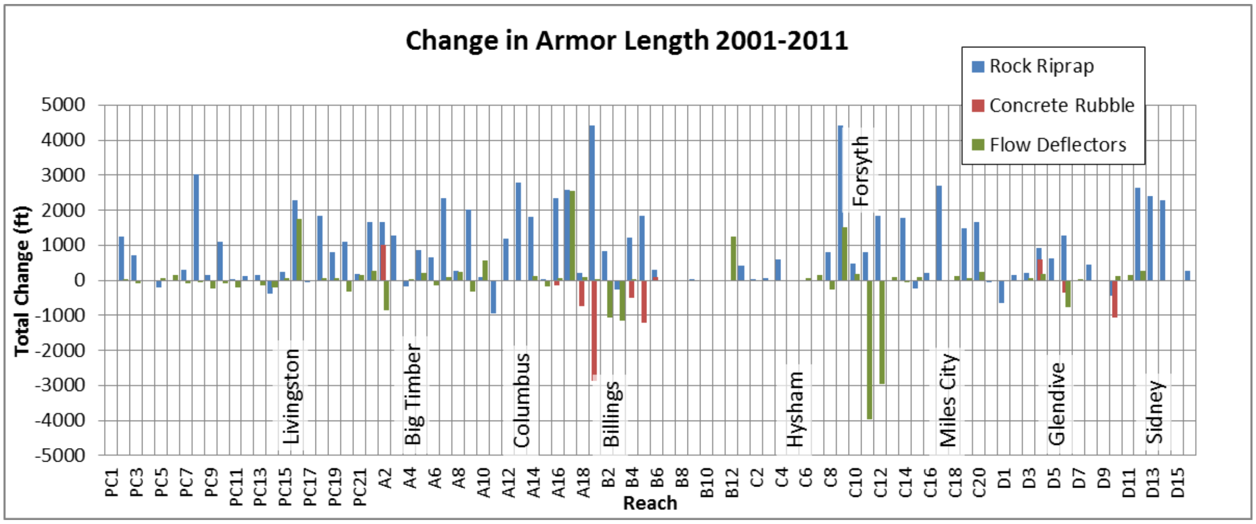


Figure 9-8 Net change in armor length, 2001-2011.

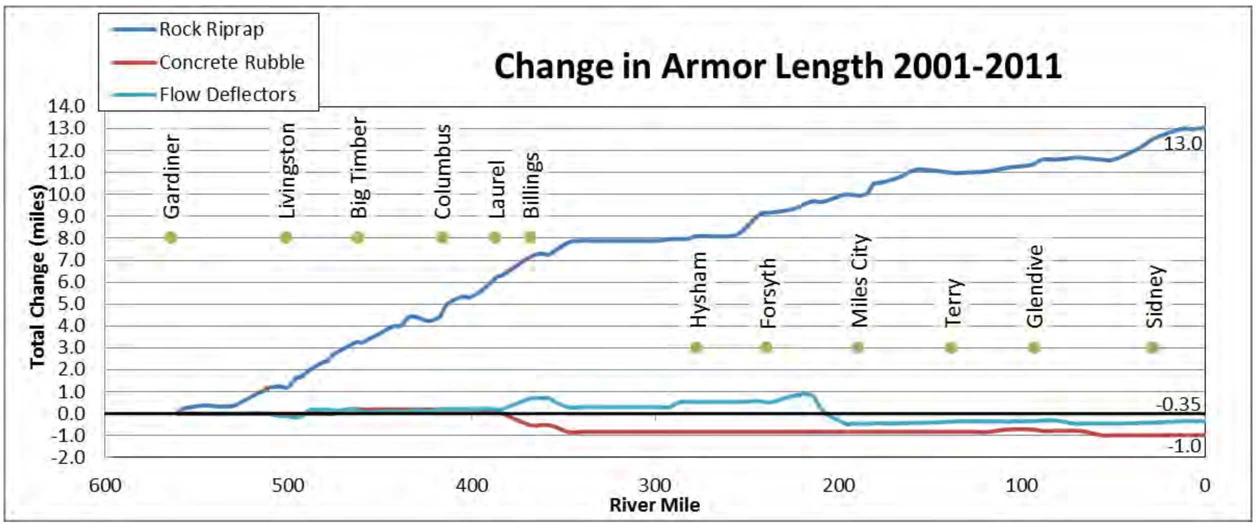


Figure 9-9 Cumulative change in armor length from 2001-2011, upstream to downstream direction.

Figure 9-10 Failed flow deflectors, Reach A4 near Big Timber.

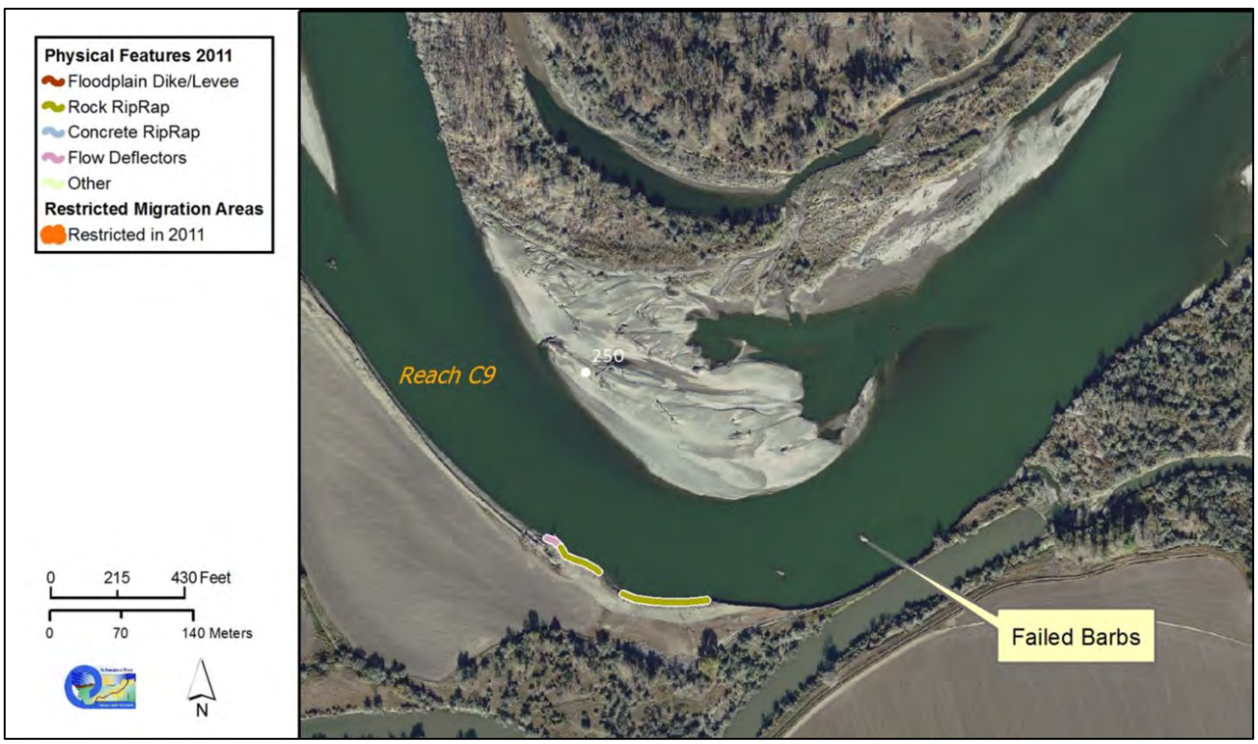


Figure 9-11 Failed barbs, Reach C9 upstream of Forsyth.

9.4 Land-use Association with Bank Armor

Bank armor features contained within the 2001 physical features inventory dataset were attributed by proximal land use to estimate the length of armor present for a given purpose. The results show that in

2001, the primary land uses that were protected by armor was agricultural land (irrigated land and agricultural infrastructure) and active rail line, which account for 37 and 36 percent of the total bank armor, respectively (Figure 9-12 and Figure 9-13).

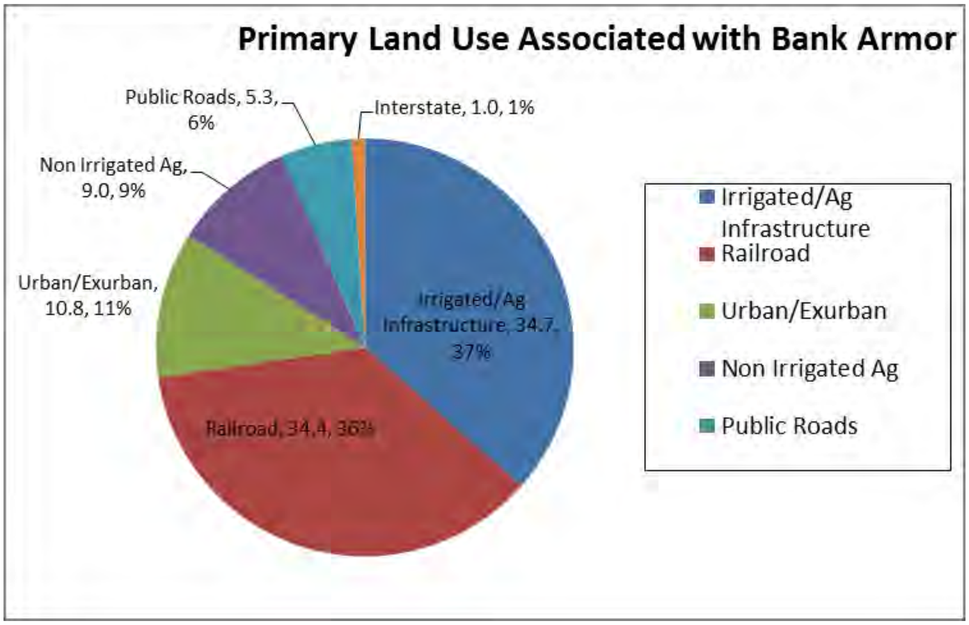


Figure 9-12 Pie chart showing types of land uses protected by bank armor; labeled by total

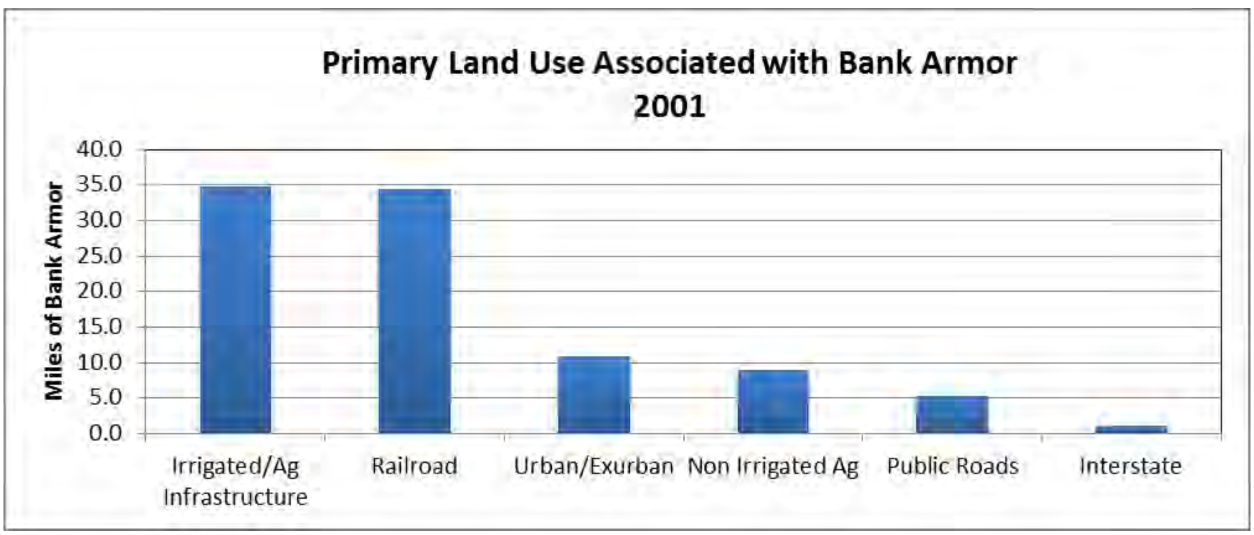


Figure 9-13 Primary land uses associated with bank armor, 2001 physical features inventory.

10.0 LAND USE WITHIN THE CHANNEL MIGRATION ZONE (CMZ)

The Channel Migration Zone mapping of the Yellowstone River (DTM and AGI, 2009), consisted of the delineation of a river corridor that would accommodate 100 years of unimpeded movement of the river across its floodplain based on historic rates of change. The CMZ consists of the following components:

- ***Historic Migration Zone (HMZ):*** The HMZ is the composite footprint of all active river channels and islands since 1950.

- ***Erosion Hazard Area (EHA):*** The EHZ, sometimes referred to as the “erosion buffer” consists of a reach-scale buffer that was assigned to the 2001 banklines. The width of the buffer was the average reach-scale 100-year migration distance determined by measurements of historic rates of change. The buffer intended to provide an envelope around the river that can accommodate 100 years of future channel movement.

- ***Avulsion Hazard Zone (AHZ):*** The AHZ encompasses areas within the active stream corridor and on the adjacent floodplain that host topographic features that might contribute to an avulsion, which is the creation of a new channel. These areas include meander cores, as well as floodplain areas that host swales or remnant channels that appear capable of reactivation. The AHZ reflects a different type of risk than the EHA, as avulsions are relatively rare, flood driven events that can be difficult to predict. In contrast, the EHA reflects the continual process of river migration across the floodplain.

An example of the CMZ mapping is shown below (Figure 10-1). In that figure, the blue reflects the HMZ, the orange is the EHA, and the pink is the AHZ.

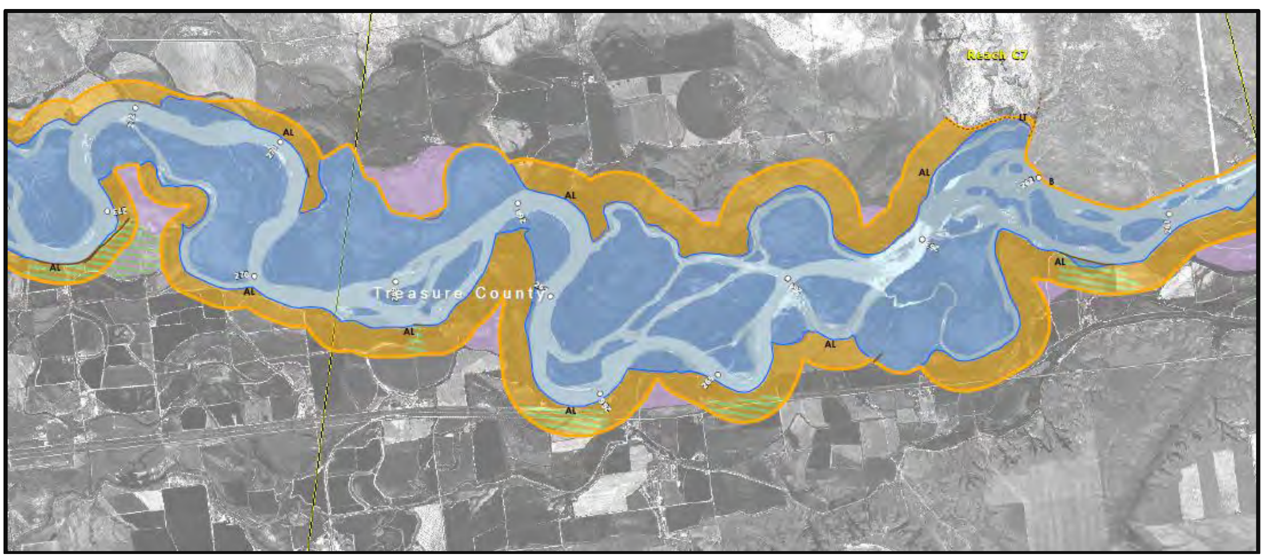


Figure 10-1 Composite Channel Migration Zone on 2005 NAIP imagery.

CMZ boundaries define the historic footprint of the river (HMZ) as well as adjacent areas at risk of erosion or avulsion (EHA and AHZ). Land uses within these areas are thus highly likely to be affected by stream process. Development within the CMZ has the potential to put infrastructure at risk which in turn drives a need for bank stabilization. Because some of the geomorphic changes evident on the river include reduced rates of floodplain turnover, reduced rates of large woody debris recruitment, and reduced side channel length, it is appropriate to consider the land uses within the active river corridor, to help determine whether that development is related to those changes. Restoring developed areas within the CMZ to a more natural condition would also support natural stream function.

10.1 Land Uses within the Historic Migration Zone (HMZ)

As the Historic Migration Zone (HMZ) encompasses the river corridor occupied by channels and islands since 1950, it defines the modern core of the river and floodplain. Development within this area typically consists of clearing and development of riparian areas on old islands, mostly for agricultural use. Summarizing the locations and extents of these areas supports the overall Cumulative Effects Analysis by determining the extent of development within the core of the stream corridor, and also identifies areas where riparian restoration would be highly appropriate.

10.1.1 Agricultural Land Uses within the HMZ

The majority of agricultural development in the HMZ has been conversion of riparian areas to flood irrigated fields, and most of that conversion has taken place below the mouth of the Bighorn River (Figure 10-2). This development within the HMZ has expanded since 1950 in all regions. River-wide, a total of 720 acres within the HMZ have been converted to flood irrigation, and 112 acres have been converted to pivots. The majority of pivot development in the HMZ occurred in Reach D10 about 15 miles below Intake, where an old island has been cleared and developed into a single pivot (Figure 10-3 and Figure 10-4).

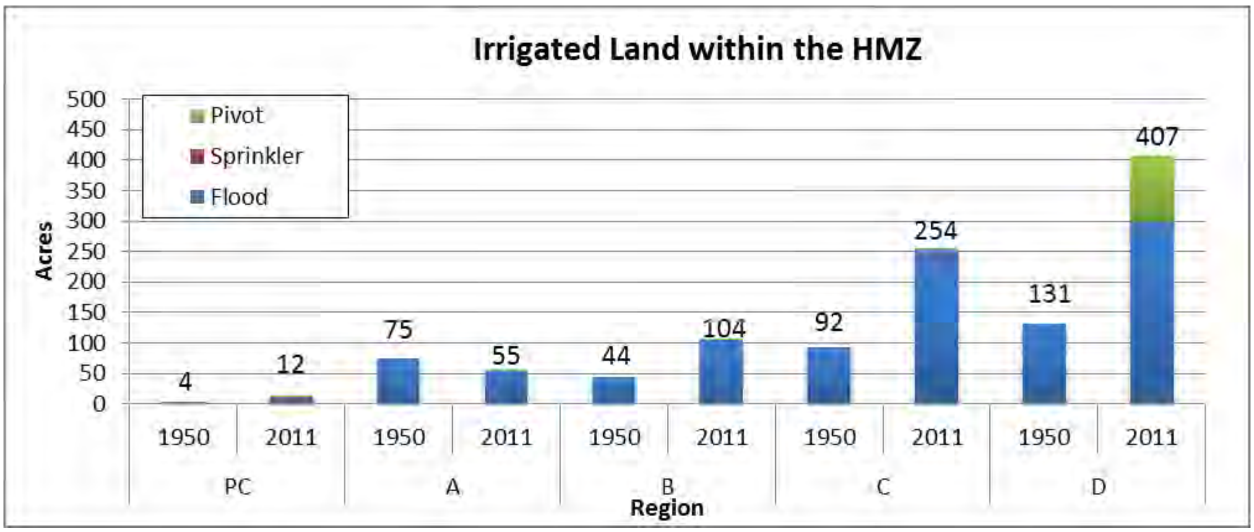


Figure 10-2 Total extent of irrigated land within the Historic Migration Zone (HMZ), 1950 and 2011

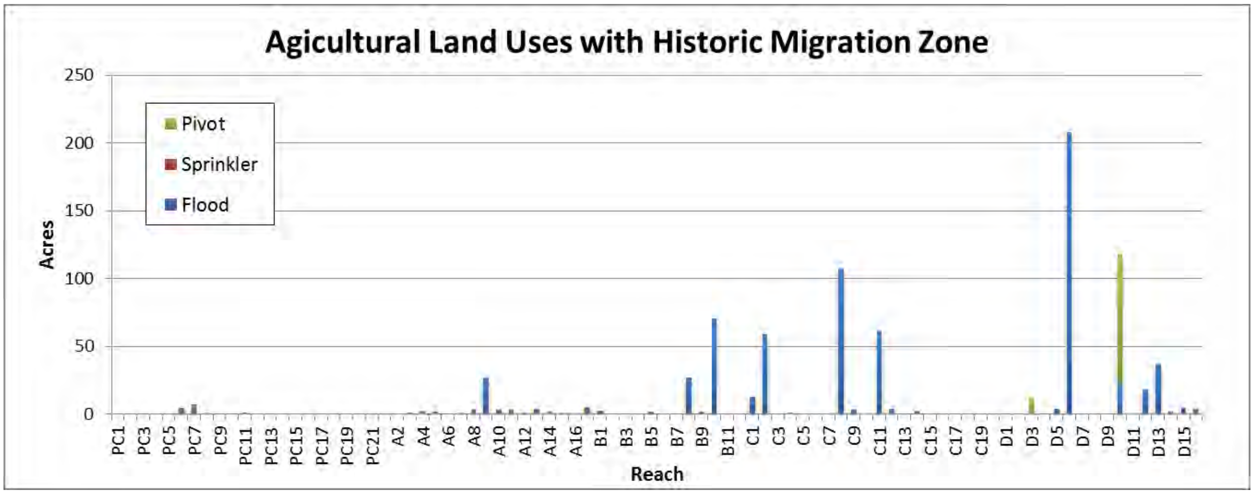


Figure 10-3 Total extent of agricultural land use within the Historic Migration Zone (HMZ) by reach.

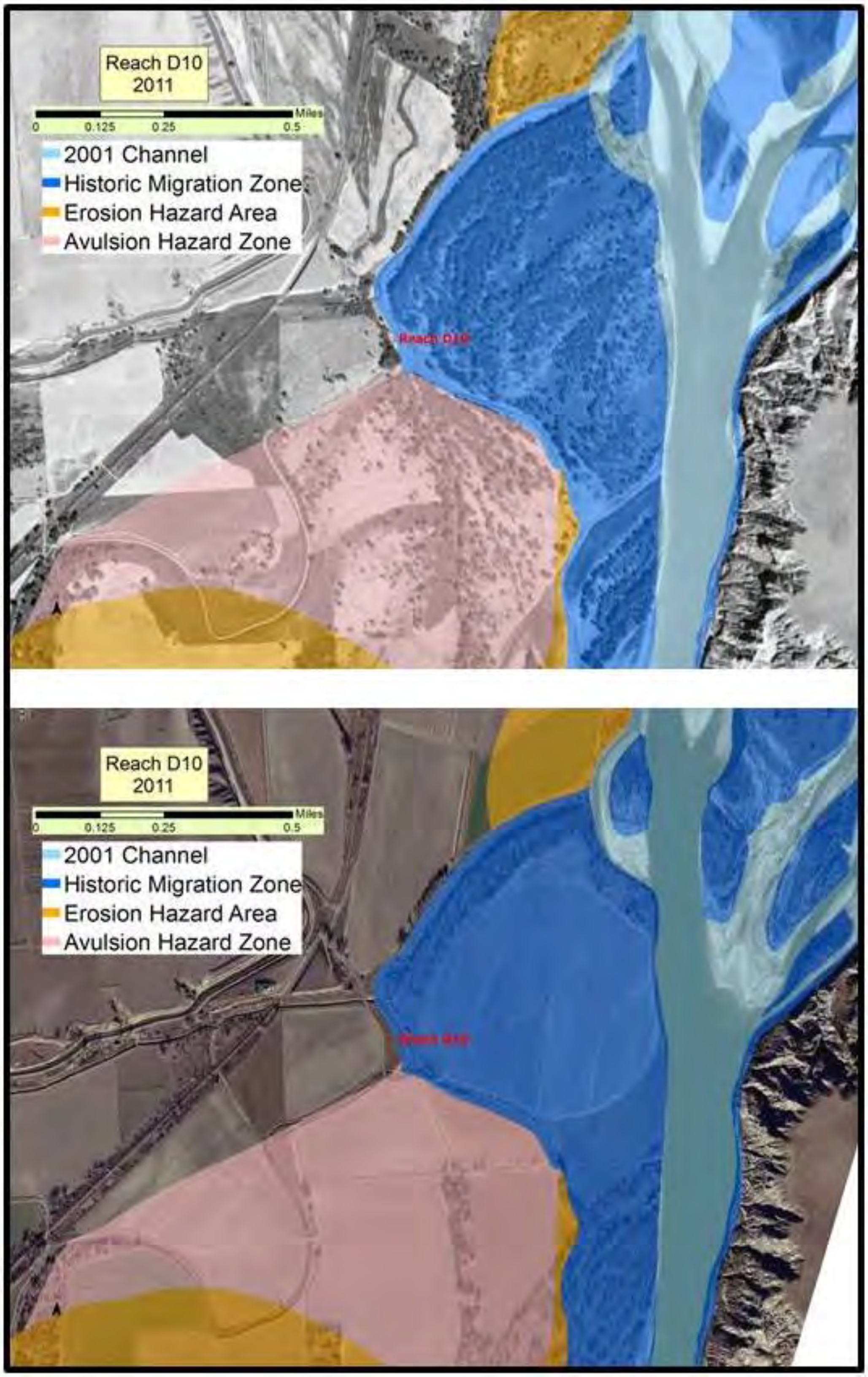


Figure 10-4 Portion of Reach D10 showing land use conversions within CMZ from 1950 (top) to 2011 (bottom).

10.1.2 Urban, Exurban, and Transportation

Development within the Historic Migration Zone has included land uses related to urban an exurban development, as well as transportation infrastructure. The majority of this development has taken place in Region B since 1950 (Figure 10-5). On a reach-scale, the development has been concentrated as exurban development upstream of South Billings Blvd (Reach B1), and urban development within the core of Billings (Reach B2). Within Reaches B1 and B2, over 80 acres of the HMZ has been developed into urban/exurban land uses since 1950 (Figure 10-6).

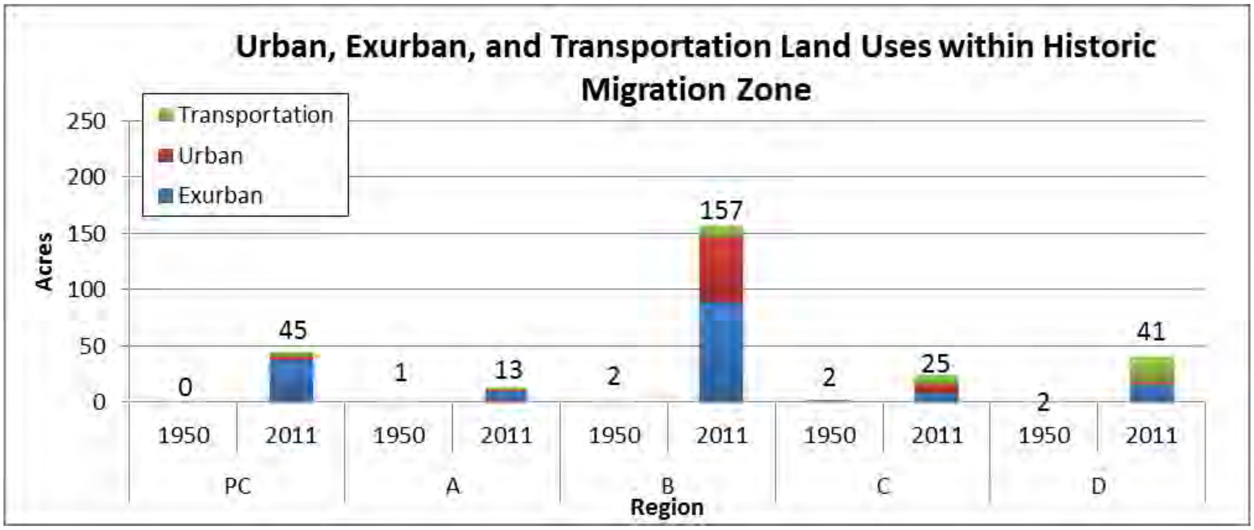


Figure 10-5 **Total extent of urban/exurban and transportation land within the HMZ, 1950 and 2011**

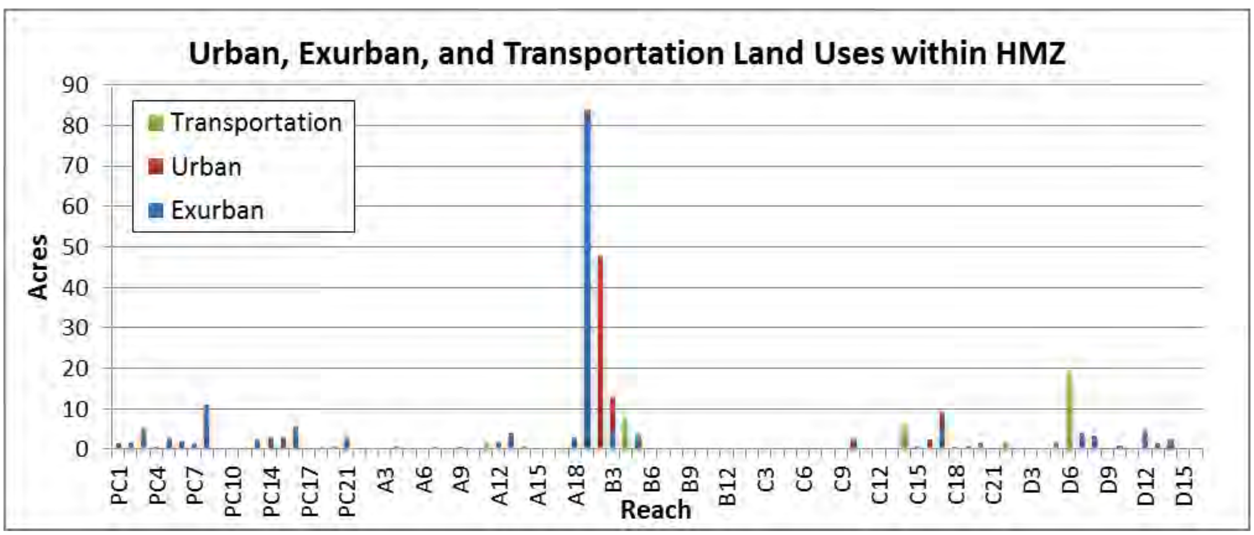


Figure 10-6 **Total extent of urban/exurban and transportation land use within HMZ by reach, 2011.**

10.2 Land Uses within the Erosion Hazard Area (EHA) and Avulsion Hazard Zone (AHZ)

Whereas the Historic Migration Zone defines the collective footprint of the active river corridor since 1950, the Erosion Hazard Area and Avulsion Hazard Zone identify areas prone to future erosion as the river continues to migrate across its floodplain and occasionally carve new channels through meander cutoff or floodplain avulsion. Development within the EHA/AHZ therefore reflects land-use conversions adjacent to the active river corridor where risk of erosion is high.

10.2.1 Agricultural Land Uses within the EHA and AHZ

As of 2011, approximately 19,500 acres of land mapped as within the Erosion Hazard Area or Avulsion Hazard Zone of the Yellowstone River were irrigated. Typically, on the order of one-third of the entire EHA/AHZ footprint has been developed for irrigation, and much of that irrigation was in place in 1950 (Figure 10-7 and Figure 10-8). The most intensive irrigation in these areas occurs in the lower portions of Regions C and D, where the Erosion Hazard Area is broad due to the size of the river, and the valley bottom is extensively irrigated (Figure 10-9).

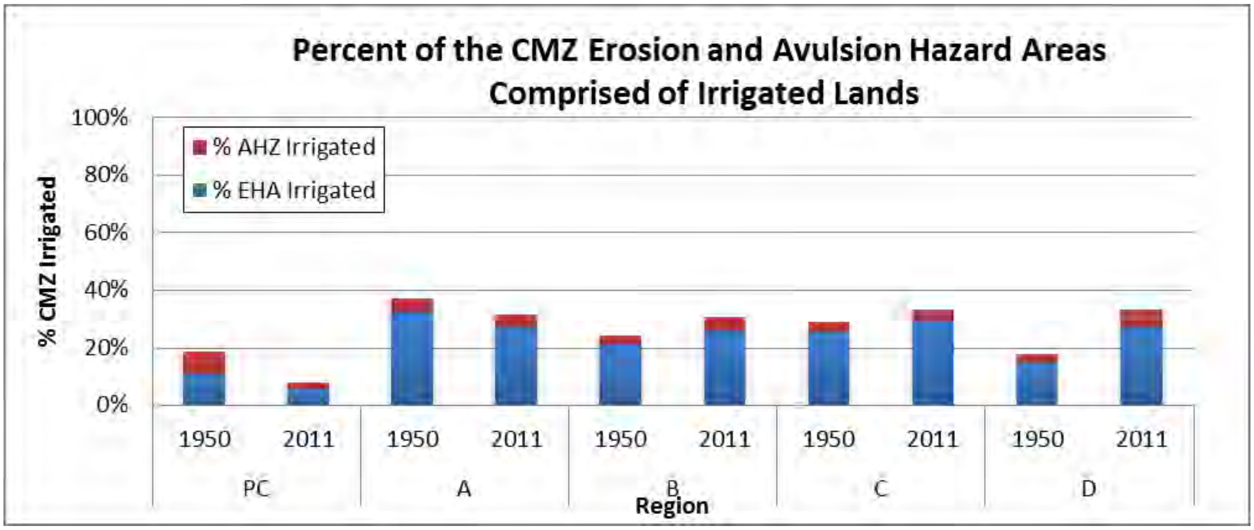


Figure 10-7 Percent of total area in EHA and AHZ under irrigation.

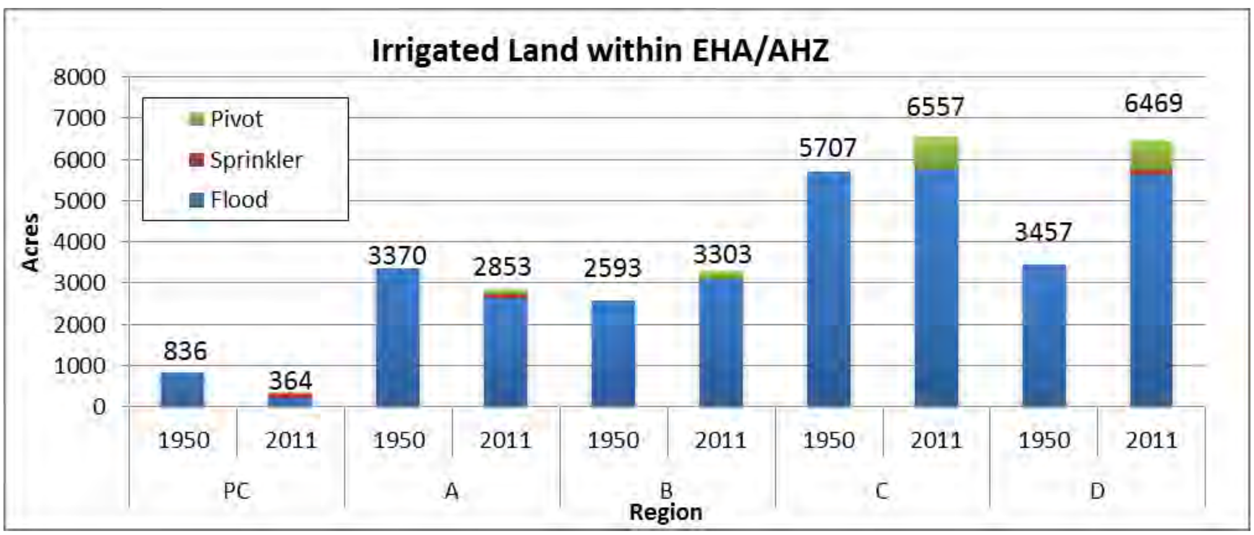


Figure 10-8 Total extent of irrigated land within the EHA and AHZ, 1950 and 2011.

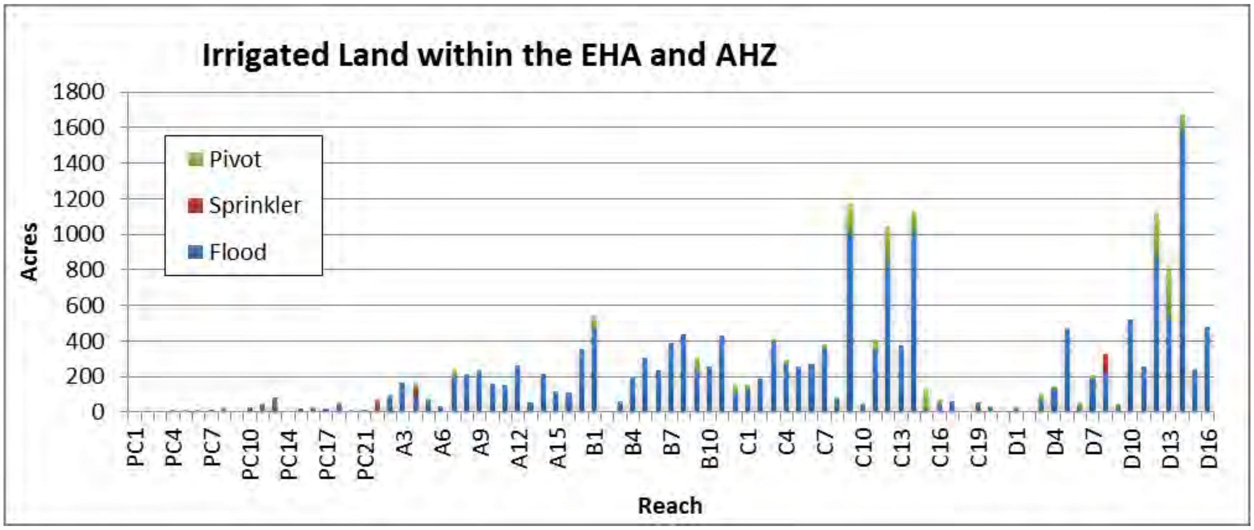


Figure 10-9 Total extent of irrigated land within EHA and AHZ by reach, 2011.

10.2.2 Urban, Exurban, and Transportation Land Uses within the EHA and AHZ

In 1950, about 1,500 acres of urban, exurban, and transportation–related land was located within the Erosion Hazard Area or Avulsion Hazard Zone of the Yellowstone River (Figure 10-10). By 2011, that number essentially doubled to 3,311 acres. Regions that show an increase in development in the EHA/AHZ by around a factor of three include Park County, Region B, and Region D. Park County has seen several hundreds of additional acres of development in erosion prone areas, especially in Reaches PC14 and PC15 at Livingston (Figure 10-11). In Region A, the development has been mostly transportation-infrastructure related. Region B, which extends from Columbus to Bighorn, has seen 600 acres of urban/exurban development within the EHA and AHZ since 1950, and most of this development has occurred around Billings. Development within Region C has been concentrated at Reach C17 at Miles City.

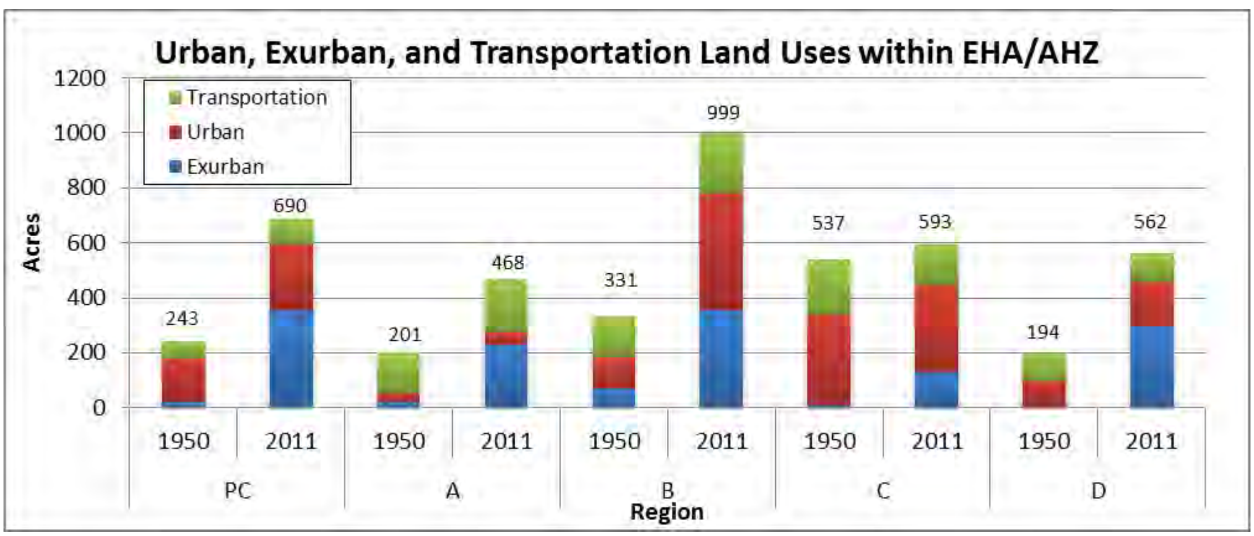


Figure 10-10 Total extent of urban, exurban, and transportation land within the EHA and AHZ, 1950 and 2011.

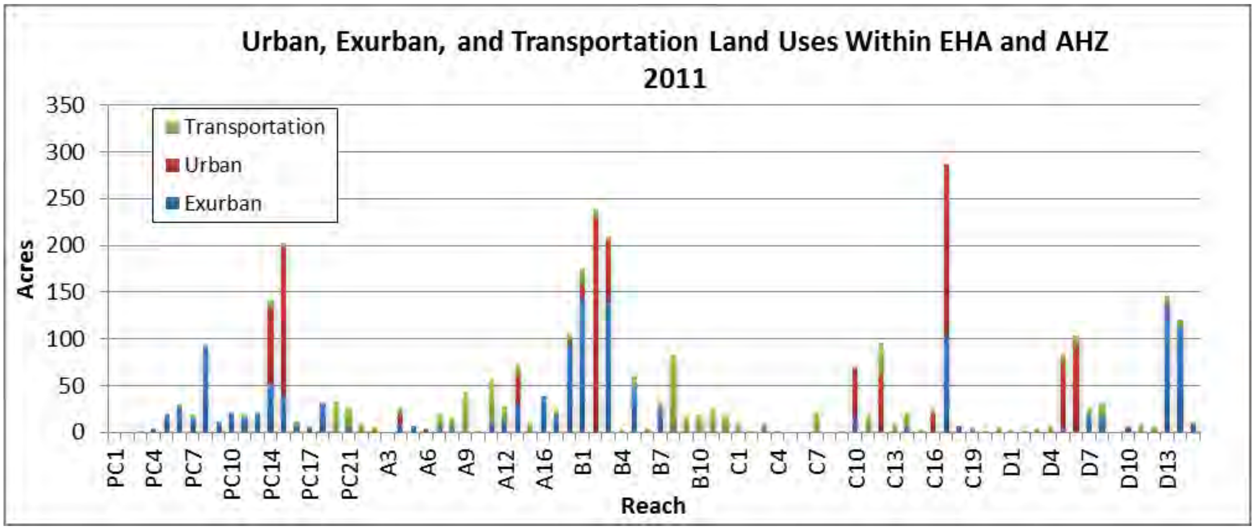


Figure 10-11 Total extent of urban/exurban and transportation land use within EHA and AHZ by reach, 2011.

The nature and extent of development within the Yellowstone River corridor indicates that infrastructure investment in areas along the river that are prone to erosion has been ongoing since pre-1950. With regard to Cumulative Impacts, development within the CMZ commonly consists of a direct impact of riparian clearing and wetland modifications, and also indirectly drives bank armoring when developed areas are at risk.

Table 10-1
Yellowstone River Reach classification.

Reach Identification	Length (km)	County	Classification	Comments
PC1	7.6	Park	CS: Confined straight	Gardiner to Little Trail Cr.
PC2	5.0	Park	CM: Confined meandering	Devil's Slide area
PC3	16.6	Park	CS: Confined straight	Corwin Springs to Carbella; Yankee Jim Canyon
PC4	5.8	Park	CM: Confined meandering	Carbella to Hwy 89 Br.
PC5	6.2	Park	PCA: Partially confined anabranching	Hwy 89 Br. to Big Creek
PC6	6.9	Park	CM: Confined meandering	Big Creek to Six Mile Cr
PC7	9.9	Park	PCA: Partially confined anabranching	Six Mile Cr to Grey Owl
PC8	20.3	Park	CM: Confined meandering	Grey Owl to just below Mallard's Rest; very sinuous, confined
PC9	3.1	Park	PCA: Partially confined anabranching	To Pine Creek
PC10	5.6	Park	PCM: Partially confined meandering	To downstream of Deep Creek; Weeping wall, Jumping Rainbow; onset of spring creeks
PC11	3.8	Park	PCA: Partially confined anabranching	To near Suce Cr, Wineglass Mtn to west
PC12	3.2	Park	PCM: Partially confined meandering	To Carters Bridge
PC13	2.5	Park	PCB: Partially confined braided	Through canyon upstream of Livingston
PC14	5.6	Park	PCA: Partially confined anabranching	Through Interstate bridge crossing to Livingston; multiple threads
PC15	2.9	Park	PCS: Partially confined straight	To Mayors Landing; moderate south valley wall control

Reach Identification	Length (km)	County	Classification	Comments
PC16	6.9	Park	PCA: Partially confined anabranching	To just upstream of Hwy 89 bridge
PC17	3.2	Park	PCB: Partially confined braided	Through Hwy 89 bridge crossing to Shields River
PC18	8.5	Park	UA: Unconfined anabranching	To below Mission Creek; multiple channels
PC19	4.4	Park	CS: Confined straight	To near Locke Cr; railroad closely borders to south
PC20	7.2	Park	PCS: Partially confined straight	Moderately confined canyon section; railroad closely borders to south
PC21	3.7	Park	PCA: Partially confined anabranching	To Springdale; multiple threads
A1	5.4	Sweetgrass	PCB: Partially confined braided	Springdale: Low primary sinuosity; large open bar area; extensive armoring
A2	11.1	Sweetgrass	UB: Unconfined braided	Grey Bear fishing access
A3	8.6	Sweetgrass	PCB: Partially confined braided	Upstream of Big Timber; Hell Creek Formation valley wall
A4	5.6	Sweetgrass	UB: Unconfined braided	To Boulder River confluence; encroachment at Big Timber; extensive armor
A5	5.2	Sweetgrass	UB: Unconfined braided	Low Qat1 terrace on right bank
A6	4.8	Sweetgrass	PCS: Partially confined straight	Channel closely follows left valley wall
A7	15.9	Sweetgrass	PCB: Partially confined braided	Greycliff: Narrow valley bottom with alluvial fan margins
A8	8.2	Sweetgrass	PCB: Partially confined braided	Floodplain isolation behind interstate and R/R
A9	6.2	Sweetgrass Stillwater	UA: Unconfined anabranching	To Reed Pt; extensive secondary channels in corridor
A10	6.9	Stillwater	PCS: Partially confined straight	Channel closely follows left valley wall
A11	11.2	Stillwater	PCB: Partially confined braided	High right bank terrace with bedrock toe; I-90 bridge crossing
A12	9.8	Stillwater	PCB: Partially confined braided	To Stillwater confluence

Reach Identification	Length (km)	County	Classification	Comments
A13	5.8	Stillwater	PCA: Partially confined anabranching	Columbus; extensive armoring, broad islands
A14	12.5	Stillwater	PCA: Partially confined anabranching	Valley bottom crossover
A15	9.5	Stillwater, Carbon	PCB: Partially confined braided	Follows Stillwater/Carbon County line
A16	12.4	Stillwater, Carbon	PCA: Partially confined anabranching	Park City: Major shift in land use, and increase in valley bottom width
A17	10.4	Yellowstone Carbon	UA: Unconfined anabranching	To Laurel; WAI Reach A
A18	3.8	Yellowstone	UA: Unconfined anabranching	To Clark Fork; land-use change to row crops; WAI Reach A
B1	24.6	Yellowstone	UB: Unconfined braided	Extensive armoring u/s Billings; WAI Reaches B,C,D
B2	9.8	Yellowstone	PCB: Partially confined braided	Billings; WAI Reach E
B3	7.0	Yellowstone	UB: Unconfined braided	Wide corridor d/s Billings; WAI Reach F
B4	6.1	Yellowstone	PCS: Partially confined straight	Channel closely follows right valley wall; extensive bank armor
B5	12.0	Yellowstone	UA: Unconfined anabranching	Huntley: includes Spraklin Island
B6	9.9	Yellowstone	PCB: Partially confined braided	Channel closely follows left valley wall
B7	13.9	Yellowstone	UB: Unconfined braided	Unconfined reach
B8	14.7	Yellowstone	PCA: Partially confined anabranching	Pompey's Pillar
B9	7.5	Yellowstone	UA: Unconfined anabranching	Meander cutoff isolated by railroad
B10	11.6	Yellowstone	PCM: Partially confined meandering	Encroached
B11	13.1	Yellowstone	PCA: Partially confined anabranching	To Custer Bridge
B12	7.3	Yellowstone	UA: Unconfined anabranching	To Bighorn River confluence

Reach Identification	Length (km)	County	Classification	Comments
C1	9.5	Treasure	UA: Unconfined anabranching	From Bighorn confluence: Includes 1 mile of left bank valley wall control; Extensive bank protection.
C2	8.9	Treasure	PCB: Partially confined braided	To Myers Br (RM 285.5); Railroad adjacent to channel on valley wall; low sinuosity
C3	7.6	Treasure	UA: Unconfined anabranching	To Yellowstone Diversion: very sinuous; large meanders, extensive bars; historic avulsion
C4	6.1	Treasure	PCB: Partially confined braided	Below Yellowstone Diversion
C5	5.1	Treasure	PCS: Partially confined straight	Hysham
C6	9.1	Treasure	UA: Unconfined anabranching	Mission Valley
C7	14.7	Treasure	UA: Unconfined anabranching	Mission Valley
C8	10.4	Treasure Rosebud	PCS: Partially confined straight	Rosebud/Treasure County Line
C9	17.2	Rosebud	UA: Unconfined anabranching	Hammond Valley
C10	11.0	Rosebud	PCM: Partially confined meandering	Forsyth
C11	18.3	Rosebud	PCM/I: Partially confined meandering/islands	To Cartersville Bridge
C12	16.2	Rosebud	PCM/I: Partially confined meandering/islands	Rosebud; numerous meander cutoffs
C13	10.8	Rosebud	PCM/I: Partially confined meandering/islands	Valley bottom crossover
C14	19.6	Rosebud Custer	PCM/I: Partially confined meandering/islands	Series of meander bends
C15	6.0	Custer	PCS: Partially confined straight	Very low riparian vegetation
C16	11.6	Custer	PCM/I: Partially confined meandering/islands	to Miles City
C17	7.2	Custer	PCS: Partially confined straight	Miles City; Tongue River

Reach Identification	Length (km)	County	Classification	Comments
C18	5.2	Custer	PCS: Partially confined straight	Channel follows left valley wall
C19	17.9	Custer	CS: Confined straight	Confined
C20	12.2	Custer Prairie	CS: Confined straight	Confined
C21	15.2	Custer Prairie	CM: Confined meandering	To Powder River; confined
D1	19.5	Prairie	CM: Confined meandering	To Terry Bridge; confined
D2	17.0	Prairie	CM: Confined meandering	To Fallon, I-90 Bridge; confined
D3	13.4	Prairie Dawson	PCS: Partially confined straight	Hugs right bank wall; into Dawson County
D4	17.7	Dawson	PCM/I: Partially confined meandering/islands	
D5	20.3	Dawson	PCA: Partially confined anabranching	Long secondary channels; to Glendive
D6	8.9	Dawson	PCM/I: Partially confined meandering/islands	Glendive
D7	12.3	Dawson	PCA: Partially confined anabranching	
D8	16.4	Dawson	PCA: Partially confined anabranching	To Intake
D9	5.6	Dawson	PCM/I: Partially confined meandering/islands	Downstream of Intake
D10	18.3	Dawson Wibaux Richland	PCA: Partially confined anabranching	Vegetated islands
D11	10.3	Richland	PCA: Partially confined anabranching	Elk Island: Very wide riparian; marked change in channel course since 1981 geologic map base
D12	21.9	Richland	PCA: Partially confined anabranching	Secondary channel on valley wall; Sinuous; long abandoned secondary channel
D13	13.8	Richland	PCM/I: Partially confined meandering/islands	

Reach Identification	Length (km)	County	Classification	Comments
D14	23.1	Richland, McKenzie	PCM/I: Partially confined meandering/islands	Into McKenzie County, North Dakota: High sinuosity
D15	9.6	McKenzie	PCM/I: Partially confined meandering/islands	
D16	11.9	McKenzie	US/I: Unconfined straight/islands	To mouth: low sinuosity; alternate bars; vegetated islands

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 5

Water Quality

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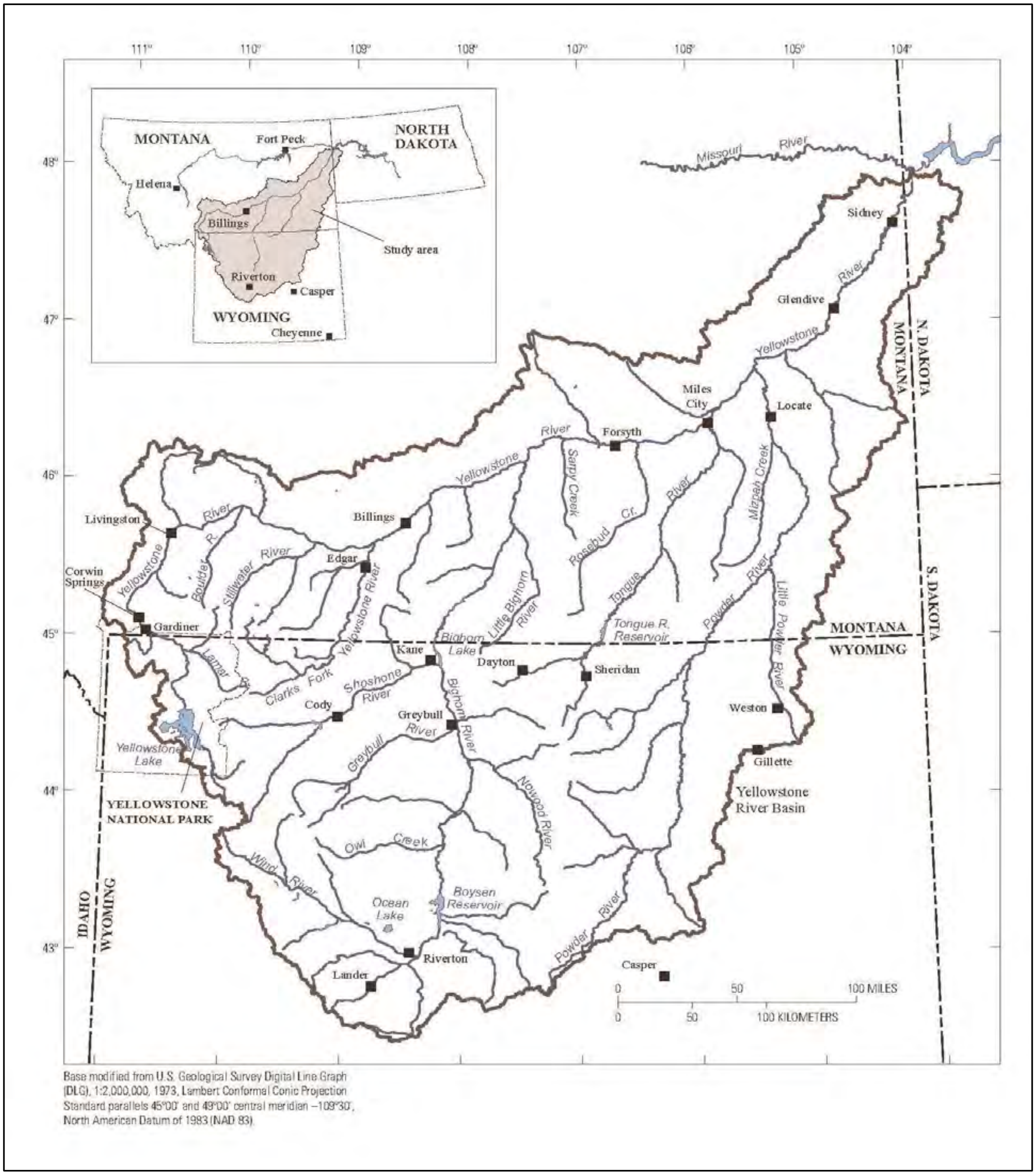
1.0 INTRODUCTION

Water-quality is commonly defined as the chemical, physical, biological, and radiological property of water relative to an intended use such as for drinking water, industry, agriculture, aquatic life support, or recreation. Water-quality is an important aspect of any river system, especially so for the Yellowstone River which originates near Yellowstone National Park and represents one of the few remaining relatively unmodified river ecosystems in the lower 48 states. Human (anthropogenic) and natural factors influence water-quality throughout the diverse environmental setting of the Yellowstone River basin. As the outlet for the 70,100 square mile (nearly 45 million acres) Yellowstone River drainage basin, the river integrates water quality characteristics of all land uses and human activities in its many tributaries (Zelt et al. 2005) (Figure 1-1). The purpose of this document is to present and discuss the water-quality monitoring data, technical studies, and related research materials that have been used to assess the historic and present quality of water in the Yellowstone River within the study area. For the purpose of the CEA report, water quality is evaluated and discussed primarily for the mainstem Yellowstone River in Montana and North Dakota but does address water quality-related issues for major tributaries and the larger Yellowstone drainage basin, as appropriate.



Source: USGS

Figure 1-1 Location Map of the Yellowstone River basin in Montana, Wyoming, and North Dakota.

1.1 Primary Data Sources

This Appendix summarizes the Cumulative Effects Analysis for Yellowstone River Water-quality. The analysis is based on the following series of primary data sources, although many other sources have been consulted (see References):

1. **Water-quality Portal: Online water-quality database.** (National Water-quality Monitoring Council, 2014). The Water-quality Portal (WQP) is a cooperative service sponsored by the United States Geological Survey (USGS), the Environmental Protection Agency (EPA) and the National Water-quality Monitoring Council (NWQMC) that integrates publicly available water-quality data from the USGS National Water Information System (NWIS) the EPA STOrage and RETrieval (STORET) Data Warehouse, and the USDA ARS Sustaining The Earth's Watersheds - Agricultural Research Database System (STEWARDS).

2. **Yellowstone River Mainstem: Summary of Existing Data for Use in TMDL Planning**. (PBS&J, 2005). This report contains a summary of the available physical, chemical and biological water-quality data available for the nine TMDL planning segments of the Yellowstone River in Montana.

3. **Environmental setting of the Yellowstone River Basin, Montana, North Dakota, and Wyoming. (**Zelt, R.B., G. Boughton, K.A. Miller, J.P. Mason, and L.M. Gianakos, 1999). U.S. Geological Survey Water-Resources Investigations Report 98-4269. Available on the internet at: http://water.usgs.gov/pubs/wri/wri984269/wri984269.pdf. This report provides a general description of environmental conditions and human activity in the Yellowstone River Basin (YRB) in Montana and Wyoming. It includes discussions of physiography, climate, geology, vegetation, surface water, stream ecology, ground water, and anthropogenic factors.

4. **Water-Quality Assessment of the Yellowstone River Basin, Montana and Wyoming—Water Quality of Fixed Sites, 1999-2001.** (Miller, K.A., M.L. Clark, and P.R. Wright, 2005).

    a. The NAWQA assessment of water resources in the Yellowstone Basin began in 1997. Water-quality samples were collected regularly at 10 fixed sites between 1999 and 2001 in the Yellowstone Basin, with 4 sites on the mainstem of the Yellowstone River. These 4 sites are all considered integrator sites, which are heterogeneous in land use and geology. Sampling frequency was at least monthly and included field measurements and laboratory analysis of fecal-indicator bacteria, major ions, dissolved solids, nutrients, trace elements, pesticides, and suspended sediment. Field measurements, major ions, nutrients, iron, manganese, and suspended sediment were sampled at all four mainstem sites all three years. Bacteria were sampled at all 4 sites in 2000 and 2001. Trace elements were sampled at Corwin Springs and Billings in 1999, while trace elements were sampled at Forsyth and Sidney in 1999, 2000, and 2001. Pesticides were sampled at Billings in 1999 and at Forsyth and Sidney in 1999, 2000, and 2001.

5. **Water Quality in the Yellowstone River Basin, Wyoming, Montana, and North Dakota, 1999-2001**. (Peterson, D.A., K.A. Miller, T.T. Bartos, M.L. Clark, S.D. Porter, and T.L. Quinn, 2004).

    a. This report summarizes the first three periods of high-intensity monitoring conducted in the Yellowstone River by the U.S Geological Survey as part of the National Water-Quality Assessment Program (NAWQA). Ten basic and intensive stream-sampling sites were established in the Yellowstone River Basin (YRB). General water chemistry data was collected monthly and during high flow at ten "basic fixed" sites between January 1999 and October 2001. Three out of the ten sites were considered “intensive fixed” sites selected in areas with a high amount of agricultural use. These sites were sampled biweekly-to-monthly between January 1999 and December1999 and were analyzed for pesticides. Stream ecology samples were performed during August-September 1999. Bed-sediment and fish-tissue samples were collected at 24 sites during July to September 1998. The algal-nutrient study was conducted at 11 sites on the mainstem of the Yellowstone River and 5 tributary sites in August of 2000. Sites relative to TMDL planning for the Yellowstone River mainstem include:

- Yellowstone River at Corwin Springs
- Yellowstone River at Billings
- Yellowstone River at Forsyth
- Yellowstone River near Sidney
- Clarks Fork Yellowstone River Yellowstone River at Edgar
- Powder River near Locate (no fish tissue samples)

6. **Chemical and biological indicators of nutrient enrichment in the Yellowstone River Basin, Montana and Wyoming during August of 2000**. (Peterson, D.A., S.D. Porter and S.M. Kinsey 2001). Data was collected during low-flow conditions in August of 2000 at 11 sites on the mainstem of the Yellowstone River between Corwin Springs and Sidney and on Clark Forks Yellowstone River, Bighorn River and Tongue River as part of the National Water-Quality Assessment Program (NAWQA). Parameters measured include turbidity, light extinction, diel measurements, suspended sediment, nutrients, periphyton taxonomy, periphyton chlorophyll *a* and AFDM, and invertebrate taxonomy. Not all parameters were measured at all sites.

7. **Biological and chemical indicators of eutrophication in the Yellowstone River and major tributaries during August 2000.** (Peterson, D.A., and S.D. Porter 2002). Reprinted with permission from: Proceedings, 2002 National Monitoring Conference, National Water-quality Monitoring Council (http://www.nwqmc.org/). Available on the internet at: http://wy.water.usgs.gov/YELL/nwqmc/nwqmc.pdf

   a. This study was performed in August 2000 as part of the National Water-Quality Assessment Program (NAWQA). This study indicated that the trophic condition of the Yellowstone River and its major tributaries during low-flow conditions was better represented by algal biomass and community autecology than by nutrient concentrations in water samples. This report characterized nutrient concentrations as generally low throughout the length of the Yellowstone River. This study concluded that accelerated eutrophication processes may be occurring in the upper segments of the Yellowstone River. While nuisance filamentous algal growths are currently restricted to the middle portions of the Yellowstone River and the mouths of major tributaries, increases in the percentage of eutrophic algae at other sites may represent the first stages of water-quality degradation. Currently, the availability of dissolved nitrogen appears to be a controlling factor in the upper and middle reaches of the Yellowstone River. Low dissolved nutrient concentrations in the upper and middle segments of the river may reflect high rates of nutrient uptake by benthic algae. Residential development along some river segments and irrigated agriculture practices along other segments were cited as potential sources of nutrients that could sustain large amounts of algae biomass (Zelt et al., 1999).

8. **Organic Compounds and Trace Elements in Fish Tissue and Bed Sediment from Streams in the Yellowstone River Basin, Montana and Wyoming, 1998.** (Peterson, D.A., and G.K. Boughton 2000). Bed-sediment samples were collected at 24 sites and fish tissue samples were collected at 21 sites in 1998 as part of the National Water-Quality Assessment Program (NAWQA). Sampling took place between late-July and late-September in 1998. Six sites in this study are pertinent to the data collection efforts for the mainstem of the Yellowstone River:

    - Yellowstone River at Corwin Springs
    - Yellowstone River at Billings
    - Yellowstone River at Forsyth
    - Yellowstone River near Sidney
    - Clarks Fork Yellowstone River Yellowstone River at Edgar
    - Powder River near Locate (no fish tissue samples)

    The report presents results and implications of trace elements, organochlorine insecticides, metabolites, and other organic compounds detected in fish tissues and bed-sediments at the six mainstem study sites as well as at other sampling sites in the Yellowstone River basin.

9. **Element Concentrations in Bed Sediment of the Yellowstone River Basin, Montana, North Dakota, and Wyoming--A Retrospective Analysis.** (Peterson, D.A., and R.B. Zelt 1999). This retrospective analysis, which was conducted as part of the National Water-Quality Assessment Program (NAWQA), examined approximately 13,000 bed-sediment samples collected between 1974 and 1979 as part of the Hyrogeochemical and Stream Sediment Reconnaissance (HSSR), which was part of the National Uranium Resource Evaluation program (NURE). The report concluded that a small percentage of the samples had chromium, copper, lead, nickel, or zinc concentrations that exceeded sediment-quality assessment values for the protection of aquatic life. The highest concentrations of chromium, copper, nickel, and zinc tended to be located in the western part of the study unit, in areas of crystalline rocks of Precambrian age and volcanic rocks of Tertiary and Cretaceous age.

10. **Model-Based Nitrogen and Phosphorus (Nutrient) Criteria for Large Temperate Rivers: 2. Criteria Derivation 2014.** (Suplee, M.W., K.F. Flynn, and S.C. Chapra. 2014). Numeric nutrient standards for total nitrogen and total phosphorus were developed for two segments of the Lower Yellowstone River using a process-based model (QUAL2K). Limits of 150 mg Chla per square meter, 5 milligrams per liter Dissolved Oxygen concentration and hydrogen ion concentration (pH) values between 6.5 and 9.0 as representative ecological variables stipulated in existing water-quality standards were used to protect recreation uses and aquatic life related to modeled nutrient values. This paper describes the process and rationale for model development along with considerations for use. Criteria thresholds of 55 micrograms total phosphorus per liter and 655 micrograms total nitrogen per liter was recommended between the Bighorn River and the Powder

River. Recommended criterion for downstream of the Powder River are 95 micrograms total phosphorus per liter and 815 milligrams total nitrogen per liter.

11. **Yellowstone River Historical Retrospective Completion Report.** (Confluence Consulting, Inc., 2003). This report summarizes a review of historical information for the Yellowstone River mainstem regarding fish, water quality, fluvial geomorphology, vegetation, and wildlife activity prior to 1900. Academic studies, historical records, archival documents, photographs, and maps, interviews, and other sources were used to create the summary and accompanying database of annotated comments. The information is useful in gaining a large scale view of conditions pre- and post-settlement. Increased turbidity and sediment loads below the mouths of the Clarks Fork Yellowstone River, Bighorn, Powder and Tongue were noted. An increased amount of sand and gravel bars were noted downstream of the Tongue River, while the bars were comprised primarily of sand and mud downstream of the Powder River.

12. **Assessing Site Specific Management Strategies to Reduce Nutrient Export from the Yellowstone River Basin Using Spatially Explicit SPARROW Models. Yellowstone Basin** (Frankfurter, JD. P.R. Wright, D.M. Robertson, and D.A. Saad 2015. SPAtially Referenced Regression on Watershed attributes (SPARROW) models were developed for the Missouri River basin by the USGS (Brown et al., 2011, Robertson et al. 2014) as part of a national assessment of nutrient sources and transport mechanisms in six major regions of the US. For additional information see http://water.usgs.gov/nawqa/sparrow/. The modeling was conducted as part of the USGS's NAWQA program. SPARROW, a nonlinear regression model, was used to relate annual nutrient loads based on monitoring data to spatially-referenced watershed characteristics pertinent to nutrient sources and transport factors present in the early 2000s. To assist in the evaluation of water-quality considerations in the Yellowstone River CEA, the SPARROW model results were clipped to the Yellowstone River's 45-million-acre (182 thousand km^2) watershed in Wyoming, North Dakota and Montana. Results were organized by eight-digit Hydrologic Unit Code (HUC8) for the base year (Robertson and Saad, 2013). Nutrient outputs were expressed as yields rather than loads to better assist users in understanding nutrient sources and the movement of nutrients through the Yellowstone system. Outputs of the modeling include the identity and source of primary nutrient (delivered aggregated yields of total nitrogen (N) and phosphorus (P)) sources and terrestrial and aquatic transport factors; predictions of N and P loads yields and concentrations throughout the Missouri River system; and an evaluation of the effect of lake and reservoir attenuation and irrigation on nutrient loads. Model outputs were updated to reflect 2012 census of agriculture data. Several management scenarios were run to evaluate the effect of changes in population, fertilizer application, and other nutrient sources in reducing nutrient transport.

1.1.1 Major Findings in Support of Cumulative Effects Analysis

The primary findings of the riparian and related land use analysis that may support multiple aspects of the CEA include the following:

- By most classic measures of water-quality, the Yellowstone River's water quality has improved over the past few decades as a result of improved treatment of industrial and municipal waste discharges, however, indicators of eutrophication are present in the middle portions of the river.

- Total Dissolved Solids (TDS) in water, as expressed by Specific Conductivity (SC) is inversely related to discharge and varies by location, generally increasing in a downstream direction. Human influences have likely elevated SC in the lower watershed but the degree of change is not known. Current TDS and SC values in the Yellowstone River do not appear to adversely affect beneficial uses. Further decreases in discharge as a result of withdrawals or climate change will result in higher TDS and SC values which could begin to affect beneficial uses in the lower watershed.

- The Yellowstone River is a minor source of nutrients to the Gulf of Mexico, however as one of the headwaters of the Mississippi River, nutrient sources are expected to be low.

- Nutrient concentrations in the Yellowstone River are greatest during winter months when there is less dilution of nutrient-rich ground water and algae is not actively growing. Nutrient concentrations increase in a downstream direction.

- Nitrogen concentrations are not directly correlated to streamflow since groundwater delivers a substantial portion of the total annual N load to the stream. The Clarks Fork Yellowstone River, Bighorn and Powder Rivers delivery sizeable loads of total N to the Yellowstone River system. The top three SPARROW model predicted delivered aggregated yields of total nitrogen in the Yellowstone River are from the Shoshone River in Wyoming and the Yellowstone - Pompeys Pillar and Yellowstone - Lake Basin Hydrologic Units (8-digit HUCs). Fertilizer and atmospheric deposition are the primary sources predicted by the model.

- Phosphorus (P) concentrations in the Yellowstone are highly correlated to discharge as sediment particles carry attached phosphorus. As a result, total P concentrations are highest in spring during runoff and increase moving downstream. The SPARROW model predicted that the Lower Bighorn watershed contributed the highest delivered aggregated yield of total phosphorus to the Yellowstone basin followed by the Yellowstone - Pompeys Pillar and the Little Bighorn watersheds. Manure, fertilizer, and natural sources were the largest model-predicted origins of total phosphorus in the Yellowstone River basin.

- Suspended sediment concentrations increase in a downstream direction. Suspended sediment loads in tributaries are positively related to drainage area, geologic and soil characteristics, rangeland area, and the extent of Tertiary-period sedimentary rocks. The Powder River and Clarks Fork Yellowstone River contributed 270 and 420 tons per square mile (1999-2001) respectively to the Yellowstone. The suspended sediment load in the upper Bighorn River in Wyoming was greater for the same time period however, delivery to the Yellowstone River was drastically reduced due to sediment retention in Bighorn Lake.

- Water temperature varies daily, seasonally, and generally (excepting near Corwin Springs thermal discharge) increases (in summer) in a downstream direction. Due to limitations in the available record, statistical determination of change in summer water temperature is not possible, although some slight increase in recent years is noted. Further decreases in stream discharge, notably in late summer and early fall as a result of additional water withdrawals or climate change will result in higher water temperature which could affect beneficial uses in affected reaches.

- Alterations to the hydrology and suspended sediment content of Bighorn River flows have affected the water quality and ecology of the Yellowstone River below the confluence. Dam-regulated discharges have reduced sediment delivery to the Yellowstone as well as elevated winter water temperatures below the confluence. Yellowtail Dam also appears to attenuate total dissolved solids and phosphorus attached to sediment.

- Indicators of water-quality and habitat degradation were noted in the Clarks Fork Yellowstone River Yellowstone and Bighorn Rivers relative to algal biomass, macroinvertebrate indices (EPT) and fish anomalies. Similar indicators were also seen at sites on the Yellowstone River (Billings and Forsyth) below the confluence with these tributaries. Indicators of moderate eutrophication were noted in the middle Bighorn River near Hardin. Higher nutrient concentrations were also noted in both the Clarks Fork Yellowstone River and Bighorn Rivers.

- Concentrations of some trace elements (metals) in the Yellowstone River are generally below human health standards in surface water and sediment samples, however a few sites show elevated levels, thought to be primarily related to natural sources. Arsenic concentrations in the Yellowstone River near Corwin Springs and as far downstream as Billings exceeded the US EPA and Montana standard of 10 µg/L in some samples that also represent possible adverse impacts to aquatic life. Mercury levels in Yellowstone River fish tissue samples are comparatively higher than in many other basins in the country and are thought to be related to chemical and physical processes in reservoirs within the basin. Concentrations of some metals are much higher in tributaries such as the Powder, Little Powder, Bighorn, and Shoshone Rivers and in Soda Butte Creek.

- An array of herbicides and insecticides and breakdown products were detected in the Yellowstone River and adjacent groundwater, however the concentrations did not exceed state standards for drinking water and aquatic life. Herbicides were detected more frequently than insecticides. The number of detections increased going downstream. Atrazine, a very mobile herbicide was the most frequently detected pesticide in surface and ground water samples. Yellowstone detections ranked in the lower 25th percentile of concentrations measured nationwide.

- Yellowstone fish tissue samples showed greater concentrations of organochlorine pesticides and PCBs than did sediment samples. Concentration of organochlorine pesticides in fish tissue and sediment were primarily linked to historic use of DDT in the upper watershed. Concentrations of semi-volatile organic compounds were greatest in urban areas such as near Billings (Reach B2) where concentrations of multiple polycyclic aromatic compounds detected were below aquatic life standards but high enough to potentially cause adverse effects to aquatic life.

- Continued hydrologic modifications as a result of increasing water consumption and/or climate change may seasonally impact water quality as less water is available for dilution of pollutants. Diminished discharge can also be a major factor in elevating water temperature during low flow periods.

- Pollutants related to industrial wastewater discharges have been detected in water and sediment samples in the Yellowstone but at relatively low levels below human and aquatic health standards. Improvements in wastewater treatment technology should lead to no further issues unless growth and expansion of industry in the basin leads to added pollutant loads.

- Pharmaceutical compounds were not evaluated in detail as part of this study but are noted to be issues that should be addressed in the future since many compounds have been detected in the River's water. While detected at very low concentrations, safe levels for aquatic and human life of many of these compounds have not been confirmed nor have their cumulative impact when jointly present. Current wastewater treatment technology as well as septic disposal systems does not substantially alter these compounds. Further study and monitoring of these compounds is recommended to help future water users develop safe use and discharge practices and treatment options.

- Contribution of pollutants to the Yellowstone River from domestic septic tanks is largely an unknown quantity. Unless properly installed and maintained, septic tanks are thought to be a potential source of nutrients and bacteria in developed river segments. The net area of high risk septic tank ratings increased by nearly 250 acres between 1990 and 2010 while the net area of moderate risk ratings increased by almost 2,000 acres. The greatest increase in both categories took place in Reach B1. The area of high risk septic tank ratings increased by xx between

2.0 SUMMARY OF EXISTING DATA

Water quality, bed and suspended sediment, and fish tissue data for the CES reaches has been compiled using a number of data sources and correlated to one of the eleven Montana Department of Environmental Quality (DEQ) Assessment Unit IDs (AUIDs) for the Yellowstone River. Analysis of US Geological Survey (USGS) records at the ten Yellowstone River mainstem gaging stations (Table 2-1 and Figure 2-1) along with other analytic results downloaded from the Water-quality Portal were used to characterize past and present conditions on the Yellowstone River. Table 2-1 also provides a general correlation of USGS gages with the geomorphic reaches established for the Yellowstone River. Records from the Yellowstone Lake Outlet USGS Station Number 06186500 were not included in this analysis since it does not represent conditions within the project area. Results presented for the respective USGS stations are largely representative of conditions upstream of the station unless noted otherwise. The station at Billings integrates water quality of the Yellowstone River with that of the Clarks Fork Yellowstone River of the Yellowstone which enters above the station. Similarly, the Forsyth station integrated the Bighorn River and the Glendive station integrates the effect of the Powder River on Yellowstone River waters. Water-quality concentrations are presented here in metric units as they are commonly reported throughout the academic and scientific community. Conversions to English units are indicated as appropriate.

2.1 Water and Sediment Quality

Water quality of the Yellowstone River is sensitive to geographic location since common parameters used to characterize water quality vary considerably as a result of differences in physiographic, climatic, geologic, and anthropomorphic influences within the very diverse region that makes up the Yellowstone River watershed. Following is a discussion of the major water quality and bed sediment characteristics of the Yellowstone River taken from a review of pertinent literature and analytic sample analysis.

2.1.1 Hydrogen-ion (pH) concentration

Hydrogen-ion (pH) concentration measures acidity and alkalinity in water and is typically reported in pH units. A pH value of 7.0 represents a neutral solution; greater than 7.0 is alkaline and below 7.0 is acidic. In general, water in the Yellowstone River is considered alkaline with pH ranging from 7.4 to 8.6. The 1999-2001 NAWQA Program reported a maximum pH value at Forsyth of 8.4 and a low pH of 7.2 at Corwin Springs. PH generally increases in a downstream direction and is typically not outside of established Montana or North Dakota water-quality standards for pH (Miller et al. 2005).

Table 2-1
USGS stations along the Yellowstone River in Montana and North Dakota.

USGS Station dentification Number	Station Name	Respective CEA Geomorphic Reach Number
06191500	Yellowstone River at Corwin Springs, MT	PC1 – PC2
06192500	Yellowstone River near Livingston, MT	PC3 – PC14
06195750	Yellowstone River at Springdale, MT	PC15 – PC21
06195950	Yellowstone River at Big Timber, MT	A1 – A4
06214500	Yellowstone River at Billings, MT	A5 – B1
06295000	Yellowstone River at Forsyth, MT	B2 – C10
06309000	Yellowstone River at Miles City, MT	C11 – C16
06327500	Yellowstone River at Glendive, MT	C17 – D5
06329500	Yellowstone River near Sidney, MT	D6 – D12
06329610	Yellowstone River No. 2 near Cartwright, ND	D13 – D16

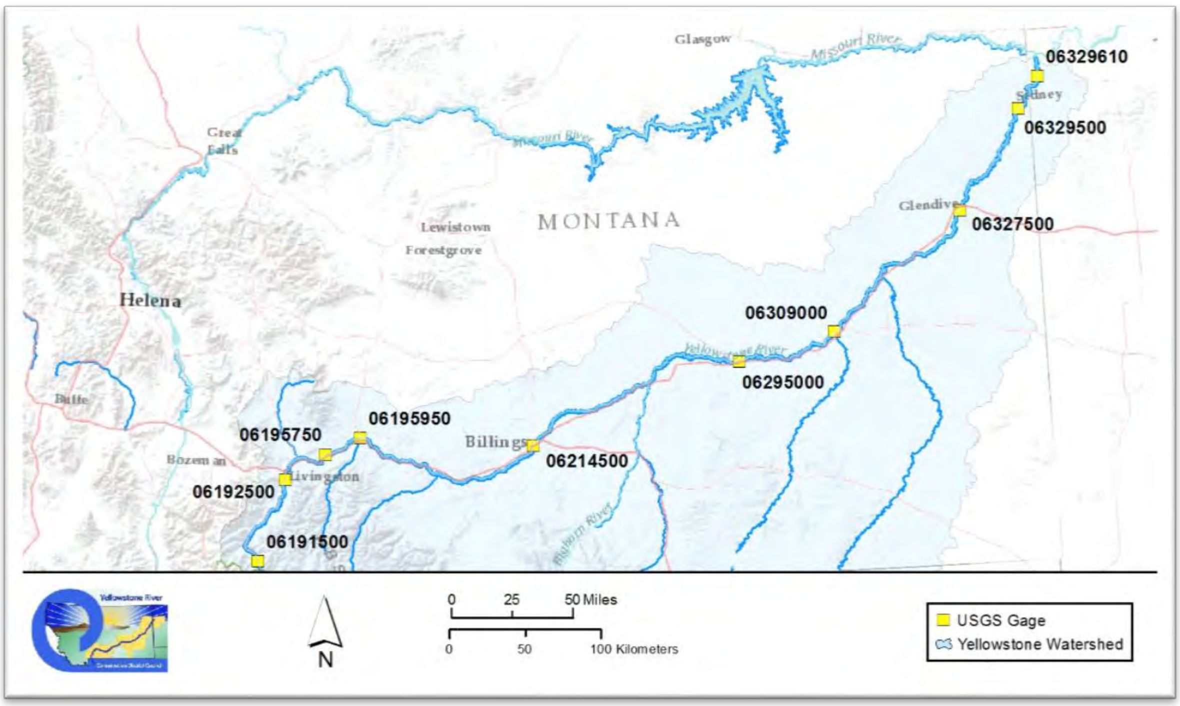


Figure 2-1 **Map of Yellowstone River fixed stream gage and water-quality stations operated by the USGS. Periods of record vary and not all stations have the same data available. For a list of Montana stream gages operated by the USGS in Montana see http://waterdata.usgs.gov/MT/nwis/current/?type=flow.**

2.1.2 Dissolved oxygen

Dissolved oxygen (DO) measures how much oxygen is dissolved in water. Dissolved oxygen comes from the atmosphere and from photosynthesis by aquatic plants, and is depleted through chemical oxidation and respiration by aquatic animals and microorganisms, especially during the decomposition of plant biomass and other organic material. The amount of oxygen that dissolves varies in daily and seasonal patterns, and decreases with higher temperature, salinity, and elevation (atmospheric pressure). The maximum solubility of oxygen in water at 1 atm pressure (standard air pressure at sea level) ranges from about 15 milligrams per liter (mg/L) at 0 degrees Centigrade (ºC) to 8 mg/L at 30ºC. As such, water near freezing temperatures holds twice as much dissolved oxygen as does warm water (Wetzel, 2001). Concentrations of DO are generally 8 to 10 mg/L or near saturation. Water-quality standards for DO are based on aquatic life stages present rather than a single concentration (MDEQ, 2012). Yellowstone River water typically has high levels of dissolved oxygen because it is always flowing and mixing and doesn't have large, active sources of depletion found in slower moving or still water however, several instances of low DO levels below the Billings area (B3-B4 during summer 2010) may be related to the eutrophication noted in following sections of this report. Summer season values are typically higher in the river's headwaters and lower going downstream as water temperature increases (Miller et al., 2005).

2.1.3 Total Dissolved Solids

Total Dissolved Solids (TDS) in water is a measure of the amount of dissolved material in water. TDS includes sodium, calcium, magnesium, bicarbonate, chloride and other material that remains as a solid residue after the liquid is evaporated. Excess dissolved solids can adversely affect aquatic life, industrial, agricultural, and drinking water beneficial uses. Dissolved solids concentration is often expressed as electrical conductivity (EC) in units of microsiemens per centimeter (µS/cm). EC is a measure of the capacity of water to conduct electricity; the more ions in water, the more electricity is conducted. Specific conductance or conductivity (SC) is EC at a constant temperature of 25^0C. EC varies with water temperature so the constant of 25^0C is used for comparison. SC values at USGS gage sites on the Yellowstone River are inversely correlated to discharge (Figure 2-2 to Figure 2-8) and increase in response to decreases in discharge which may be an issue given diminished discharge over time and potential decreases in the future (Appendix 3 Hydrology). Concentrations of dissolved solids in the Yellowstone River generally increase in a downstream direction (Figure 2-9) as the increasingly larger watershed concentrates naturally weathered minerals. Median dissolved solids concentrations in the Yellowstone River increased from 152 mg/L near its mountainous headwaters to 453 mg/L at the farthest downstream site at Sidney. Human activity that results in increased weathering and delivery of minerals such as irrigation, coal mining, oil extraction, and industrial and municipal wastewater discharges can elevate dissolved solids in the river. EC values below 1.0 are considered good for most uses, with irrigation generally having the greatest sensitivity since plant functions are affected by higher EC values. Currently, we are not able to say with certainty how much TDS or EC concentrations have increased in the Yellowstone River since long-term, statistically comparable information is not available. Certainly, values have increased in the lower watershed, but we do not know to what extent.

Neither Montana nor North Dakota have established numeric water-quality standards for EC in the Yellowstone River. Montana has designated seasonal numeric standards for the Powder River, Little Power River, Tongue River, and Rosebud Creek tributary drainages in conjunction with efforts to protect use of these waters for irrigation and aquatic life (ARM 17.30.670) in light of increased ground water discharges in Wyoming and Montana as part of expanding coal-bed natural gas (CBNG) development and production. CBNG development involves de-watering coal seams to release trapped natural gas. Pumped CBNG ground water is typically stored or released to nearby drainages after the gas is trapped and stored. Statistically significant upward trends in EC concentrations and for associated sodium absorption ratio (SAR) values at some sampling sites on the Tongue and Powder Rivers has been noted and possibly attributed to CBNG production and other sources (Sando et al., 2014; Clark, 2012).

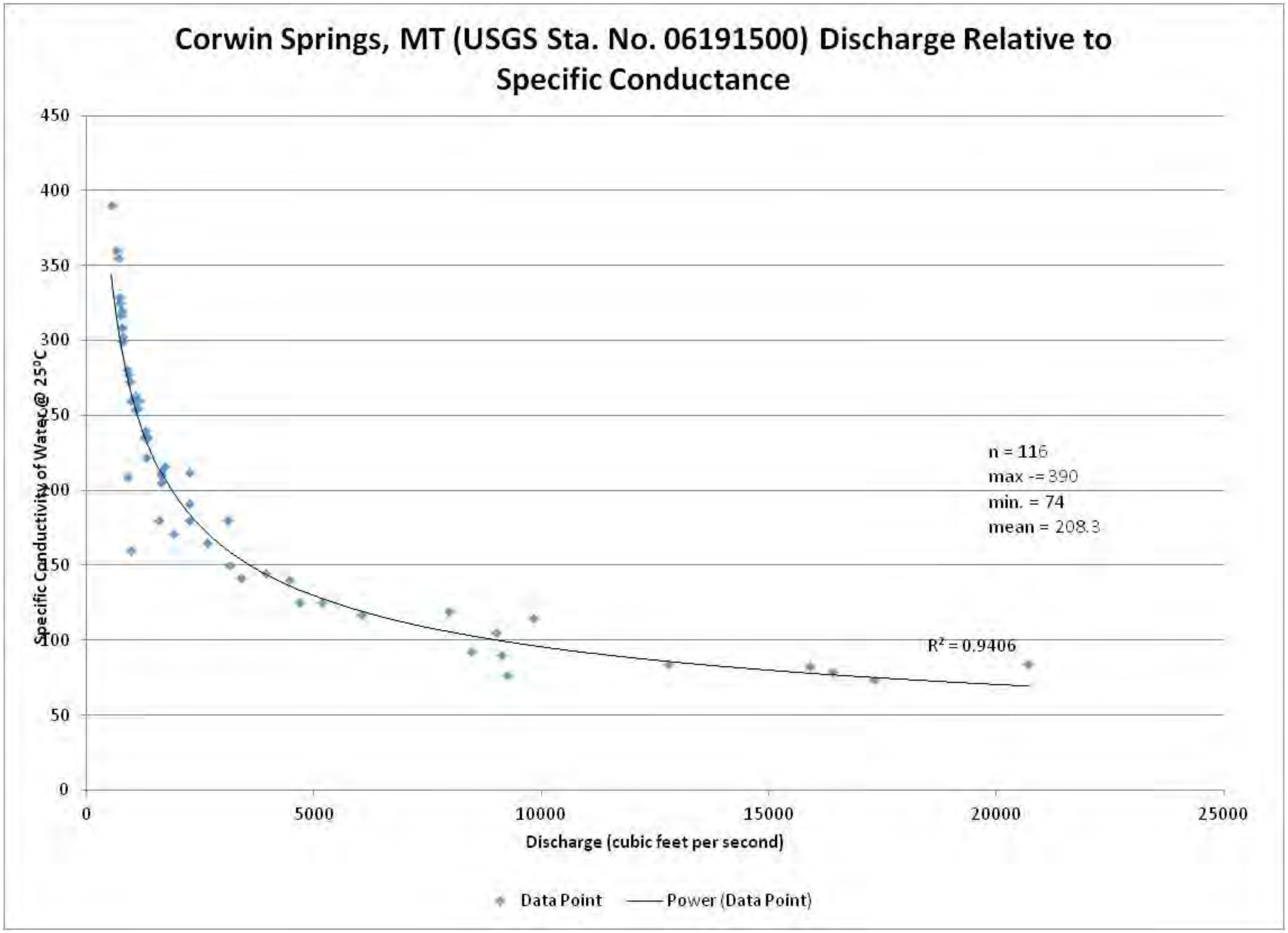


Figure 2-2 **Specific conductivity (electrical conductivity µS/cm at a constant of 25^{0}C) correlates very well with discharge (cubic feet per second) at the USGS Corwin Springs Sta. No. 06191500. Runoff from ground and surface water in the headwaters of the Yellowstone is relatively low in dissolved solids excepting thermal features in the Park. Increasing flow dilutes salts and other soluble materials derived from bedrock and alluvium**

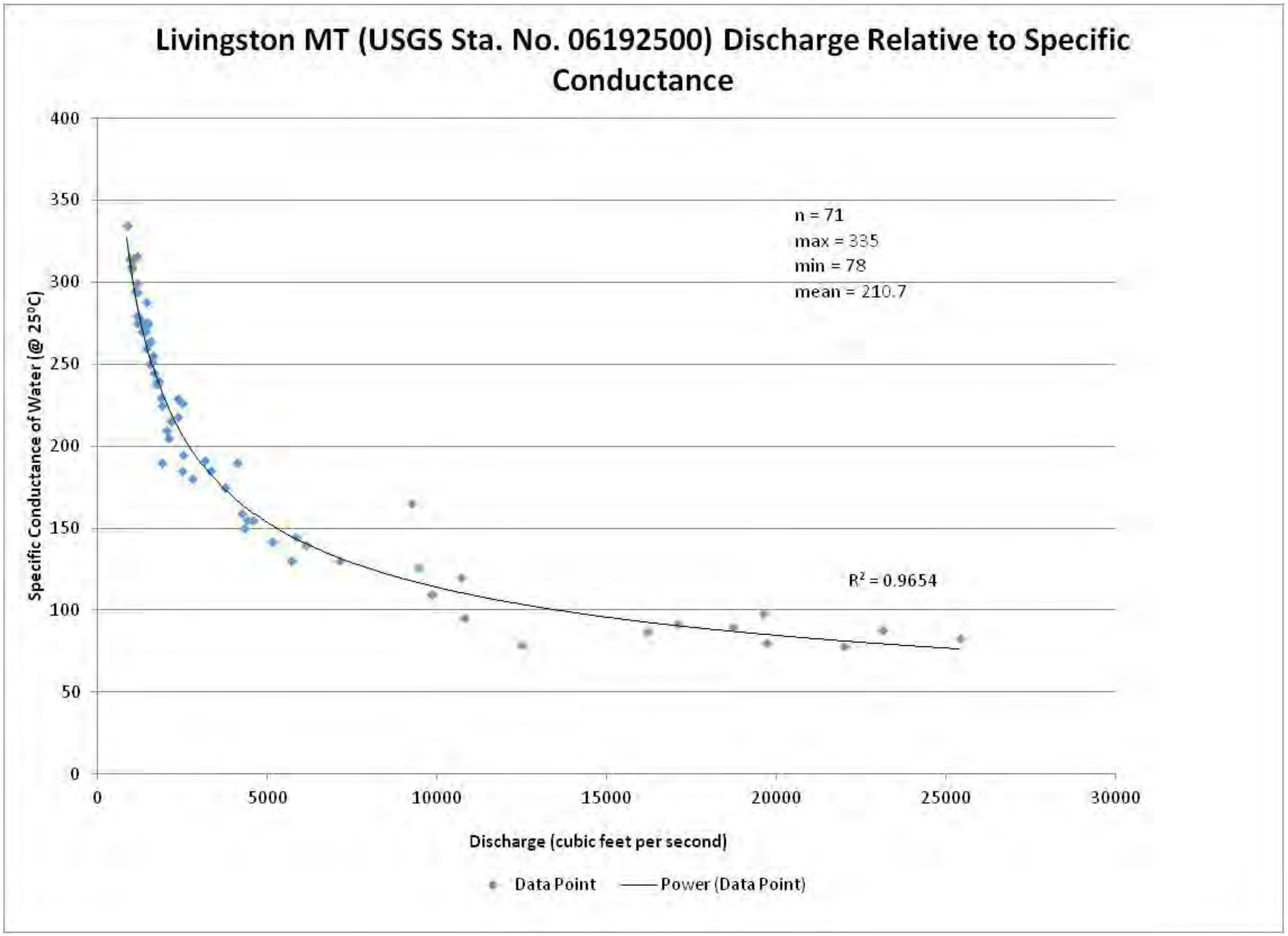


Figure 2-3 Specific Conductance (µS/cm at 25^{0}C) at Livingston is elevated slightly from the levels shown for Corwin Springs but is still relatively low and represents natural conditions for the upper river.

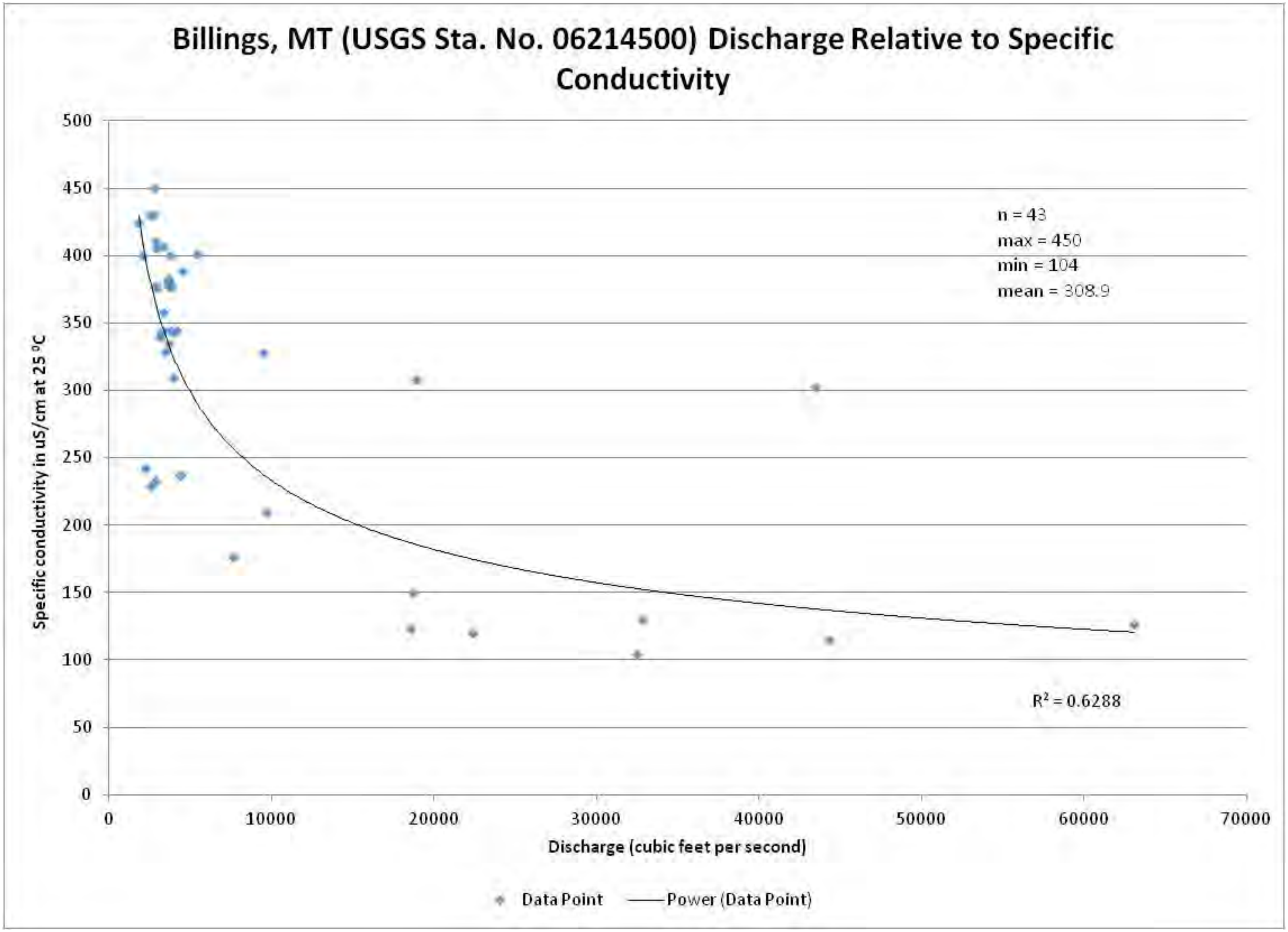


Figure 2-4 **Specific conductivity (μS/cm) at Billings begins to show greater variability and elevated values as tributaries contribute waters from different sources, particularly the Clarks Fork Yellowstone River of the Yellowstone.**

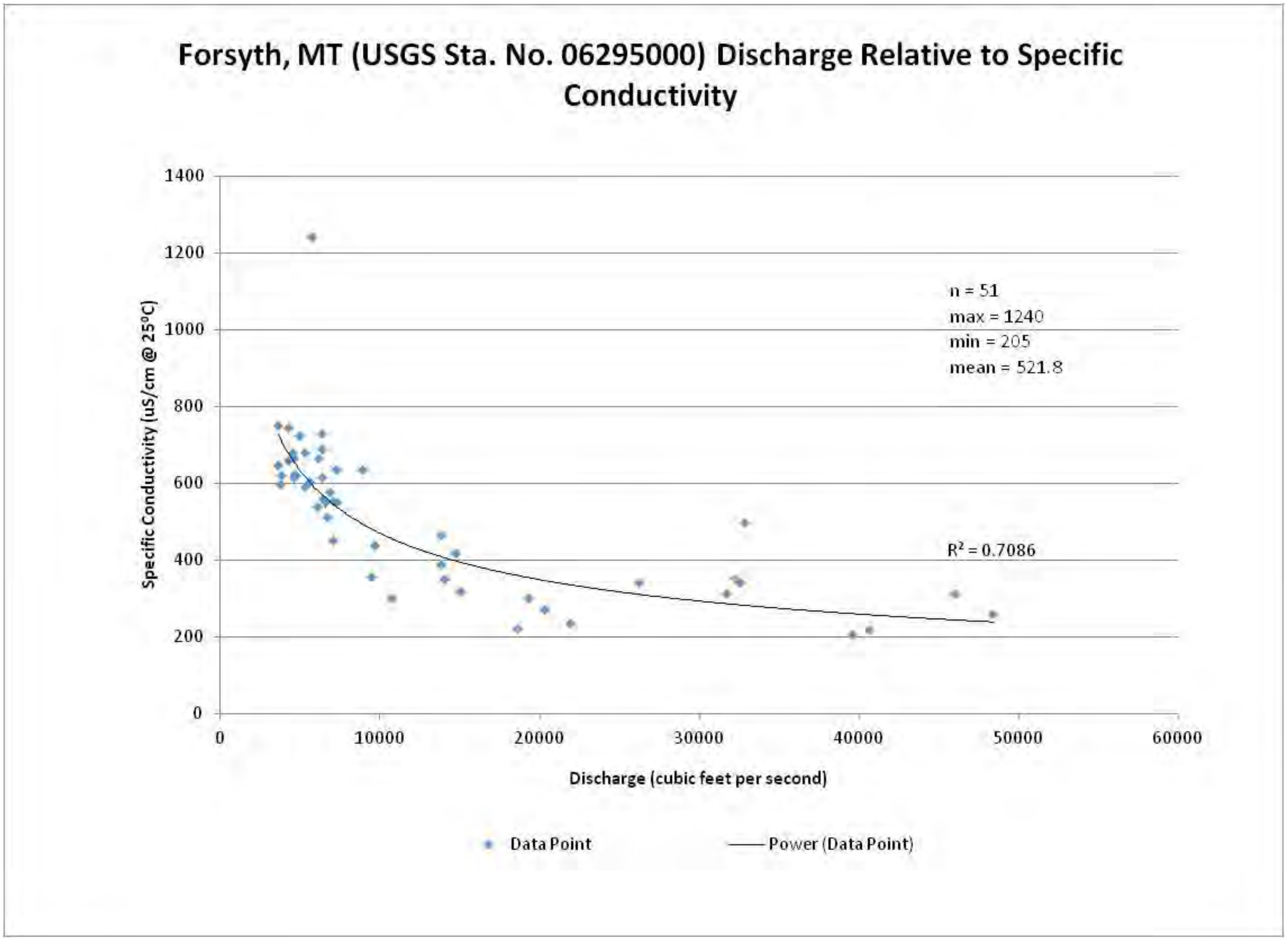


Figure 2-5 **Specific conductivity (μS/cm) at Forsyth exhibits greater values going downstream as the cumulative catchment area drains land with increasingly higher salt content and as ground water and irrigation returns flows containing leached salt constitute a greater portion of the instantaneous discharge.**

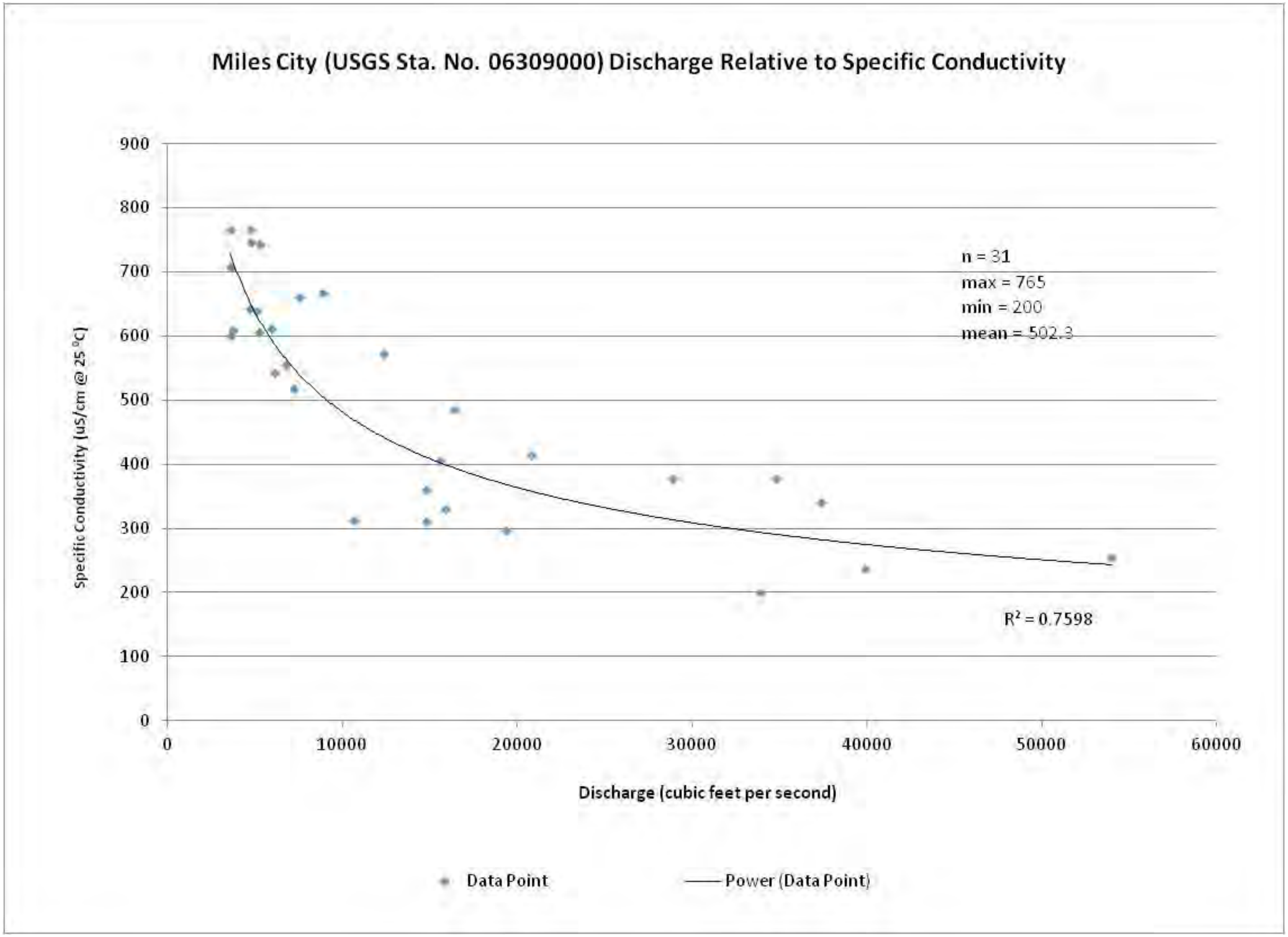


Figure 2-6 **Specific conductivity (µS/cm) data at Miles City shows the influence on the Yellowstone of the somewhat less salty Tongue River which drains from the north end of the Bighorn Mountains and exhibits more of a classic snowmelt driven system as opposed to a prairie system.**

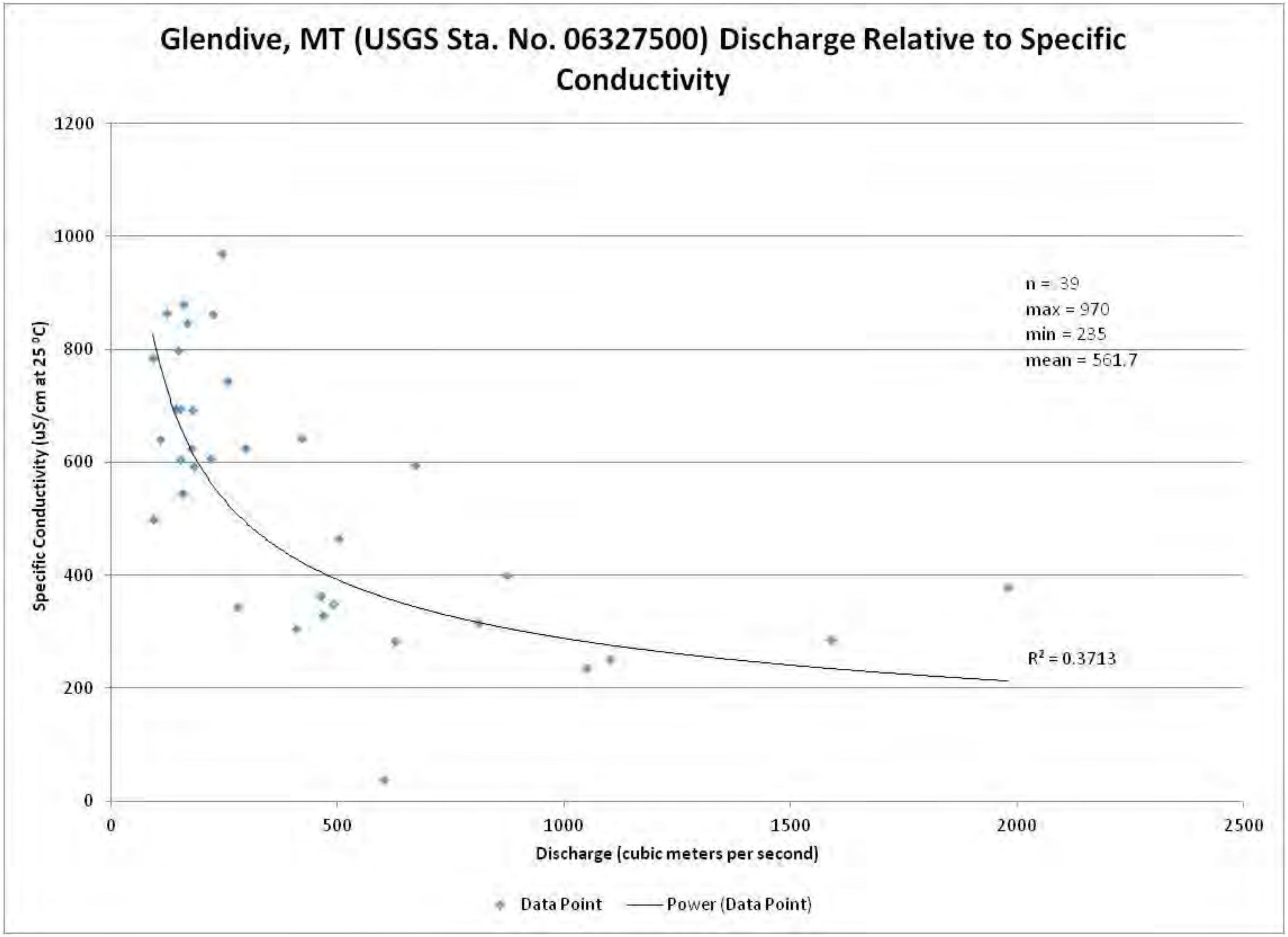


Figure 2-7 **Specific conductivity (µS/cm) values at Glendive reflect a return to the trend in higher downstream conductivity with the monitoring site located well below the confluence with the Powder River. With multiple influences on water chemistry, the correlation between discharge and conductivity is evident but statistically diminished.**

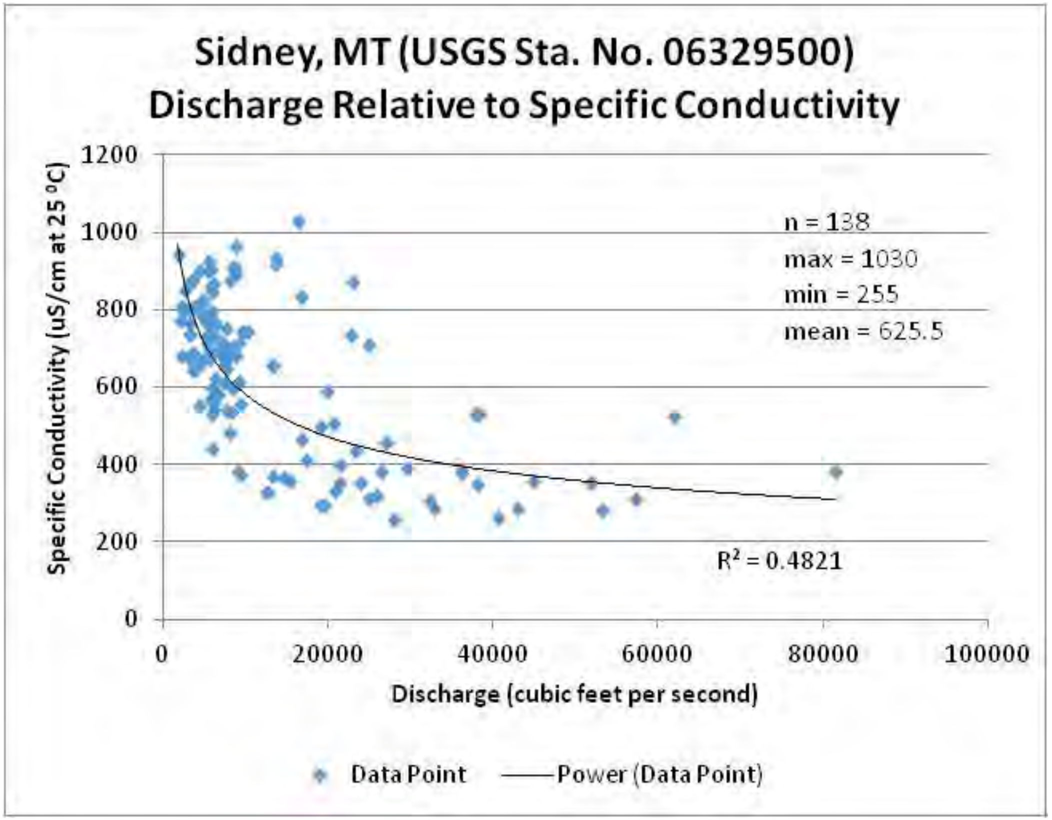


Figure 2-8 **The USGS gage at Sidney represents the water quality of the final 75 miles or so of the Yellowstone River water before the confluence with the Missouri. Conductivity (µS/cm) continues to increase but still retains a good relationship to discharge and appears to still be within the expected range given the environmental setting.**

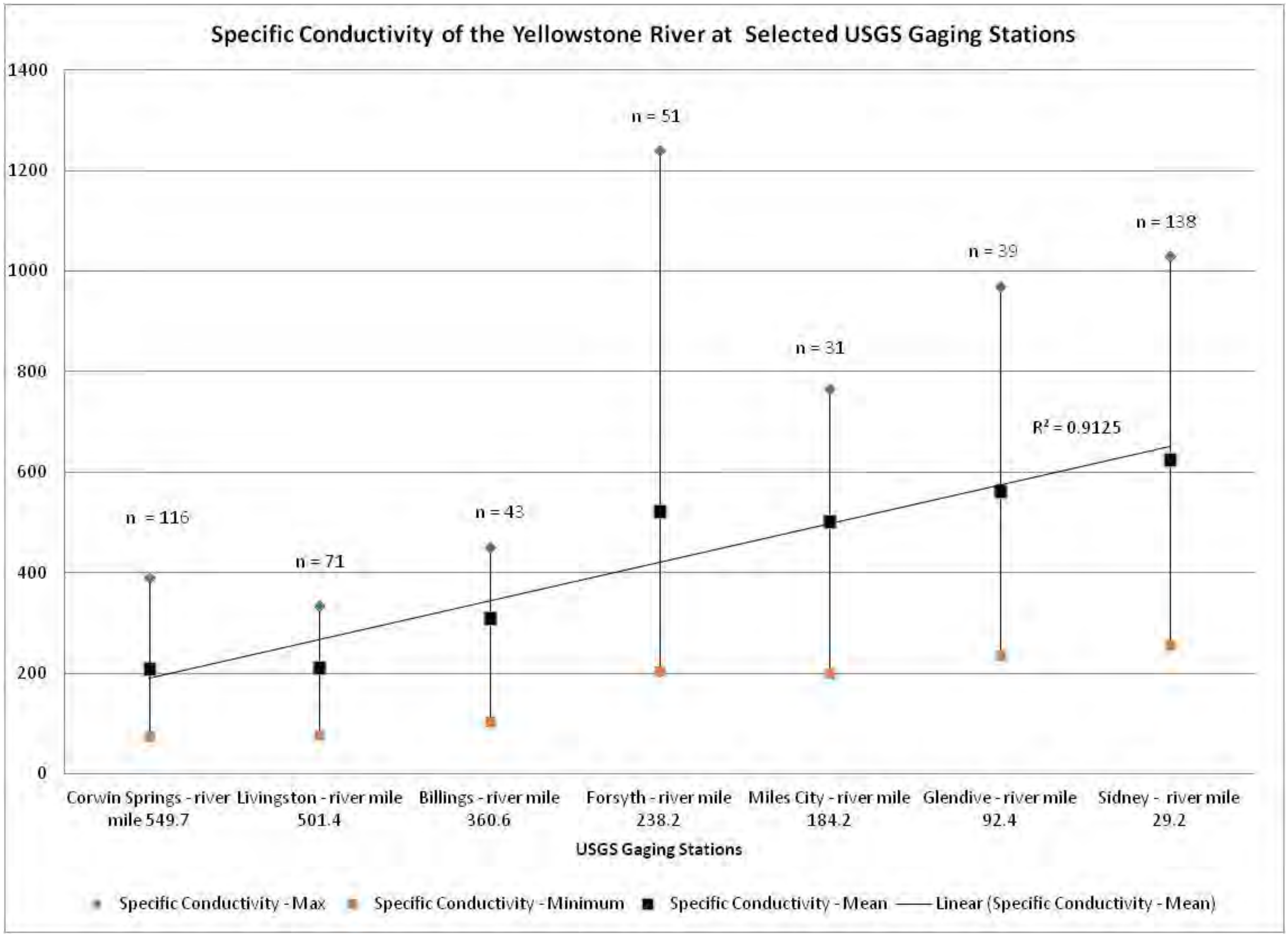


Figure 2-9 **Range of values for Specific Conductivity (µS/cm) at seven fixed–station USGS gages along the Yellowstone River. Values increase going downriver as salts and other dissolved ions accumulate.**

2.1.4 Nutrients

Nutrients – primarily phosphorus and nitrogen, play an important role in the growth of nearly all organisms. However, when they are excessively present in water they are then designated as a water pollutant (EPA 2014). The primary effect of excessive nutrients in rivers, lakes, and streams is to stimulate algal and aquatic plant growth (Frankforter et al. 2015). Excessive algal growth creates multiple problems for human users and aquatic organisms. The process of excess nutrients producing plant and algal growth responses in waterways is known as eutrophication (Chislock et al., 2013). Eutrophication is a natural process that occurs over millennia but human activities that increase the availability of nutrients can accelerate the process in aquatic ecosystems and produce undesirable results. Some algal species produce potent toxins that kill humans, livestock, and aquatic and terrestrial wildlife (USGS, 1999). Algal growth can also produce undesirable odors and taste in drinking water. Excess nutrients are responsible for impairment of some 206 assessment units (total N) and 235 assessment units (total P) in streams in Montana (MDEQ, 2014). Table 2-2 lists common problems associated with an over-abundance of algae in waterways.

Table 2-2
Common problems associated with an over-abundance of algae in waterways.

Impacts to Human Uses	Impacts to Aquatic Uses
Drinking water taste and odor	Harmful diel (night/day)fluctuations in pH and dissolved oxygen
Water clarity is reduced	Total biomass of algae is increased relative to other organisms
Blockage of intake screens and filters	Changes in species composition of algae and related diatoms
Disruption of water treatment processes	Macrophyte over-abundance – impedes flow and passage
Increased disinfection required which creates potential carcinogens in drinking water	Reduces macroinvertebrate and fish habitat especially near shorelines
Swimming, boating, and other recreational uses are restricted	Increased probability of fish kills due to depleted dissolved O_2
Fouling of submerged infrastructure	Toxin producing algae (moreso in reservoirs)
Reduced property values and amenity (odor and aesthetics)	Affects distribution and abundance of fishery
Lost tourism income	

Source: Smith et al. (1999) and Dodds et al. (2009) cited in Flynn and Suplee 2013).

In 2001, Miller et al. (2005) evaluated nutrient concentrations at 10 fixed station sites throughout the Yellowstone River basin based on sampling conducted as part of the National Water-Quality Assessment Program during 1999-2001. Four sites were located on the mainstem: Corwin Springs, Billings, Forsyth, and Sidney. Nutrient concentrations throughout the Yellowstone Basin generally were low and indicative of the relatively undeveloped conditions in the basin; however, some nutrient concentrations were found that correlate with human influences. Nutrient concentrations varied by season. Dissolved nitrate concentrations generally were greatest between October and March when plant growth and nutrient uptake is low. Total phosphorus concentrations were largest between April and June when suspended sediment in runoff is also at its peak concentration (Miller et al., 2005). Median dissolved-nitrate concentrations in all samples from the 10 fixed sites ranged from 0.04 milligram per liter to 0.54 milligram per liter. Flow-weighted mean dissolved-nitrate concentrations were positively correlated with increasing agricultural land use and rangeland on alluvial deposits upstream from the study sites and negatively correlated with increasing forested land. Samples collected from the Yellowstone River at Corwin Springs, Montana, had the greatest ammonia concentrations. The site is downstream from Yellowstone National Park and is influenced by geothermal spring waters that are high in ammonia. Median total phosphorus concentrations ranged from 0.007 to 0.18 mg/L. Median total phosphorus concentrations exceeded the U.S. Environmental Protection Agency's recommended goal of 0.10 milligram per liter for preventing nuisance plant growth for samples collected from the Bighorn River, Powder River, and Yellowstone River (Miller et al., 2005).

Nitrate concentrations in the Yellowstone River increased downstream from an average of about 0.08 mg/L at Corwin Springs to an average of greater than 0.3 mg/L near Sidney and were highest in the winter. Median nitrate concentrations were below reporting levels in July and August (Miller et al., 2005) (Peterson et al. 2004). Total nitrogen ranged from 0.3 mg/L to 0.4 mg/L (Peterson et al. 2000). Nitrate generally remained below detection limits, though a value of 0.053 mg/L was recorded at Billings and a value of 0.772 mg/L was recorded in the Clarks Fork Yellowstone River Yellowstone River.

Instantaneous dissolved nitrate loads of 280 kilograms per day (kg/d) and 297 kg/d were estimated for the Yellowstone River at Billings and the Clarks Fork Yellowstone River Yellowstone River, respectively, while the Bighorn (BH2) had an instantaneous dissolved nitrate load of 775 kg/d. Total phosphorus concentrations increased from 0.016 mg/L at Corwin Springs) to 0.038 mg/L in the lower segments of the river.

Flynn et al. (2014) developed numeric nutrient criteria for the lower Yellowstone River which is based on avoiding nuisance benthic algal growth (>150 milligrams per square meter) to protect recreational uses. Table 2-3 provides the numeric nutrient criteria the authors developed using a mechanistic computer model for two segments of the lower Yellowstone River. Development of numeric criteria using a similar modeling process for upper sections of the river is in progress.

Table 2-3
Nutrient criteria developed using a mechanistic computer model for two segments of the lower Yellowstone River. The derived values for total nitrogen and phosphorus were found to be protective of the recreational use which the authors determined to be less than 150 mg/m^2 chlorophyll *a* (Flynn et al., 2014).

River Segment	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)
Bighorn River to Powder River	655	55
Powder River to North Dakota State Line	815	95

Although concentrations of common forms of nutrients (total nitrogen, dissolved nitrate, dissolved phosphorus and total phosphorus) have been found to occur at relatively low values, nutrient enrichment in the upper and middle Yellowstone (Regions, PC, A, B, and C) and major tributaries (Clarks Fork Yellowstone River, Bighorn and Powder Rivers) has been recognized through various investigations (Peterson and Porter, 2002; Peterson et al., 2004). Algal biomass and autecological (relationship between an organism and its environment) indicators reflect eutrophic conditions and nuisance growths of filamentous algae in certain river segments (Peterson and Porter, 2002). The authors suggest that nutrient uptake by benthic algae are responsible for the relatively low observed dissolved nitrate values.

Eutrophic diatoms were common in the Bighorn and Clark's Fork Rivers. Microalgae biomass was greatest near Billings (Reach B2) and Forsyth (Reach C10) in the Yellowstone and near the mouths of the major tributaries. Algal standing crops and chlorophyll *a* concentrations where highest in the middle sections of the Yellowstone River and appeared to be related to inflows from the Clarks Fork Yellowstone River and Bighorn Rivers. A maximum chlorophyll *a* concentration of 797 mg/m² was recorded in the Yellowstone River at Billings (Reach B2).

Potential sources of nutrients that could drive the observed response of algal biomass are atmospheric deposition, upstream residential development, and irrigated agriculture (Flynn and Suplee, 2013; Zelt et al., 1999). In the Yellowstone River basin, nonagricultural sources of phosphorus have contributed an estimated 65 percent of the total phosphorus yield (Smith et al., 1997).

Related responses in western streams have been associated with increases in rural and residential development in the west, although point sources in the Laurel to Billings reach have been calculated to contribute less than 30 percent of the nitrate load compared to non-point source loads contributed by the Clarks Fork Yellowstone River (Newby, cited in Peterson and Porter, 2002). Non-point sources of nutrients are natural sources, fertilized agricultural crops, and rural residential sources (septic tanks, lawn fertilizer, and domestic animal waste). Turbidity associated with suspended matter that suppresses available light in the lower river below Forsyth likely plays a role in suppressing biomass production there.

Algal biomass and community structure appear to be influenced by the relative availability of nutrients (dissolved inorganic and organic nitrogen) as well as the relative turbidity of the water. A ratio of 16 nitrogen to 1 phosphorus is generally considered to be the ideal nutrient ratio for plant growth (Redfield, 1958 cited in USEPA, 2004). With phosphorus generally abundant, additional inputs of nitrogen increasingly drive primary production up to the point the 16:1 ratio is attained. The utilization of further nitrogen is then limited by the availability of phosphorus. With relatively large amounts of phosphorus available in the Yellowstone, attention should be given to ensure that sources of added nitrogen do not increase the moderate levels of eutrophication already observed in the middle and upper river.

In addition to the evaluation of instream impacts of elevated nutrients in the Yellowstone River, we also evaluated the relative impacts of nutrient export from the Yellowstone River, particularly into the Mississippi River system and eventually the Gulf of Mexico where nutrient blooms have been reported (Brown et al. 2011) (Robertson et al. 2014). The SPARROW model identified six potential sources of total nitrogen: farm fertilizer, manure from confined animals, inputs associated with legume crops, atmospheric deposition, wastewater treatment plants (WWTPs), and urban areas. Seven forces of total phosphorus were identified: farm fertilizers, total manure, WWTPs, urban areas, wetland/forested areas, channels in moderate-size streams, and deeply weathered loess (wind deposited) soils

Results of the SPARROW model for the Yellowstone River indicate that the estimated delivered aggregated yield of total nitrogen to the Gulf of Mexico is only 12.34 kg/km^2/yr (0.11 lbs./acre/year) compared to other Mississippi River tributaries that contribute up to an estimated 1,318 kg/km^2 (11.8 lbs./acre) (Frankforter et al. 2015). The top 20 HUC8s were ranked to indicate those yielding the greatest total nitrogen yield (Figure 10). The top 20 HUC8s are projected to cumulatively contribute 83 percent of the delivered aggregated total nitrogen yield in the basin. The SPARROW model predicted the largest source of total nitrogen in the basin is the Shoshone River basin in Wyoming followed by the Upper Yellowstone – Pompeys Pillar and the Upper Yellowstone – Lake Basin. Farm fertilizers (41 percent) and atmospheric deposition (30 percent) were the primary sources of delivered nitrogen. **Error! Reference source not found.** through Figure 2-12 depict the relative model-derived contributions and sources of total nitrogen yield in the Yellowstone basin. It is noted that while many of the HUC8s derived total nitrogen yield from many sources, the dominant projected source of nitrogen within the Upper

Yellowstone-Pompeys Pillar HUC8 is WWTPs, potentially contributing up to 36 percent of the total nitrogen contributed by this HUC8. It should be recognized, however, that this estimate is based on 2002 discharge contributions and does not include more recent modifications to the efficiency of the WWTPs in the HUC.

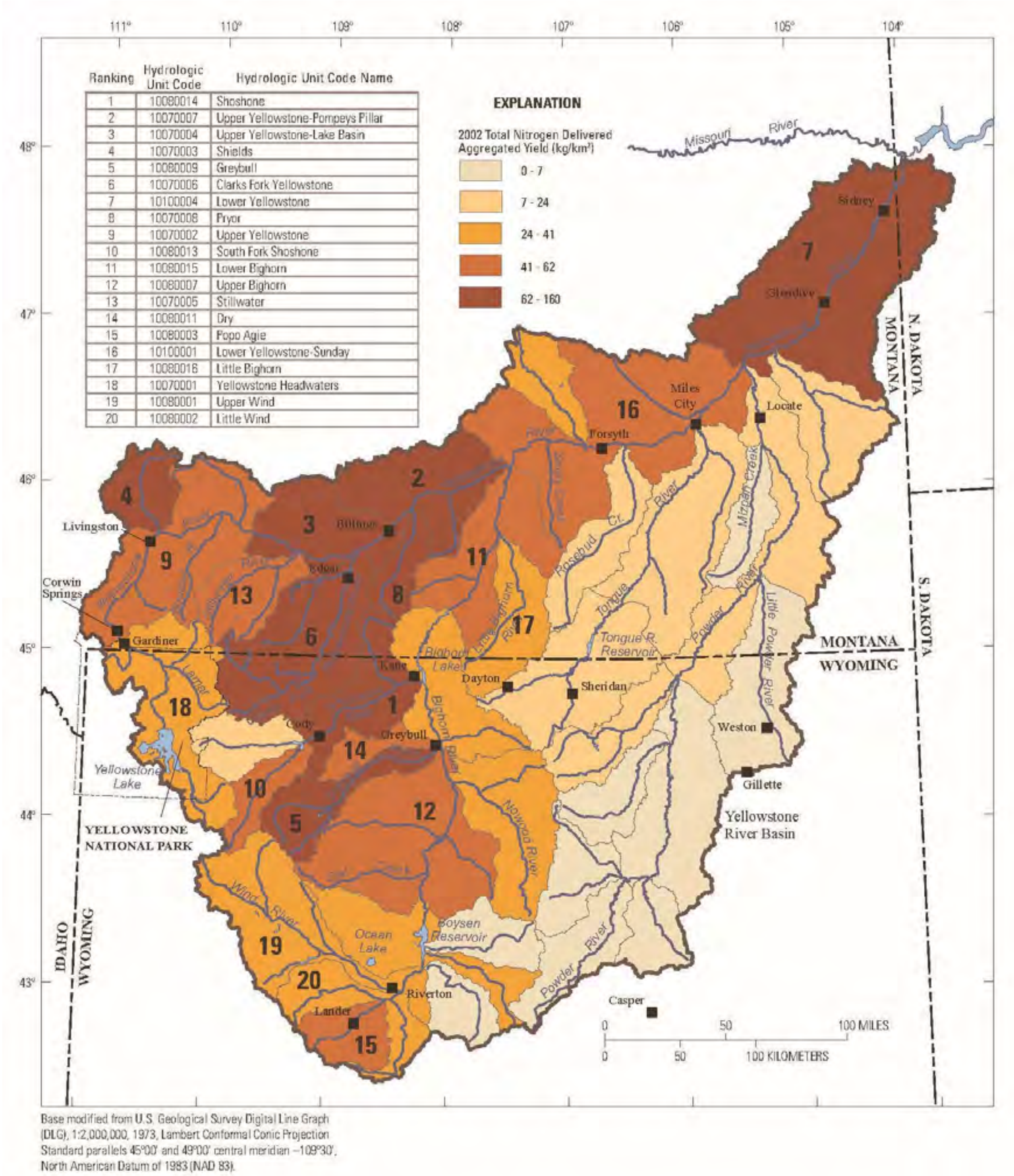


Figure 2-10 **Locations of the twenty watersheds (as defined by 8-digit hydrologic unit code) with the highest predicted delivered aggregated yield of total nitrogen (in kilograms per square kilometer per year) within the Yellowstone River Basin in Montana, Wyoming, and North Dakota.**

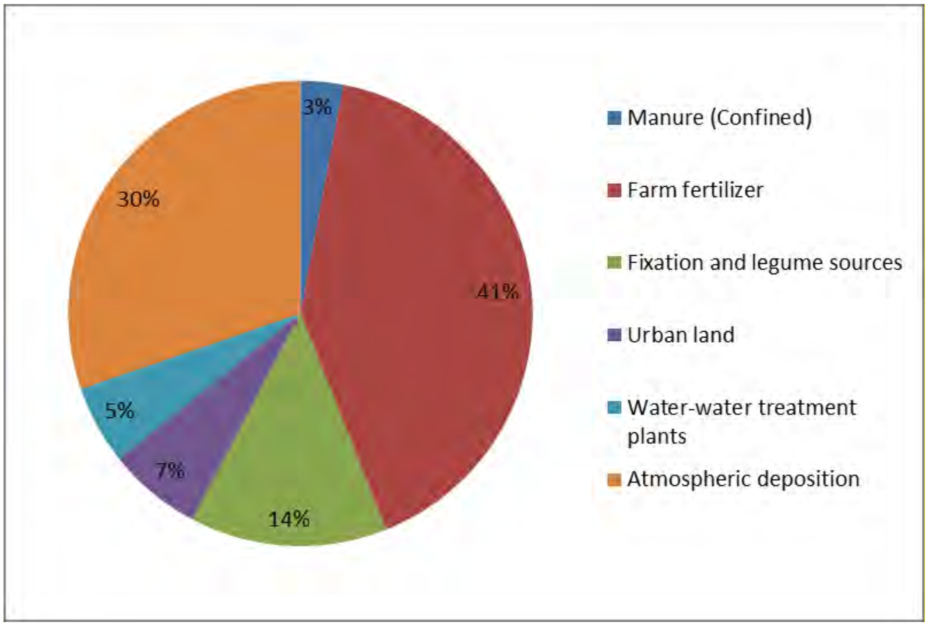


Figure 2-11 Predicted sources of the delivered aggregated yields of total nitrogen in the Yellowstone River Basin (in percent contribution). Farm fertilizer and atmospheric deposition are the greatest relative sources of total nitrogen in the Yellowstone River watershed.

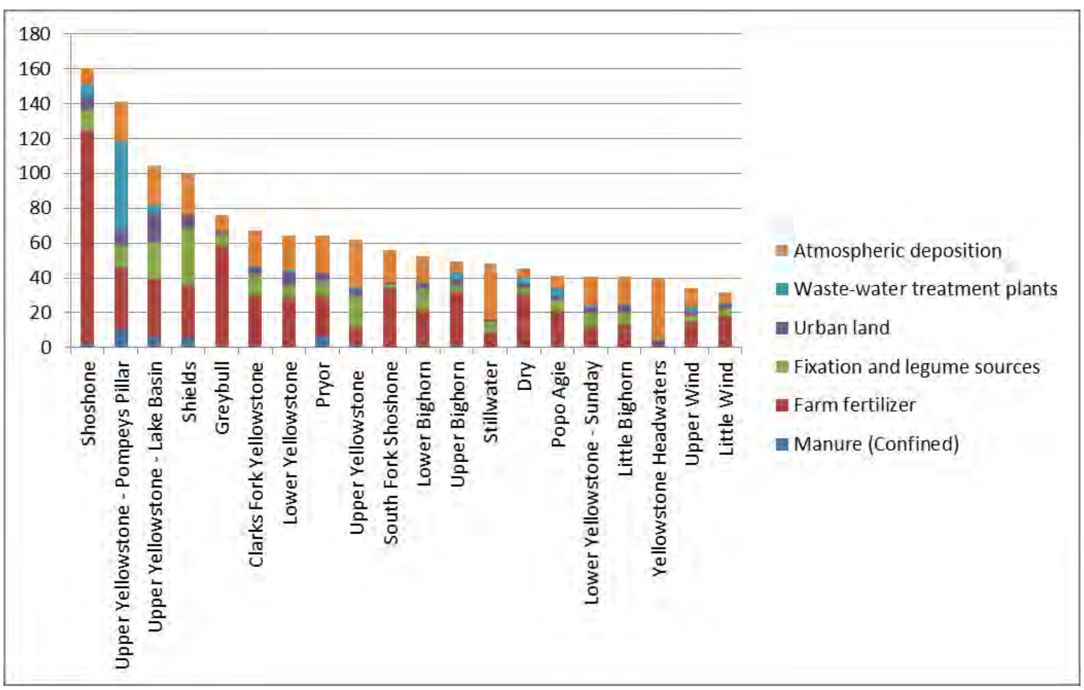
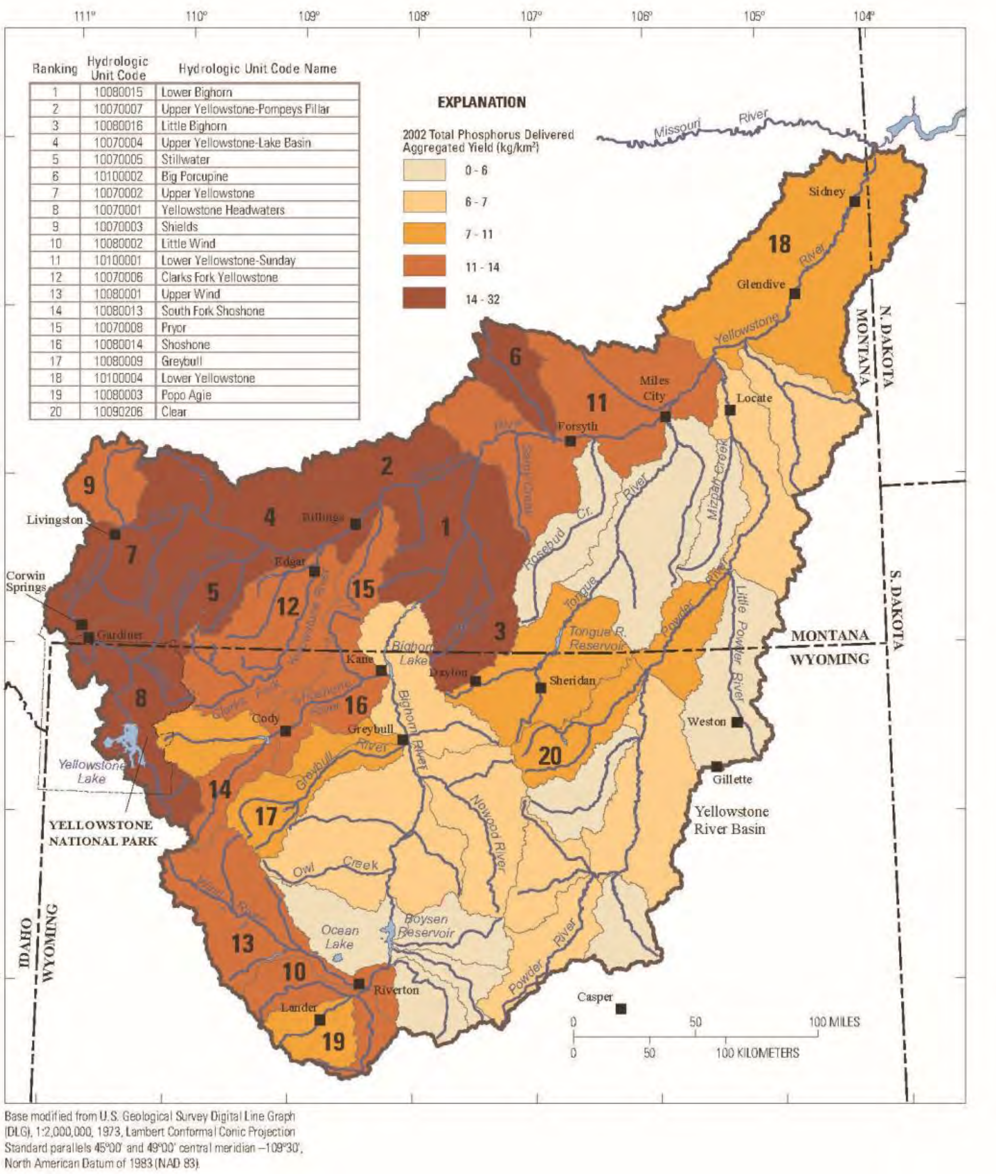


Figure 2-12 Sources of the predicted yields of delivered aggregated nitrogen yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year).

The SPARROW estimate of the delivered aggregated yield of phosphorus to the Gulf is 2.73 kg/km^2/yr (0.024 lbs./acre/year) as opposed to other drainages contributing as much as 187 kg/km^2/yr (1.66 lbs./acre/year) (Frankforter et al. 2015) Brown et al. 2011). The model predicted that the Lower Bighorn watershed and the Upper Yellowstone – Pompeys Pillar and Little Bighorn watersheds were the greatest contributors of delivered aggregated total phosphorus yield) Figure 2-13. The largest predicted sources of total phosphorus delivered aggregated yield in the basin were from a diverse number of sources including natural sources (stream channel – 39 percent)), livestock manure (confined and unconfined – 22



Ranking	Hydrologic Unit Code	Hydrologic Unit Code Name
1	10080015	Lower Bighorn
2	10070007	Upper Yellowstone-Pompeys Pillar
3	10080016	Little Bighorn
4	10070004	Upper Yellowstone-Lake Basin
5	10070005	Stillwater
6	10100002	Big Porcupine
7	10070002	Upper Yellowstone
8	10070001	Yellowstone Headwaters
9	10070003	Shields
10	10080002	Little Wind
11	10100001	Lower Yellowstone-Sunday
12	10070006	Clarks Fork Yellowstone
13	10080001	Upper Wind
14	10080013	South Fork Shoshone
15	10070008	Pryor
16	10080014	Shoshone
17	10080009	Greybull
18	10100004	Lower Yellowstone
19	10080003	Popo Agie
20	10090206	Clear

Figure 2-13 **Locations of the twenty watersheds (as defined by the 8-digit hydrologic unit code) with the highest predicted delivered aggregated yield of total phosphorus (in kilograms per square kilometer per year) within the Yellowstone River Basin in Montana, Wyoming, and North Dakota.**

percent)), and forest and wetlands – 17 percent origins. The top 20 HUC8s were ranked to indicate those yielding the greatest total phosphorus yield. The top 20 HUC8s are projected to cumulatively contribute 72 percent of the delivered aggregated yield of total phosphorus in the basin. Figures 2-14 and 2-15 depict the relative model-derived contributions and sources of total phosphorus delivered aggregated yield. Efforts to reduce nutrient loads and yields in the Yellowstone River should focus on those watersheds contributing the greatest human-related sources of nutrients. Since many of the larger sources and accumulated yields occur on the mainstem and major tributaries, nutrient management efforts will need to utilize a watershed approach to have any level of success.

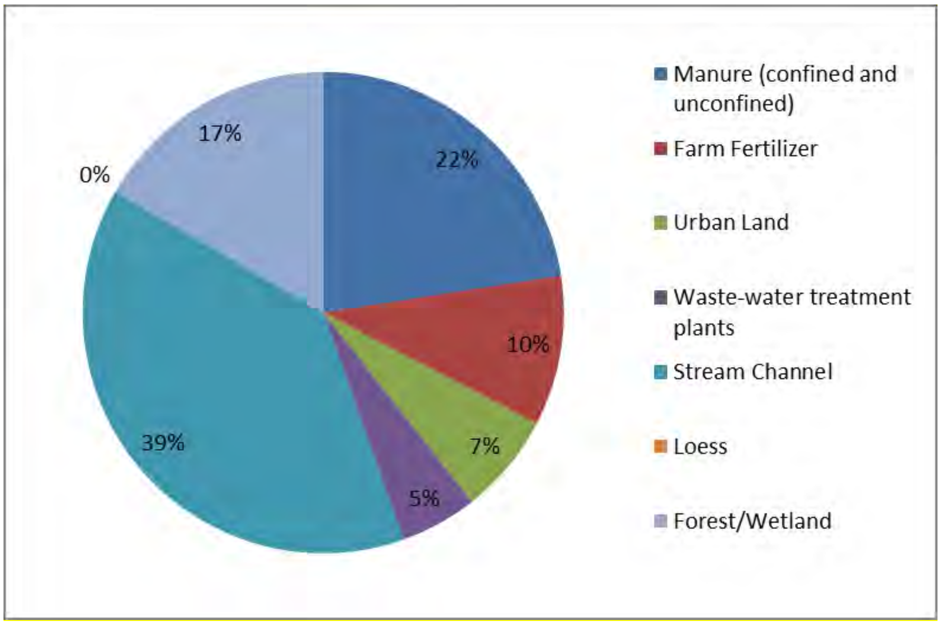


Figure 2-14 Predicted sources of the delivered aggregated yields of total phosphorus in the Yellowstone River Basin (in percent contribution)

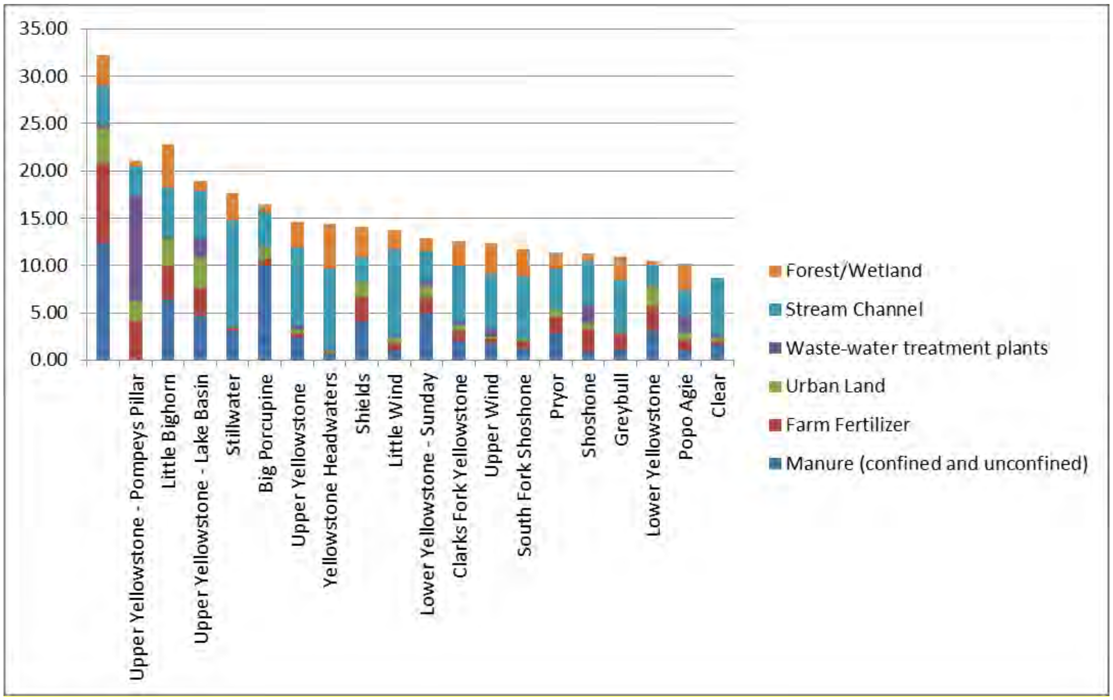


Figure 2-15 Sources of the predicted yields of delivered aggregated phosphorus yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year).

Using the SPARROW Decision Support (DSS) tool (http://cida.usgs.gov/sparrow/) Frankforter et al.(2015) modeled several scenarios to evaluate the effects of changing nutrient inputs from a variety of sources. Two scenarios were evaluated for nitrogen reduction using 10 and 15 percent decreases in fertilizer use as a result of the potential implementation of practices such as slow release fertilizers, variable rate fertilizer application, and overall reduction in fertilizer use. The result of these two scenarios showed the greatest reductions occurred in HUCs with substantial ag lands where the total aggregated nitrogen yield declined by 18 kg.km^2/year (11 percent), however, fertilizers remained the largest predicted relative source of total nitrogen despite the reductions in inputs. Figure 2-16 shows the results of the nitrogen fertilizer reduction scenario for the 20 top-ranked HUCs.

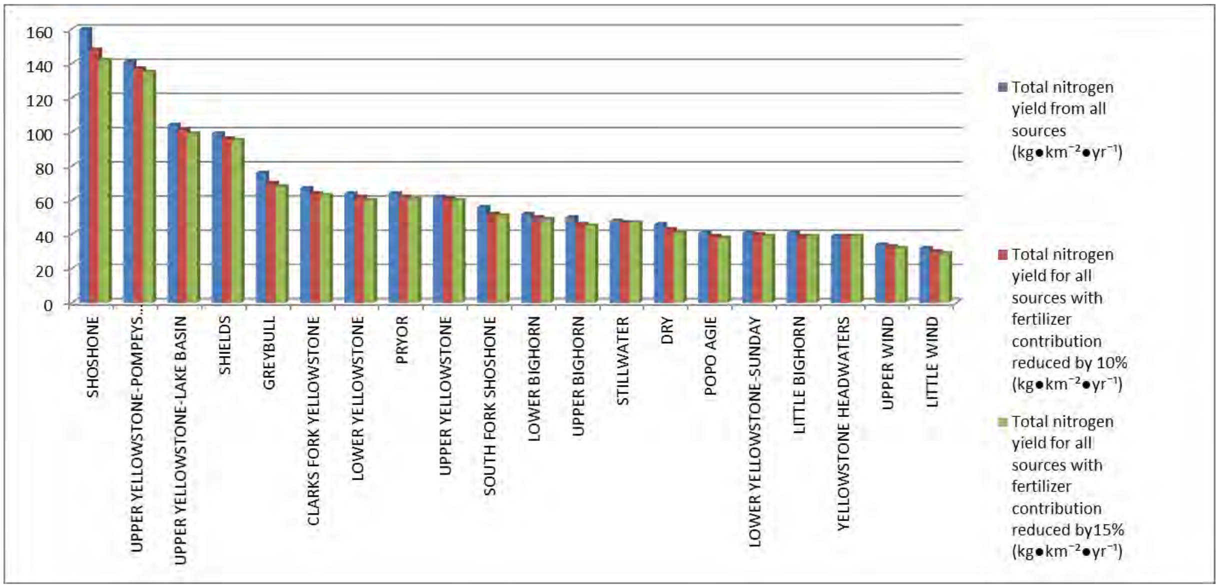


Figure 2-16 Changes in the predicted yields of total delivered aggregated nitrogen yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year) with 10 and 15 percent reductions in contributions of fertilizer.

Modeled population changes within the Yellowstone River basin were also evaluated as scenarios. Population census updates for the 2002 to 2012 period and projected population estimates to 2022 were evaluated to see what impact on nutrients might occur. A 12 percent increase in population and a corresponding six percent increase in WWTP inputs was used to model the 10-year period and double that was used for the 20-year period. The results of the model runs are shown in Figure 2-17. While the projected total nitrogen yield from WWTPs in the Upper Yellowstone-Pompeys Pillar HUC8 was the greatest noted (43 percent), the output of the two scenarios showed only a 3 and six percent increase respectively in the predicted total nitrogen yield.

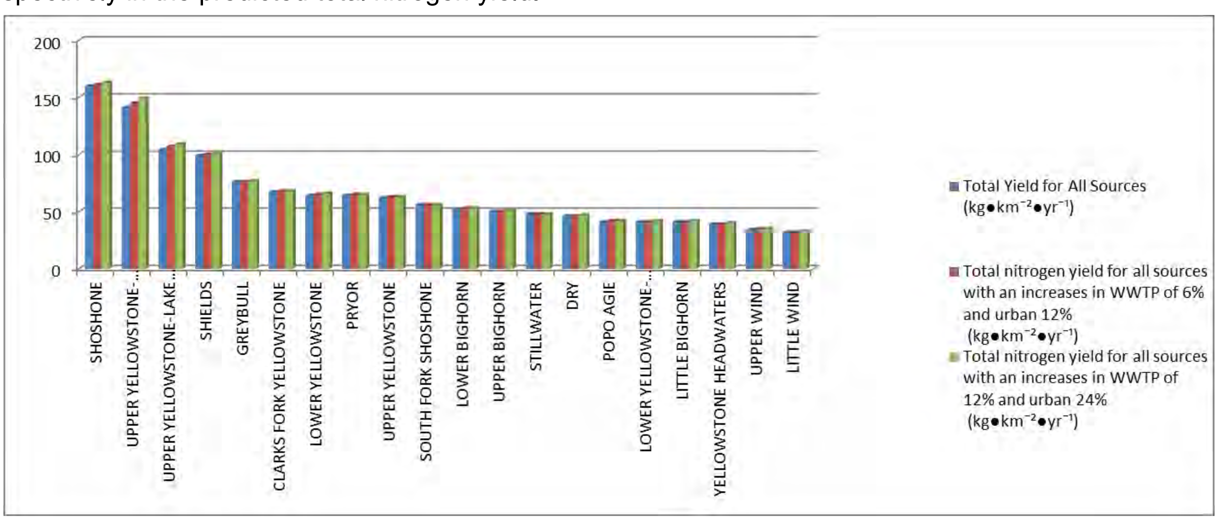


Figure 2-17 Changes in the predicted yields of delivered aggregated nitrogen yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year) with increases in urban (12 percent and 24 percent) and waste water treatment plant (6 percent and 12 percent) contributions.

A fifth scenario evaluated a 25 percent reduction in contributions from WWTPs. Decreases in total nitrogen yields were projected to be between one and 11 percent. As expected, the greatest change was observed in the Upper Yellowstone-Pompeys Pillar HUC8. Figure 2-18 depicts the predicted changes as a result of the 25 percent reduction scenario for WWTPs.

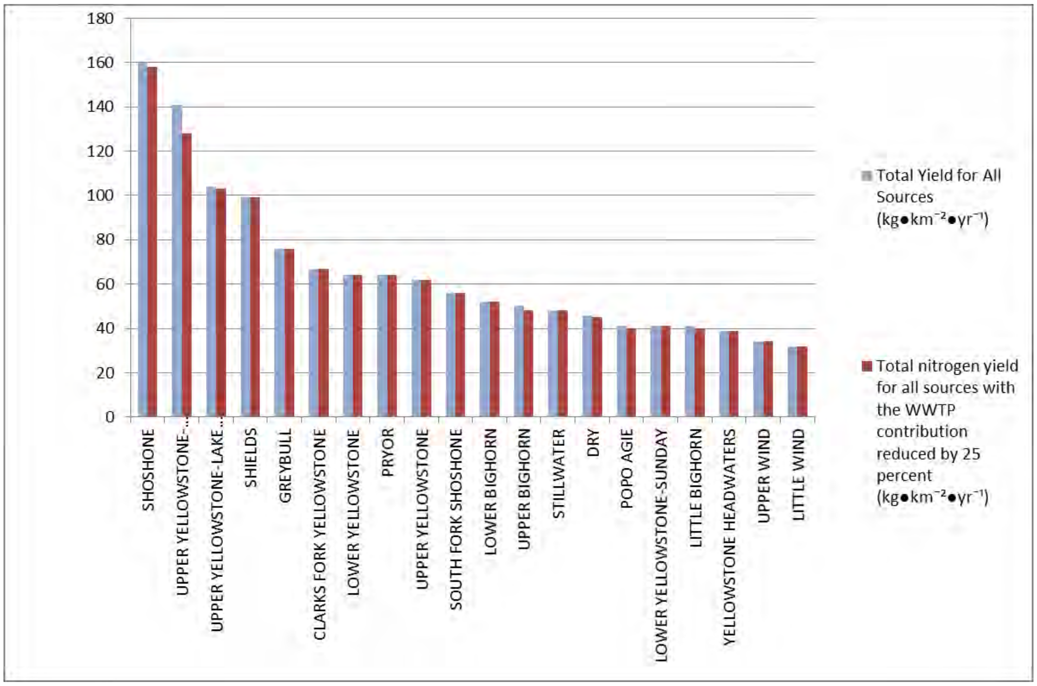


Figure 2-18 Changes in the predicted yields of delivered aggregated nitrogen yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year) after decreasing input from WWTPs by 25 percent.

Four modeling scenarios were run to evaluate how aggregated total phosphorus yields would change with modifications to total phosphorus inputs from various sources. Changes in fertilizer applications resulted in little (zero to nine percent) change in predicted total phosphorus yields (Figure 2-19). Scenarios evaluating decreases from reduced channel erosion showed greater responses with decreases of up to 17 percent in total phosphorus yields (Figure 2-20). Finally, changes to WWTP efficiency in removing phosphorus were evaluated using a 50 percent decrease (Figure 2-21). The only HUC8 with a substantial change was in the Upper Yellowstone-Pompeys Pillar HUC8 which predicted a 19 percent reduction in total phosphorus yield.

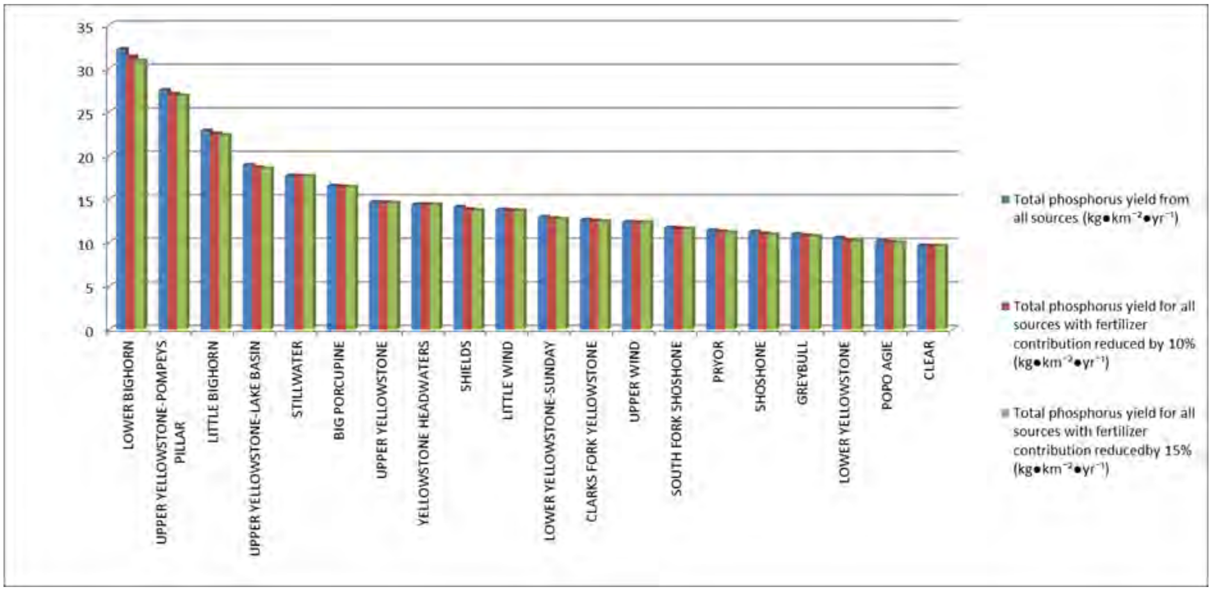


Figure 2-19 **Changes in the predicted yields of delivered aggregated phosphorus yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year) with 10 and 15 percent reductions in contributions of fertilizer.**

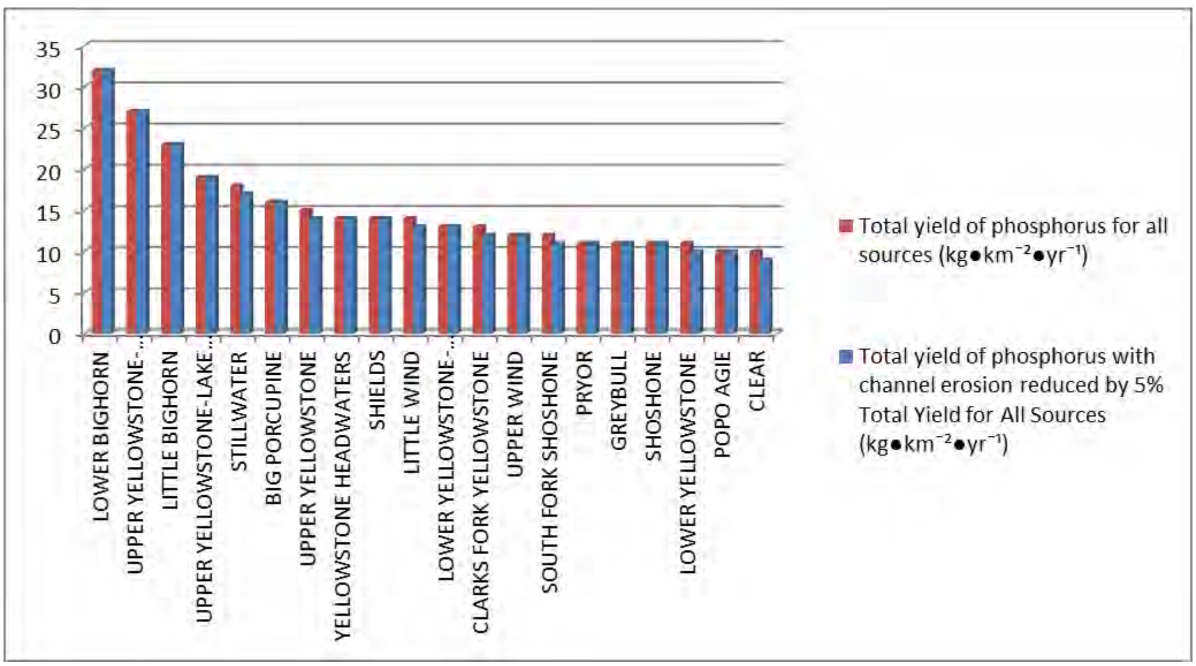


Figure 2-20 **Changes in the predicted yields of delivered aggregated phosphorus yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year) with a 5 percent reductions in contributions from the stream channel.**

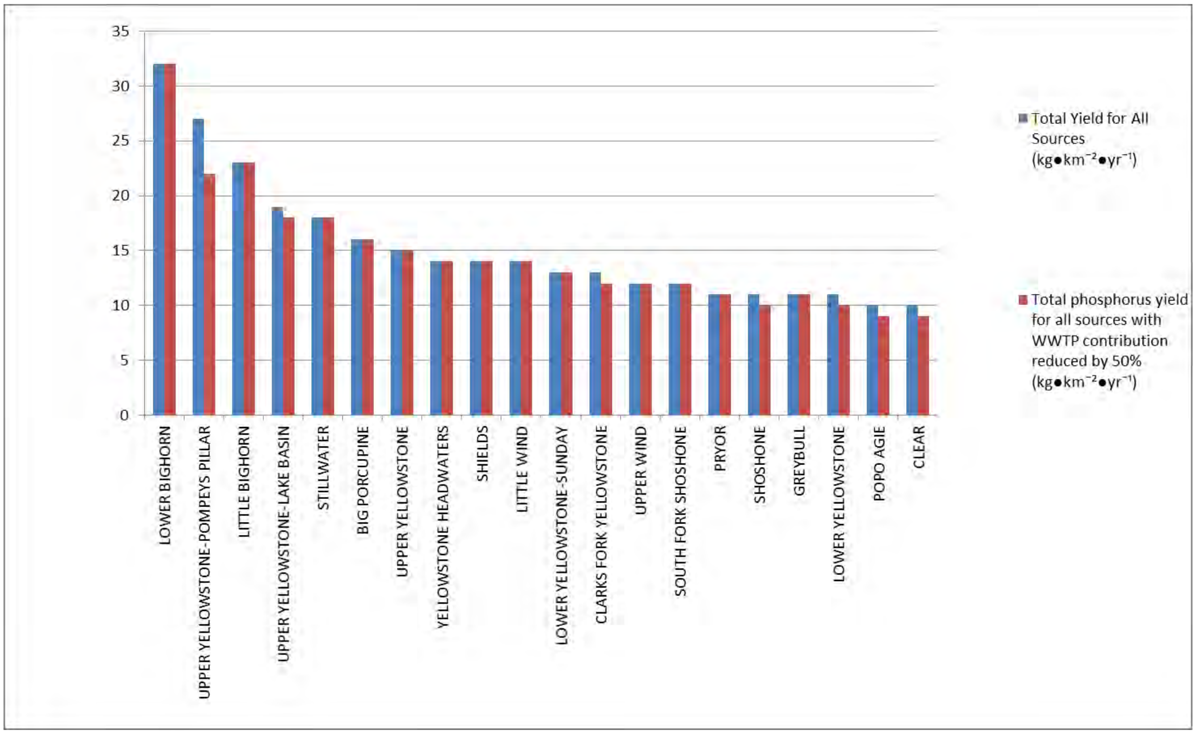


Figure 2-21 Changes in the predicted yields of delivered aggregated phosphorus yields by hydrologic units within the Yellowstone River Basin (in kilograms per square kilometer per year) after decreasing inputs from WWTPs by fifty percent.

2.1.5 Trace Element

Trace Element concentrations generally were within guidelines in water samples for sites in the Yellowstone River Basin with a few exceptions. On the Yellowstone River, median concentrations of dissolved arsenic of 21 micrograms per liter (µg/L) at Corwin Springs and 10.5 µg/L at Billings exceeded the drinking-water Maximum Contaminant Level (MCL) of 10 µg/L (MDEQ 2012). For comparison, the median concentration of arsenic at Sidney was 3.25 µg/L in 2014. Seventy-eight percent of samples at Corwin Springs exceeded the MCL while at Billings, 60 percent were above the drinking water MCL. Ingestion of elevated arsenic has been shown to cause skin and circulatory illnesses and is linked to an increased risk of cancer. Geothermal waters from Yellowstone National Park are a significant source of arsenic in the Yellowstone River (Miller et al., 2004).

Selenium is another potentially toxic trace element that is often found in waters draining Cretaceous sedimentary rock (Zelt et al., 1999) Selenium is often mobilized by irrigation of alkaline soils and has been linked to a number of reproductive disorders. Selenium concentrations were low in the Yellowstone River water samples, however the Powder River samples had concentrations near the Montana aquatic life chronic criterion of 5 µg/L. Elevated values may be problematic as selenium can be bioaccumulated in the food chain to toxic levels in organisms causing reproductive problems.

Peterson et al. (2000) reports that during July to September 1998, 44 trace elements were analyzed in streambed sediment at 24 sites throughout the Yellowstone River basin. Median concentrations of chromium, copper, and lead were highest at the sites located in Tertiary and Cretaceous time-period volcanic rocks. Median arsenic concentration was highest at the sites located in the Cretaceous sedimentary rocks. Median values for copper, arsenic, and lead were significantly less than similar values reported for the South Platte River basin and the Upper Colorado River basin. Values reported in this study are shown in Table 2-4. The Yellowstone River analytic results were within the range of historical observations (1974-1979) reported for the respective geologic time periods within the region.

Guidelines developed by the Canadian Council of Minister of the Environment (2000) (available on the internet at: http://www.ec.gc.ca/ceqg-rcqe/English/Pdf/sediment_protocol.pdf) are used as a reference since there are no criteria for trace elements in sediment in Montana. The Canadian guidelines provide two levels of effect: a lower level, referred to as an interim sediment quality guideline (ISQG), and an upper value, referred to as the probable effect level (PEL). Concentrations above the PEL are expected to be frequently associated with adverse biological effects on aquatic life, while effects are occasionally observed between the ISQG and PEL levels. The highest arsenic concentration (41 µg/g) in the Yellowstone River basin occurred at Corwin Springs, which was the only site that exceeded the PEL of 17 micrograms per gram (µg/g). Chromium exceeded the ISQG of 37.3 µg/g at all 24 sites. The PEL of 90 µg/g was exceeded at nine sites, with a maximum concentration of 180 µg/g at Corwin Springs. The Billings site was the only other Yellowstone River mainstem site to exceed the PEL for chromium, with a value of 100 µg/g. Copper exceeded the ISQG of 35.7 µg/g at eight sites, including at Corwin Springs and Billings, along with the Clarks Fork Yellowstone River. None of the samples approached the PEL of 197 µg/g. Lead exceeded the ISQG of 35 µg/g at two sites, neither of which were on the mainstem of the Yellowstone River.

Table 2-4
Bold face numbers designate sediment samples in which a trace element exceeded the respective PEL. [1/]Source: Peterson and Boughton 2000. Values are in micrograms per gram (µg/g) dry weight.

Site Name	Arsenic	Chromium	Copper	Lead
Corwin Springs	**41**	**180**	**39**	21
Billings	15	**100**	36	29
Forsyth	11	**93**	23	18
Sidney	8.8	**74**	20	17

The Yellowstone River NAWQA Program also collected fish tissue and bed sediment samples in 1998 at five sites in the basin for the purpose of mercury analysis. One set of Yellowstone River tissue and sediment samples was obtained at Sidney. As reported by Miller et al. (2000) the sauger collected at Sidney contained 1.29 µg/g dry weight mercury which is about one third the concentration of mercury in samples taken in the Bighorn River, Bighorn Lake, or the Shoshone River. The Sidney concentration is similar to the median and mean concentrations of mercury in a national study of chemical residues in fish tissue (USEPA, 1992 cited in Miller et al., 2000). Bed sediment collected at Sidney contained 18.7 nanograms/gram (ng/g) of mercury (Peterson and Boughton, 2000). Methyl-mercury, the most toxic form of mercury, was not detectable in the Sidney sediment sample. A sediment sample from the Tongue River at the Montana state line had 11 percent of the total mercury in the methyl form. The Montana Department of Public Health and Human Services (MDPHHS) has a fish consumption advisory of 1 part per million (ppm) equivalent to 1 mg/l methyl mercury in fish tissue according to its 2014 Compliance Policy Guide (Sec. 540.600). Consumption of methyl mercury can cause a variety of health problems in humans. Reduced fertilization of fish eggs has been noted in a South Dakota study (Selch et al., 2007) evaluating the impact of elevated methyl mercury levels in lakes. A three-year study is underway to determine the source of elevated levels of mercury in fish tissue in Bighorn Lake where concentrations were the third-highest measured in 520 fish sampled nationwide (French, 2014a).

Nonpoint and atmospheric sources are thought to be the greatest source of mercury in Tongue River Reservoir (Phillips et al., 1987 cited in Miller et al., 2000) which is nearby and likely is representative of mercury transport and residence in the basin. The Montana Department of Fish, Wildlife and Parks has issued mercury-related fish consumption advisories for multiple species in Tongue River Reservoir, Bighorn Lake, and Cooney Reservoir, and for channel catfish in the Yellowstone River near the Powder River (Montana Department of Fish, Wildlife and Parks, 2014).

Concentrations of cadmium, chromium, manganese, molybdenum, and vanadium were elevated in fish tissue taken from headwaters drainages associated with natural mineralization and past mining (West Fork Mill Creek and Soda Butte Creek) but no issues were noted for fish tissue at the five Yellowstone River sites. No Yellowstone River fish tissue samples exceeded selenium threshold concentrations associated with injurious effects to aquatic life (Peterson and Boughton, 2000).

2.1.6 Pesticides

The Yellowstone NAWQA program also investigated and evaluated the occurrence of man-made organic pesticides in the basin during January 1999 to September 2001) and more recently in 2014. Peterson et al. (2004) found that at least one pesticide compound was detected in 87 percent of 136 surface-water samples collected at four sites on the Yellowstone River (Corwin Springs, Billings, Forsyth, and Sidney) and two sites on the Clarks Fork Yellowstone River and Bighorn Rivers. Pesticides were detected in 54 percent of samples at Billings compared to 95 percent of samples at Sidney. Billings had the least number of pesticides detected (7) while Sidney had the greatest (16) number detected. Pesticide concentrations generally were small in samples for the three Yellowstone River sites. Compared to other sites around the United States, the Yellowstone samples were in the lowest 25 percent of concentrations measured. Herbicides were more frequently detected than insecticides. Atrazine was the most commonly detected herbicide and was detected in 74.8 percent of the samples. The greatest pesticide concentration observed was for atrazine (0.328 µg/l). Concentrations of all compounds generally were smaller than 0.01 µg/l and substantially smaller than aquatic-life or human health criteria (for compounds with criteria established). Highly mobile pesticides were detected more frequently and in higher concentrations than less mobile pesticides. Pesticide concentrations were also related to seasonal variability (and are applied seasonally) with higher concentrations after runoff events , however some highly mobile pesticides such as atrazine was found in winter indicating that groundwater was likely a means of transport in addition to surface runoff.

The NAQWA study also tested for the presence of 27 organic pesticide compounds in bed sediment at the four Yellowstone River sites: Corwin Springs, Billings, Forsyth, and Sidney. Only two of the 27 compounds were detected and none at the Yellowstone River sediment sample sites. Trans-chlordane and a DDT derivative (p,p’-DDT) were detected in Goose Creek, a tributary to the Tongue River in Wyoming (Miller et al., 2000).

Sampling was also conducted to test for the presence of man-made organic compounds in fish tissue. Only one pesticide, DDT, was detected in fish tissue at the four mainstem sites on the Yellowstone River, Corwin Springs, Billings, Forsyth, and Sidney Peterson and Boughton, 2000) (**Error! Reference source not found.**). Sites on the Bighorn River and the Clarks Fork Yellowstone River of the Yellowstone tested positive for multiple organic compounds. The fact that DDT was also detected at elevated levels in cutthroat trout from Yellowstone Lake confirms that the source of the DDT is likely the spruce budworm spraying conducted in the upper watershed in 1957. Peterson and Boughton (2000) report that DDT levels have declined in fish tissue samples over the years since spraying took place.

Possible human health and aquatic life impacts associated with pesticides are related to the limited information available concerning the combined effect of multiple pesticides, even at very small concentrations in the environment, and the fact that many pesticides in use do not have established human health and aquatic life criteria.

2.1.7 Hydrocarbons

A number of semivolatile organic compounds (SVOCs) were detected in bed sediment at Yellowstone River sites during the 1998 NAWQA study of Yellowstone basin bed sediment (Peterson and Boughton, 2000). About 20 of the SVOCs described in the 2000 USGS report are known as polynuclear aromatic hydrocarbons or PAHs. Samples from Billings had about 13 compounds found above the detection limit and that represent maximum values for the compounds detected in the basin. The upper values probably reflect the urban/industrial nature of the Billings location as common sources of PAHs in aquatic systems are atmospheric deposition, municipal and industrial discharges, and urban sources. Concentrations of PAHs in Corwin Springs, Forsyth, and Sidney sediment samples were very low to none. Importantly, the concentrations of PAHs in the Billings samples were less than established criteria for protection of aquatic life.

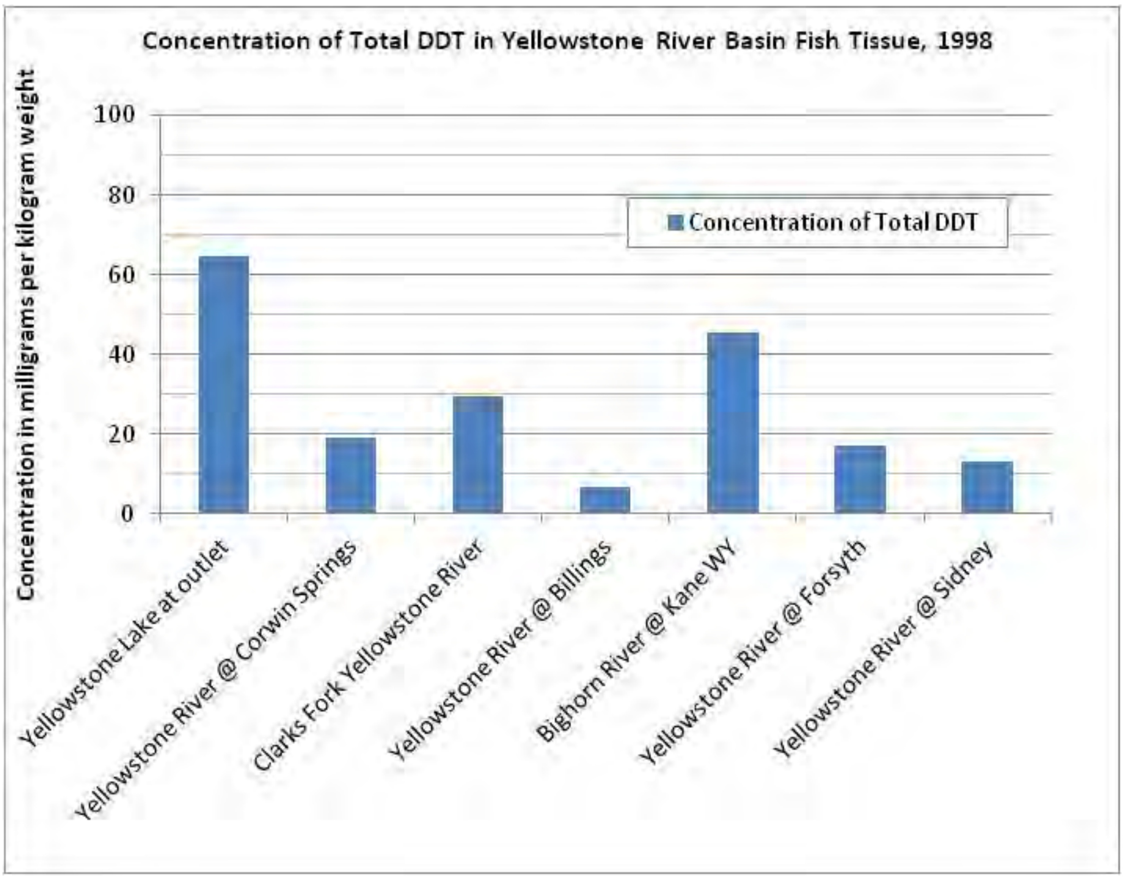


Figure 2-22 Concentration of total DDT in fish tissue at various locations in the Yellowstone River basin appears related to the proximity to Yellowstone National Park where DDT was used in the 1950s to control a spruce budworm outbreak.

Additionally, a number of SVOCs known as cresols, phenols, and phthalates were detected in Yellowstone River sediment samples. The Corwin Springs (Reach PC 3) sample contained six compounds, while the same number were detected in Billings (Reach B2) but at slightly higher concentrations. Forsyth and Sidney both had three compounds detected with concentrations not significantly different than Billings for those still present further down the river. The results indicate that the concentrations of SVOCs for the Yellowstone mainstem sites were below the normal method reporting limit (Peterson and Boughton 2000). Common sources of these compounds are combustion motor exhaust, petroleum refining (gasoline), and other manufacturing, although minute amounts can be due to natural sources (Howard 1989 cited in Peterson and Boughton 2000). Maximum concentrations of several of these SVOC compounds were found in the Little Bighorn River system at the state line.

Crude oil pipeline breaks in 2011 near Laurel and 2015 near Glendive resulted in the release of hydrocarbons directly into the Yellowstone River. Water sampling in both cases did not show harmful levels in the river water, although in the case of Glendive, benzene was detected in the water supply resulting in the shutdown of the community's water supply for several days.

2.2 Water Chemistry and Bed Sediment - AUID and Reach Summary

Table 2-5 presents a summary of water chemistry and bed sediment characteristics taken from detailed assessment reports for specific Yellowstone River assessment units (AUIDs) accessed through the Montana Department of Environmental Quality's Clean Water Act Information Center (CWAIC) online at http://deq.mt.gov/wqinfo/CWAIC/default.mcpx. The information was collected and edited further to reflect major points regarding Yellowstone River water-quality and bed sediment analysis and interpretation.

Table 2-5
Summary of water chemistry and bed sediment characteristics.

AUID	Yellowstone CES Reaches	Water Chemistry and Bed Sediment Summary for Yellowstone River AUIDs and CEA Reaches
MT43B001_011 Wyoming Border to YNP Boundary	PC 1	In 2003 nutrients were sampled at the Yellowstone Park border in the lower end of this segment. Ammonia and NO2+NO3 were elevated but most likely this is natural due to geothermic inputs from springs that naturally contain high nitrogen levels. Metals were also sampled at the site twice in 2003 but a limited number of parameters were analyzed. Copper exceeded the chronic and acute aquatic life standard. Lead exceeded the chronic aquatic life standard on the same day (5/30/03). On 9/15/03 both copper and lead were below detection limits but Arsenic exceeded the human health standard. A limited number of common ions were analyzed in 2003 and the ones analyzed had low values.
MT43B001_010 YNP Boundary to Reese Creek	PC1	The majority of the data is from the downstream USGS station at Corwin Springs. Water temperatures and DO were within appropriate ranges at the Corwin Springs station. Nutrients were sampled in 2003 at an upstream site at the upper boundary for this segment. Ammonia and NO2+NO3 were elevated but this is most likely natural due to geothermic inputs from springs that natural contain high levels. Metals were sampled at two DEQ sites in 2003. On 5/30/03 at both the upper and lower site copper exceeded the acute and the chronic aquatic life standard and lead exceeded the chronic aquatic life standard. On 9/15/03, Arsenic exceeded the human health standard at both sites. Sediment was sampled at the Corwin Springs station in 1998 and had exceeded severe effect levels for arsenic, chromium, and iron but the data may not reflect current conditions. At the downstream station at Corwin Springs the chlorophyll a was below guidance for contact recreation and aquatic life support. Fecal coliform and E. Coli concentrations also collected at the USGS site were below guidance.

AUID	Yellowstone CES Reaches	Water Chemistry and Bed Sediment Summary for Yellowstone River AUIDs and CEA Reaches
MT43B003_010 Reece Creek to Bridger Creek	PC2 to A7	USGS Stations @ Corwin Springs, Livingston, Springdale and Big Timber. Field measurements, nutrients, major ions, and suspended sediment were sampled during the NAWQA study at the USGS gaging station at Corwin Springs in 1999, 2000, and 2001, while bacteria were sampled in 2000 and 2001, and trace elements were sampled in 1999. Discharge, temperature, specific conductivity, suspended sediment sampled at designated sites. DEQ 5/30/03 Arsenic: 6 ug/L. Cadmium: <0.1 ug/L. Copper: 11 ug/L and exceeded the chronic and acute aquatic life standard. Lead: 5 ug/L and exceeded the chronic aquatic life standard. Mercury: <0.2 ug/L. 9/15/03: Mercury: <0.2 ug/L. Arsenic: 28ug/L and exceeded the human health standard. Cadmium:<0.1 ug/L. Copper: <1.0 ug/L. Lead: <1.0 ug/L. 5/30/03: Major ions sampled with no issues. Field Forms for sites on the Yellowstone River: 12/17/03: NO2+NO3: 0.25 mg/Lm TKN: 0.36 mg/L, Total P: 0.027 mg/L, Ammonia: 0.25 mg/L.
MT43F001_012 Bridger Creek to Laurel PWS	A8 to A17	Water-quality of common ions, nutrients, etc. in this reach appears to be good, both in recent samplings and older periods. Metals data are hard to evaluate because they are older and detection limits are an issue for data from that period. For this reason, the drinking water use was not assessed. Field measurements, nutrients, major ions, and suspended sediment were sampled during the NAWQA study at the USGS gaging station at Billings in 1999, 2000, and 2001, while bacteria were sampled in 2000 and 2001, pesticides were sampled in 1999, and trace elements were sampled in 1999. Nutrient data were compared to values set on the Clark Fork River (0.02 mg/L TP and 0.3 mg/L TN), and all recent data (2000 onward) were at or below these concentrations. Toxicity tests upstream of Laurel showed good water quality in the late 1980s and no toxicity issues. Study showed that recommended standards for TDS (500 mg/L) and sulfate (250 mg/L) were not exceeded in this reach of the Yellowstone.

AUID	Yellowstone CES Reaches	Water Chemistry and Bed Sediment Summary for Yellowstone River AUIDs and CEA Reaches
MT43F001_011 Laurel PWS to Billings PWS	A18 to B2	2012 Cycle: Water and sediment samples were collected as a result of the of the Silvertip Pipeline break. Sediment samples showed elevated concentrations of both inorganic and organic compounds. However the water chemistry samples were all below water-quality standards with the majority of the samples being non-detects. Sediment sampling occurred as a result of the Silvertip Pipeline break. Elevated concentrations of both organics and inorganics were observed when compared to the NOAA Screening Reference Tables. The decline in summer soluble N, along with elevated benthic algae density, suggests soluble N is a likely pollutant in this reach. A detailed study of TDS levels along the Yellowstone River showed, in the 1970s, that TDS did not ever exceed 500 mg/L at Billings. This TDS concentration is generally considered acceptable for public water supply sources.

AUID	Yellowstone CES Reaches	Water Chemistry and Bed Sediment Summary for Yellowstone River AUIDs and CEA Reaches
MT43F001_010 Billings PWS to Huntley Div. Dam	B3 to B4	USGS: Concentrations of chromium in bed-sediment samples from this reach exceeded the Canadian probable effects level (PEL) for protection of aquatic life, and arsenic was very close to exceeding. DDT and its breakdown product (p, p'-DDE) were detected in fish flesh collected from this reach. This was likely due to historic use of this compound in the drainage. Other, more recently used organic compounds were not detected in fish from this reach. Arsenic appears to be the only trace element that exceeded state surface water-quality standards. Long-term data was available for sulfate and chlorides: Sulfates demonstrate, between 1963 and 2001, a very slight declining trend with an average of a 66 mg SO4/L and a max. of 170 mg/L. National drinking water recommendations are 250 mg SO4/L or less, so acceptable. Chloride dataset similar, shows little change over time (slight possible increase) with a mean of 6 and max of 14 mg Cl/L. EC (a good general measure of all salts) shows a mean (1963-2007) of 355 µS/cm and a weak declining trend. Overall, sulfate and chloride well below recommended drinking water-quality standards. Data indicate an essentially static long-term condition for salinity/TDS/chlorides. Average suspended sediment is 198 mg/L (1973-2001), trend appears static or declining (log scale) over this time period, with large values scattered throughout dataset. Vast majority of data values, both in the past and recently, fall between 5-1000 mg/L. DO is difficult to judge relative to MT standard since comparison to natural instantaneous DO minimum for a B3 stream (5 mg/L) was exceeded during the early morning hours of August 25th. These data are consistent with the biological indicators that show heavy eutrophication of the river in this unit. 2010: Summertime diel dissolved oxygen data showed exceedences of the acute aquatic life standard for both (1) total dissolved gas (TDG) and (2) the minimum daily dissolved oxygen (5 mg DO/L). The TDG standard was exceeded by large increases in DO alone; these increases were themselves driven by eutrophication. However, ammonia samples collected during different months over several years were all well below toxicity thresholds. Arsenic exceeded the human health standard (10 ug/L) quite consistently, but is very likely natural from the geothermal sources of the river. No indication of problems with TDS/salinity/chloride, either in absolute concentrations or in long-term trends. No exceedences of E.coli standards noted. Physical and chemical data support the biological data (detailed above) which indicate eutrophication problems in this middle reach of the river. Organics were not found in detectable concentrations in fish flesh (6 suckers were collected) in the reach, except for DDT and its breakdown product, which is evidently present from historic DDT use in the basin. 2012: Water and sediment samples were collected as a result of the of the Silvertip Pipeline break. Sediment samples showed elevated concentrations of both inorganic and organic compounds. However the water chemistry samples were all below water-quality standards with the majority of the samples being non-detects.

AUID	Yellowstone CES Reaches	Water Chemistry and Bed Sediment Summary for Yellowstone River AUIDs and CEA Reaches
MT43Q001_011 Huntley Div. Dam to Bighorn River	B5 to B12	2011. Water and sediment sampled post-Silvertip Pipeline spill. None of the samples exceeded water-quality standards with the majority of the samples being non-detects. Oil residue on channel banks and mid-channel islands cleaned up for this assessment unit. In general, up-to-date water chemistry data is lacking. The only recent water chemistry data for this reach was nutrient data from 2003. Other water chemistry data including metals were available only from 1970-1981. DEQ sampled nutrients at three sites in 2003: Huntley, Pompey's Pillar, and Custer.
MT42K001_020 Bighorn River to Cartersville Div. Dam	C1 to C11	Field measurements, nutrients, trace elements, pesticides, major ions, and suspended sediment were sampled during the NAWQA study at the USGS gaging station at Forsyth in 1999, 2000, and 2000, while bacteria were sampled in 2000 and 2001. Very limited data written up for this assessment unit as a whole. Agriculture: TDS concentrations are moderate. Industrial: TSS concentrations are sometimes high but are lower than historical levels likely due to construction of Yellowtail Dam.
MT42K001_010 Cartersville Div. Dam to Powder River	C12 to C21	Most of the available water-quality data is older (mainly 1960s, 1970s, 1980s), although there is a cluster of more recent data around Miles City (USGS, etc.). Given the relatively long length of the reach (nearly 90 miles), and the fact that recent data are mainly clustered in one location, there is insufficient information to properly assess any beneficial use along this reach. Water-quality limitations noted due to ammonia, copper, lead, zinc, TDS, pH, and nitrate+nitrite due to habitat alteration, irrigated crop production, livestock grazing, municipal wastewater discharge, development, unknown and natural sources. Maximum water temperature between 2004 and 2012 at Miles City was 29.5 ^{0}C in 2006 (August 8th). Specific conductance for the same period ranged from 765 to 200 uS/cm. Discharge on August 8, 2006 was 3,630 cfs which represents the 6th percentile for low flow during the period of record. Specific conductivity on this date was 600 uS/cm.
42M001_012 Powder River to Lower Yellowstone Div. Dam	D1 to D9	Agriculture: TDS concentrations in this reach are relatively low. Industrial: Salinity concentrations in this reach are relatively low. TSS concentrations tend to be high but are lower than historical levels due construction of Yellowtail Dam. Scant long-term nutrient or metals data available, but no problems noted. 2015: Crude oil spill resulting from breach of Poplar Pipeline about six miles above Glendive resulted in detection of VOCs (including benzene) in river water and in Glendive water supply.

MT42M001_011 Lower Yellowstone Div. Dam to Border	D9 to D13	From 1999-2001, the median water temperature was 15 C; median pH value = 8.4; median SC at 25 C = ~700 uS/cm; median DO = 9.3 mg/L; median suspended-sediment concentration = ~200 mg/L. Between 2000-01, 12 fecal coliform and 11 E. coli samples were collected near Sidney; none exceeded recommended health or contact/recreation limits. From 2001-2003, pH ranged from 7.4 - 8.7; DO ranged from 6.3 - 14.5 mg/L; SC ranged from 202 - 1920 μS/cm; Suspended Sediment concentration ranged from 20 - 3320 mg/L; TDS ranged from 200 - 656 mg/L; Water temperature ranged from 0-26.7 C. About 30 percent of the annual sediment load in the Yellowstone near Sidney is from the Powder River Basin, in spite of the fact it accounts for <5 percent of the annual streamflow there. Metal concentrations exceeded state water-quality standards in a few instances in 2003 at Sidney: copper exceeded both the acute and chronic life standards (by 7 and 58 percent, respectively); lead exceeded the chronic life standard by 233 percent. For the site near Sidney, Arsenic concentrations in streambed sediment exceeded the ISQG by 49 percent, Chromium exceeded the ISQG by 98 percent; neither exceeded the PEL. From 1999-2001, ammonia concentrations did not exceed any of the aquatic-life criteria. The median total phosphorus concentration was 50 percent higher than the desired level for preventing nuisance plant growth in streams, but these concentrations are likely the result of natural conditions. The ecoregion criterion for total nitrogen on the Northwestern Great Plains = 0.38 mg/L; median value at the Sidney site = 0.7 mg/L. About 95 percent of the samples at the Sidney site had a pesticide detected in them (the highest frequency in the study area); >86 percent of the samples had two or more pesticides detected. The number of different pesticides detected in samples was highest at this site (16 different pesticide compounds were detected); it also had the highest number of different herbicides detected (11). Concentrations of pesticides were substantially (generally an order of magnitude or more) smaller than drinking-water criteria for human health in all samples. Concentrations of pesticides were also smaller than aquatic life criteria. However, criteria have not been established for 20 of the pesticides and breakdown products analyzed for this study, and human-health and aquatic-life criteria generally are established based on toxicity tests conducted for a single compound. But most of these samples contained two or more compounds, and the aquatic life criteria do not account for the potential combined effects of pesticides and other stressors, such as temperature fluctuations. Forty-four trace elements were analyzed in streambed sediment at sites in the Yellowstone River Basin; concentrations of four of these elements were of particular concern due to their elevated concentrations at many sites throughout the basin and their toxicity in the aquatic ecosystem. For the site near Sidney: Arsenic = 8.8 ug/g (exceeded the ISQG of 5.9 ug/g, but less than the PEL of 17 ug/g); Chromium = 74 ug/g (exceeded the ISQG of 37.3 ug/g, but less than the PEL of 90 ug/g. Copper = 20, (did not exceed the ISQG of 35.7 ug/g); Lead = 17 ug/g (did not exceed the ISQG of 35 ug/g). Mercury concentrations in fish-muscle and bed-sediment samples collected in cooperation with the National Mercury Project. Total Hg in Fish (2 sauger): Dry weight (ug/g) = 1.29, Wet weight (ug/g) = 0.250; Total Hg (ng/g) in Sediment: 18.7. The mercury concentrations in

the sauger from this site were similar to the median and mean concentrations of mercury from a national study of chemical residues in fish.

Nutrient concentrations in the Yellowstone River near Sidney, August 2000: Total Nitrogen = 0.4 mg/L, Total Phosphorus = 0.037 mg/L.

Ammonia concentrations did not exceed any of the aquatic life criteria. The median total phosphorus concentration was 0.15 mg/L, higher than the desired goal of 0.10 mg/L for preventing nuisance plant growth in streams. However, total phosphorus concentrations at this site are likely the result of natural conditions. The ecoregion criterion for total nitrogen (0.38 mg/L for the Northwestern Great Plains) was exceeded by the 10th-percentile concentrations for the Sidney site; median value was 0.7 mg/L. None of the monthly samples for arsenic sampled during 2014 exceeded the human health standard.

Metals concentrations only exceeded state water-quality standards in a few instances: Copper = 13.3 µg/L on 6/17/03, exceeding both acute and chronic life standards (12.4 µg/L, and 8.4 µg/L, respectively); Lead = 8.98 µg/L on 6/17/03, exceeding the chronic life standard of 2.7 µg/L

A thermograph was located on the Yellowstone River at Sidney, and the USGS calculated the mean daily temperatures for all but a few months of 1975 for this site. Average annual temperature was 8.59 ^{0}C, annual range was 0-26.0 ^{0}C, average maximum temperature was 22.2 (July), # days of 0^{0}C maximum = 126, # days of 18 ^{0}C minimum = 58. Sidney has a wide temperature variance and its climate is quite extreme compared to the other three locations considered.

About 30 percent of the annual sediment load in the Yellowstone near Sidney is from the Powder River Basin, in spite of the fact it accounts for <5 percent of the annual streamflow there.

Data were available from the site near Sidney for 1959-2003; data from 2001-03 were considered here. pH ranged from 7.4 - 8.7; DO ranged from 6.3 - 14.5 mg/L; SC ranged from 202 - 1920 µS/cm; Suspended Sediment concentration ranged from 20 – 3320 mg/L; TDS ranged from 200 - 656 mg/L; Water temperature ranged from 0-26.7 C; Turbidity ranged from 3 - 450 NTU, but the two extremes were reported on the same day in 2001, and so are suspect. E. coli ranged from 2 - 53 colonies/100 mL; Fecal coliform ranged from 2 - 113 colonies/100 mL.

Between 2000-01, 12 fecal coliform and 11 E. coli samples were collected near Sidney; none exceeded recommended health or contact/recreation limits. The median water temperature was 15 ^{0}C; the median pH value was 8.4; median SC at 25 C was ~700; median DO was 9.3 mg/L; median suspended sediment concentration was ~200 mg/L. uS/cm

Maximum water temperature for 2002 at Sidney was 29 ^{0}C. Maximum water temperature at Sidney between 2004 and 2014 was 27.5 ^{0}C. pH between 2004 and 2014 ranged from 7.6 to 8.8 ^{0}C.

Between 2004 and 2014, EC ranged from 255 to 1030 microsiemens per centimeter. Average was 625 uS/cm. Shows moderate correlation to discharge. Sulfate concentration ranged from 46 to 347

AUID	Yellowstone CES Reaches	Water Chemistry and Bed Sediment Summary for Yellowstone River AUIDs and CEA Reaches
		mg/l during the same time period. Fifteen percent of the 88 analytic results exceeded the secondary MCL of 250 mg/l.
ND-1010000-001-S_00	D14-16	No data available. Considered fully supporting for some beneficial uses. Has not been listed or impairments suggested to warrant any further targeted assessment (Olson pers. communication 2014). Oilfield wastewater spill in 2006 into Charbonneau Creek (tributary) caused impacts from brine on aquatic life and livestock use in Charbonneau Creek. Impact on Yellowstone water quality not known.

2.3 Physical Properties

2.3.1 Water Temperature

Water Temperature is an important characteristic of surface water in streams, rivers, and lakes because it can affect aquatic organisms in multiple ways. As such, water temperature is considered a pollutant under the Clean Water Act. Montana and North Dakota have established water temperature criteria and standards addressing water-quality to support aquatic life uses of water. Water temperature standards are based on the relative water-use classification of the Yellowstone River segment (17.30.611 MCA) which specifies the rate and extent of allowable water temperature change. Dissolved oxygen, required by aquatic organisms, decreases as water temperature increases. Water temperature also affects the rate of chemical reactions, cues many aquatic life cycle processes, creates stratification layers, and influences aquatic species composition and distribution (USGS, 2015). The sun's energy largely influences water temperature although water temperature is also affected by precipitation, surface runoff, groundwater, and tributary inputs), ambient air temperature, and heat exchanged through evaporation and condensation. Variation in water temperature is due to diurnal and seasonal fluctuation as well as location (elevation and latitude) and local characteristics (water depth, degree of shading, etc.).

Human activities such as discharge of treated wastewater (municipal or industrial effluent), agricultural runoff, forest harvesting (due to effects on shading), urban development that alters the characteristics and rate of stormwater runoff, and climate change may also affect water temperature (DEQ, 2012). Some pollutants also alter the physical characteristics of water such that more of the sun's energy is absorbed to raise water temperature. Suspended sediment and algal growth are two examples. Increased water temperature can kill or stress aquatic organisms making them more susceptible to other sources of disease or death. Montana Fish, Wildlife & Parks divides the Yellowstone River into three segments based in part on water temperature; the upper cold water section about 100-miles in length, a transitional cool-warm water middle section about 180 miles long, and the lower 300-mile-long warm-water section (MFWP, 2015). More information on impacts of temperature on aquatic organisms is presented in Appendix 8 Fisheries. During several warm, low-flow summers (2007 and 2012), MFWP and Yellowstone National Park restricted fishing in reaches of the upper Yellowstone River (PC17 thru A12 and the mainstem and tributaries in YNP) due to elevated water temperature (Skaar 2015) (Arnold 2015).

Following are charts (**Error! Reference source not found.** through **Error! Reference source not found.**) depicting summer water temperature over time at USGS fixed gaging stations on the Yellowstone River. Summer water temperatures are shown as this is generally the critical period for most aquatic species. In summary, water temperature increases in a downstream direction with the exception of Corwin Springs which is influenced by inflows from nearby geothermal springs. While some slight increase is noted in water temperatures over the time period depicted, there is not enough statistically comparable water temperature data available to evaluate trend over time or changes outside of normal distribution. Anecdotal reports of water temperature-related fish kills in the upper Yellowstone (Endicott MFWP personal communication) and warm water species moving further upstream (Opitz MFWP personal communication) provide justification for further study of water temperature and impacts in the future to help document trends and identify possible practices to remediate outside influences.

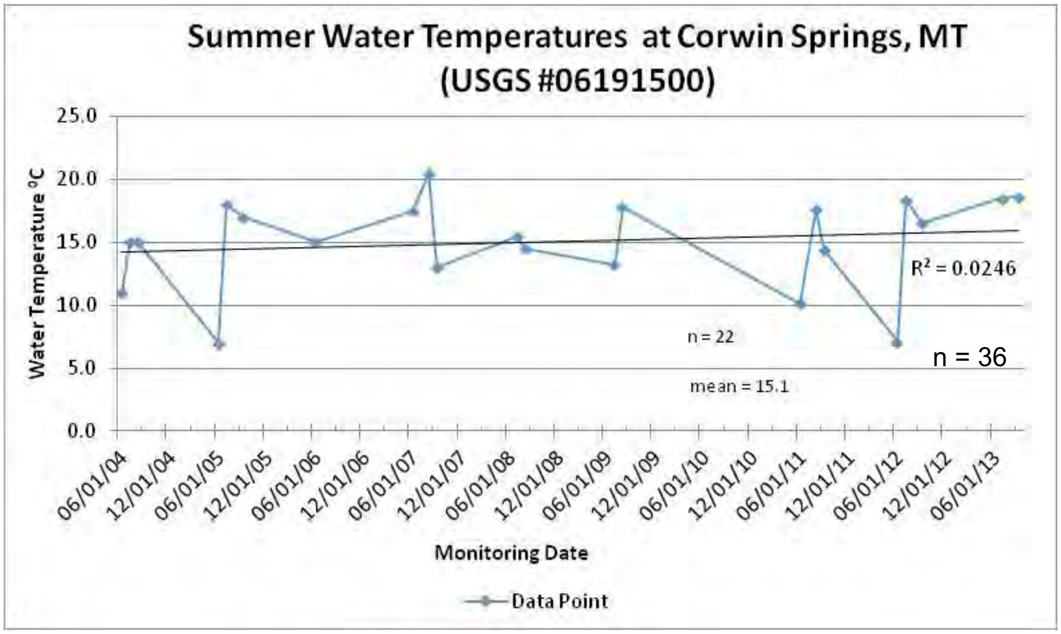


Figure 2-23 **Summer water temperatures at Corwin Springs, MT show a slight increasing trend over the nine year period of record but the difference is not statistically significant over this relatively short period.**

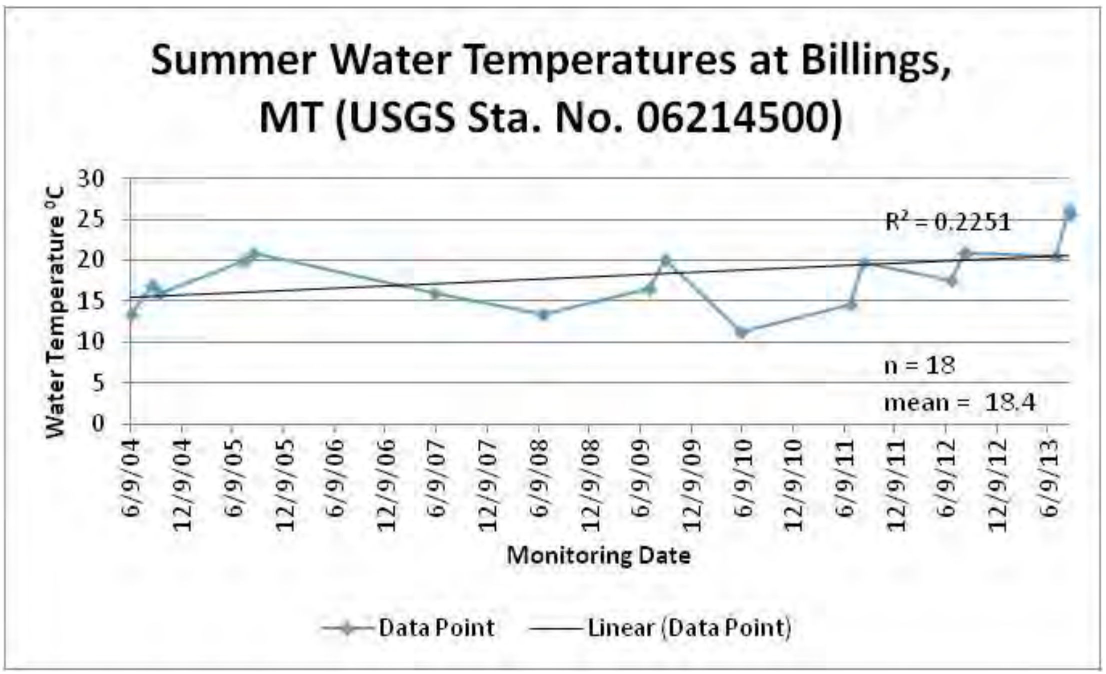


Figure 2-24 **Water temperatures for the Yellowstone River at Billings, MT show a weak increase over the nine-year period of record but again the trend is not statistically significant given the relative few measurements available. Mean water temperature is several degrees higher than at Livingston. Water temperatures indicate that the river is transitioning to a warm water system.**

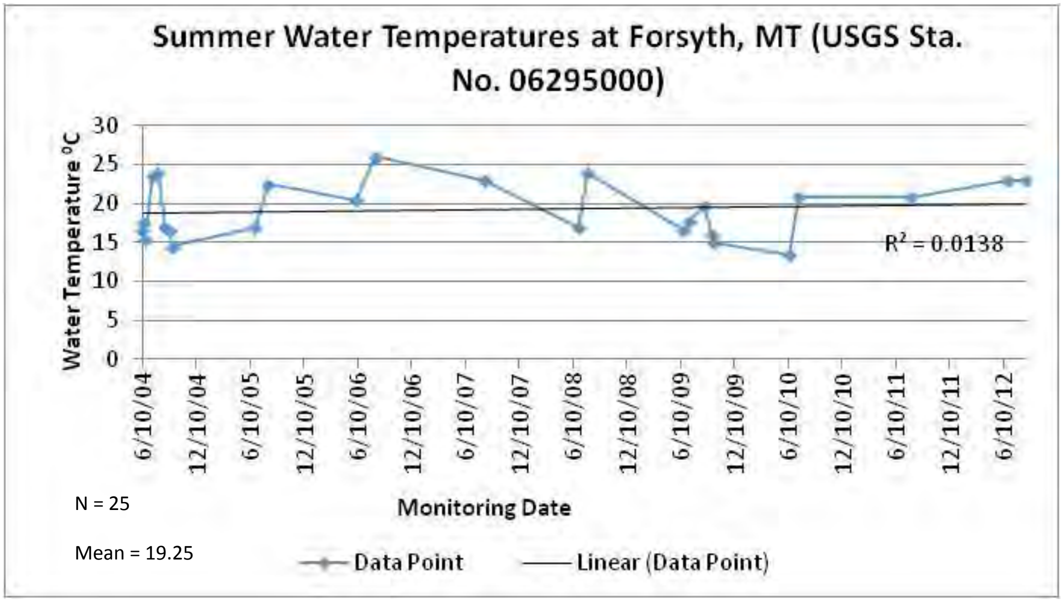


Figure 2-25 **Water temperature in the Yellowstone River at Forsyth does not show much change over time, but does indicate an increase in temperature going downstream.**

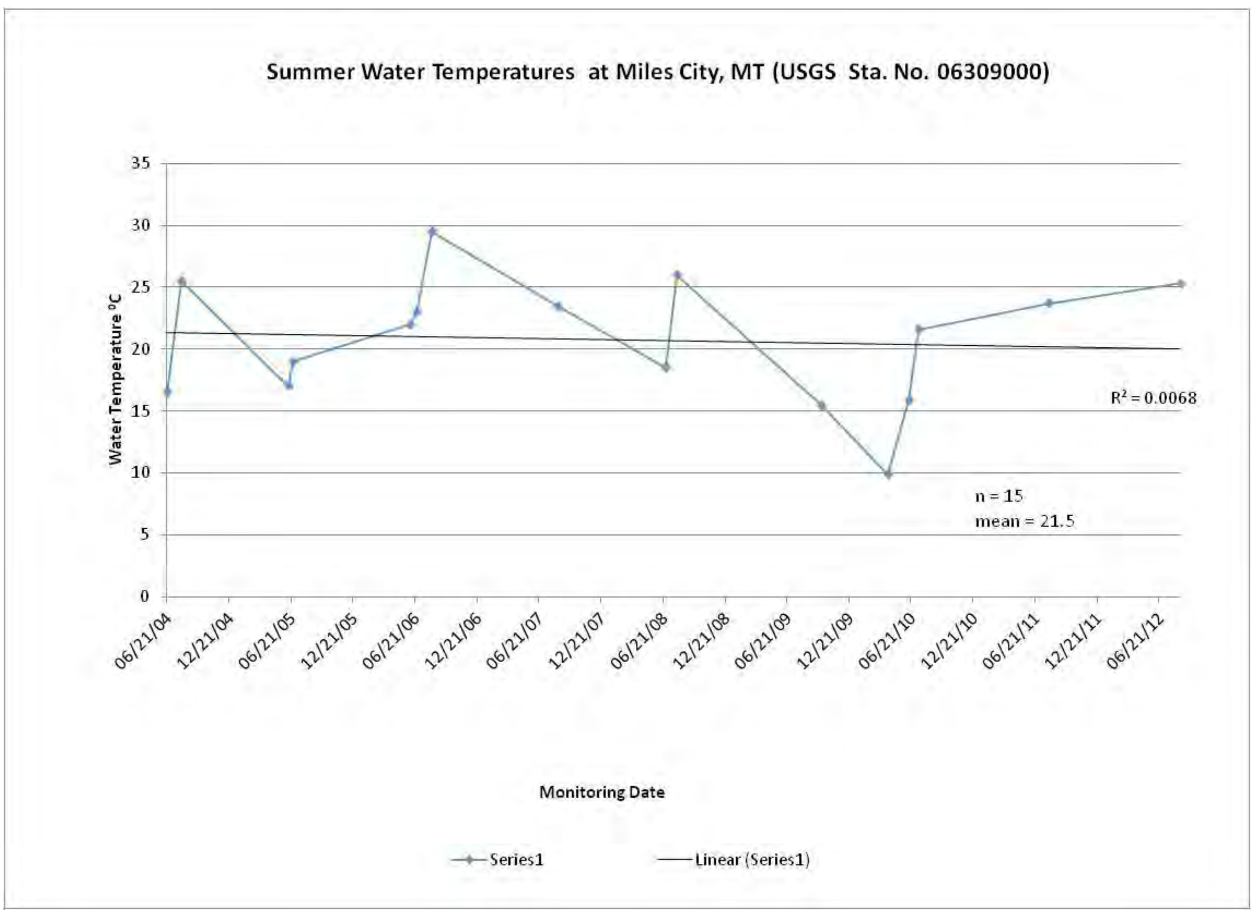


Figure 2-26 **Summer season water temperatures of the Yellowstone River at Glendive shows a good deal of variability between years but essentially no trend between 2004 and 2012.**

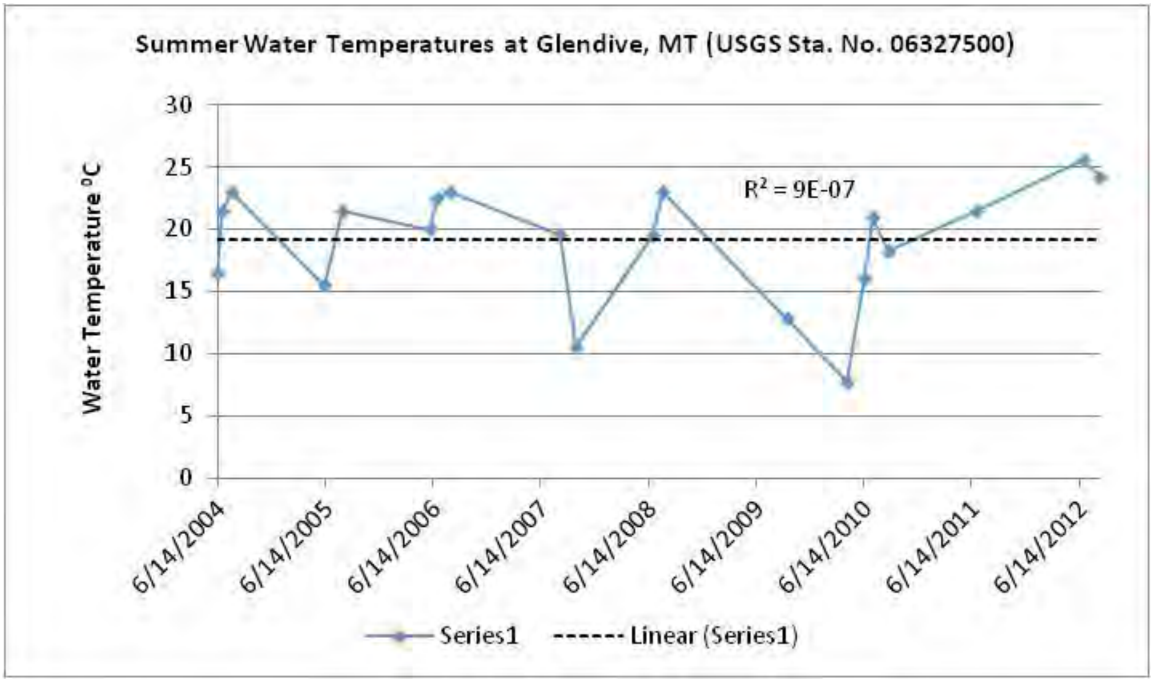


Figure 2-27 **Summer season water temperatures of the Yellowstone River at Miles City continue to increase by several degrees, but do not demonstrate a statistical trend for the relatively short period of record.**

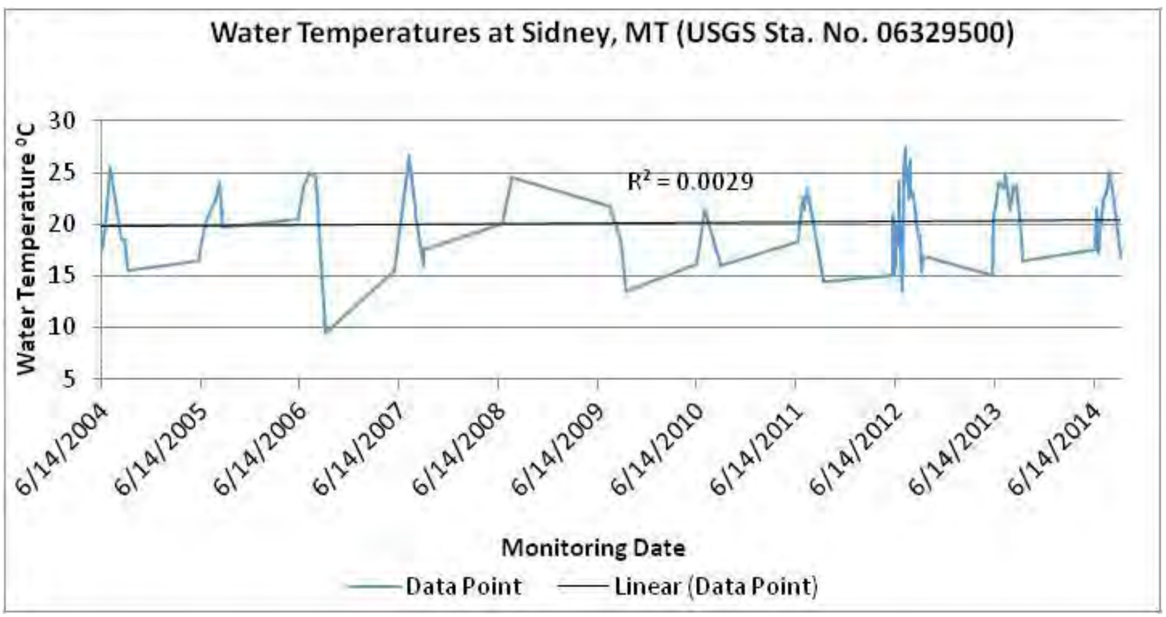


Figure 2-28 **Summer season water temperatures in the Yellowstone River at Sidney show summer variability but not much between years. No statistically valid trend is shown for the temperatures, although there is a slight uptick between 2004 and 2014.**

2.3.2 Suspended Sediment

Suspended Sediment is a natural product of erosion, transport, and deposition of sediment by moving water as well as the result of human activities that accelerate erosion. The product of this fluvial process is siltation. Siltation is a leading cause of water-quality impairment in the US and Montana, particularly in lakes where sediment deposition reduces water storage capacity and adds to eutrophication issues (MDEQ 2012b) (MDEQ 2014a). Excessive sediment can alter aquatic habitat and affect channel geometry. Diminished sediment delivery can also affect aquatic habitat and channel geometry through changes in aggradation or degradation. Suspended sediment can also deliver other water-quality pollutants such as nutrients, bacteria, pesticides, and trace elements. Reporting values are commonly expressed as concentration, load, and yield (MDEQ, 2012). Yield is the load per unit watershed area upstream from the measuring site.

Suspended sediment concentrations in the Yellowstone River are generally lower in the upper watershed draining mountainous terrain and increase going downriver where the river passes through and its tributaries drain the softer and more erosive sedimentary plains composed of Tertiary-age rocks. An exception is noted for a tributary, the Gardiner River, in Reach PC1, which drains sparsely vegetated and steep Cretaceous shales that experience sheet erosion and debris flows into the Gardiner River during runoff events (Wagner, 2006). The extent of rangeland and agricultural lands is positively correlated with suspended sediment concentrations. Channel scour erosion also contributes sediment (Lambing, 1986).

An Agricultural Research Service (ARS) study (Klimetz et al., 2009) of suspended sediment transport for stable streams in Ecoregion 43 (Northwestern Great Plains) determined that the lower Yellowstone drainage had a $Q_{1.5}$ mean annual suspended sediment yield of 1.53 tons/year while the upper Yellowstone River was 36.3 tons/year/km^2. For comparison, the same mean annual yield in the Powder River basin is 60 tons/year/km^2. The highest concentrations of suspended solids in prairie streams typically occurs during periods of precipitation runoff. Peak runoff in the Yellowstone River occurs in June (USGS, 2014). The Powder River Basin, which accounts for 5 percent of the annual streamflow at USGS Station No. 06329500 (Yellowstone River near Sidney, MT), contributes 30 percent of the annual sediment load to the Yellowstone River.

Irrigation practices in the Clarks Fork Yellowstone River Yellowstone River basin, along with natural factors, are recognized as a major source of suspended sediment at USGS Sta. No. 06214500 (Yellowstone River at Billings, MT) (Knapton and Bahls, 1993). The Clarks Fork Yellowstone River Yellowstone River had the maximum suspended sediment yield in the YRB (400 tons per square mile) during the 1999-2001 sampling effort for the NAWQA Program (Peterson et al., 2004). Irrigation practices contribute dissolved solids in the Clarks Fork Yellowstone River Yellowstone, Wind/Bighorn River, and Powder River Basins, while oil and gas development contributes dissolved solids in the Wind/Bighorn and Powder River Basins (Zelt et al., 1999).

At the Forsyth and Sidney USGS fixed stations (numbers 06191500, 06295000 and 06329500, respectively) where suspended sediment was measured long-term, there are strong correlations between suspended sediment concentrations, load, and discharge (**Error! Reference source not found.** through **Error! Reference source not found.**). Alterations to the hydrology and sediment content of the Bighorn River have demonstrably affected the water quality and ecology of the Yellowstone River below the confluence. More than 90 percent of the mean annual flow of the Bighorn River near its confluence with the Yellowstone is due to controlled releases from Bighorn Reservoir (Yellowtail Dam) (Zelt, et al. 1999) so this likely has an effect on suspended sediment delivery to the Yellowstone River. Unfortunately, the USGS did not collect suspended sediment data until around the time of the dam's closure. The US Army Corps of Engineers estimated sediment capture in the Reservoir was in the range of 3,200 acre-feet per year (2010).

The ARS study (Klimetz et al. 2009) rated the Bighorn drainage as having the fifth-highest mean annual suspended sediment yield of all rivers in Ecoregion 43 (Northwestern Great Plains). The majority of this sediment load is now stored in the Reservoir since closure of the dam in 1967. The estimated average annual sediment load (1999-2001) in the Bighorn River above the Reservoir is 2.4 million tons equivalent to about 55 percent of the total annual load in the Yellowstone at Sidney (Zelt, et al. 1999). Construction of impoundments on the Bighorn River have dropped average annual peak discharges on the Bighorn River from 20,199 cfs to 8,800 cfs (WAI, 2001). Operation of the dam has substantially reduced sediment delivery to the Yellowstone River. Prior to Yellowtail Dam's completion in 1966, annual sediment delivery at the mouth of the Bighorn River was estimated at 7.2 million tons. Based on 6 years of data, post-dam, sediment production has been estimated at 1.5 million tons per year, which represents an 80 percent decline (Silverman and Tomlinson, 1984). Hydrologic alterations and related impacts to turbidity and water temperature are known to affect movement and use of habitat by warm water fish (McMahon and Gardner 2001 cited in Yeager et al. 2005).

Despite the creation of an artificial, cold-water trout fishery below Yellowtail Dam, major negative impacts of the reservoir operation occur in the Yellowstone River and include a modified hydrologic regime (see Chapter 4.2 Hydrology), loss of side channels (Godaire, 2009), reduced sediment delivery and transport, and seasonal alterations of water temperature.

Turbidity, also a measurement indicative of suspended matter and water clarity, remained below 5 Normal Turbidity Units (NTUs) upstream of Forsyth during the 1999-2001 Yellowstone River NWQA sampling period; increasing going downstream to a maximum of 24 NTUs at Sidney, although the Powder River was dry during sampling (Miller et al. 2005) indicating that the channel is also a source of suspended sediment in the lower river.

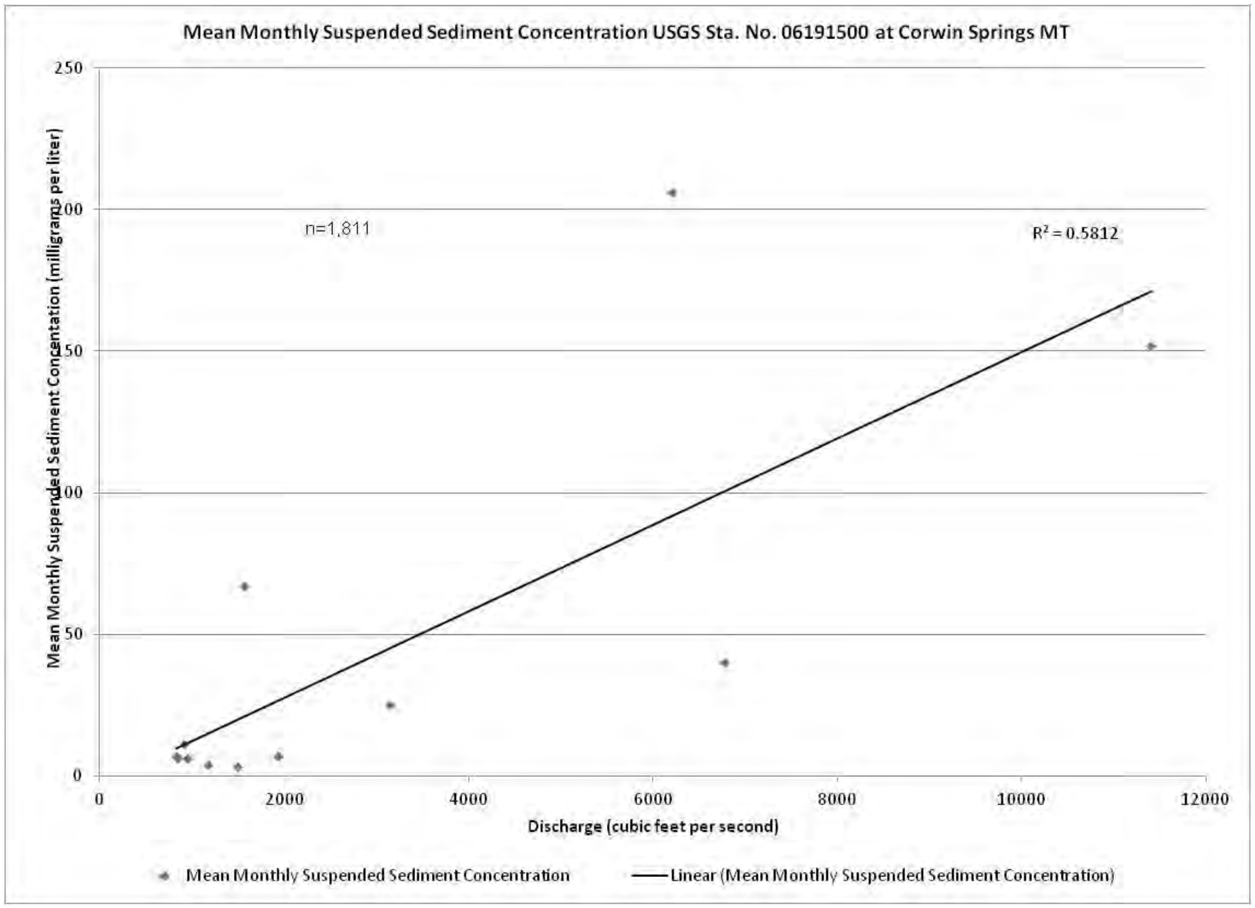


Figure 2-29 Sediment concentrations at Corwin Springs show only a moderate level of correlation to discharge, likely due to the disproportionately large influence of the Gardiner River on sediment production in this area.

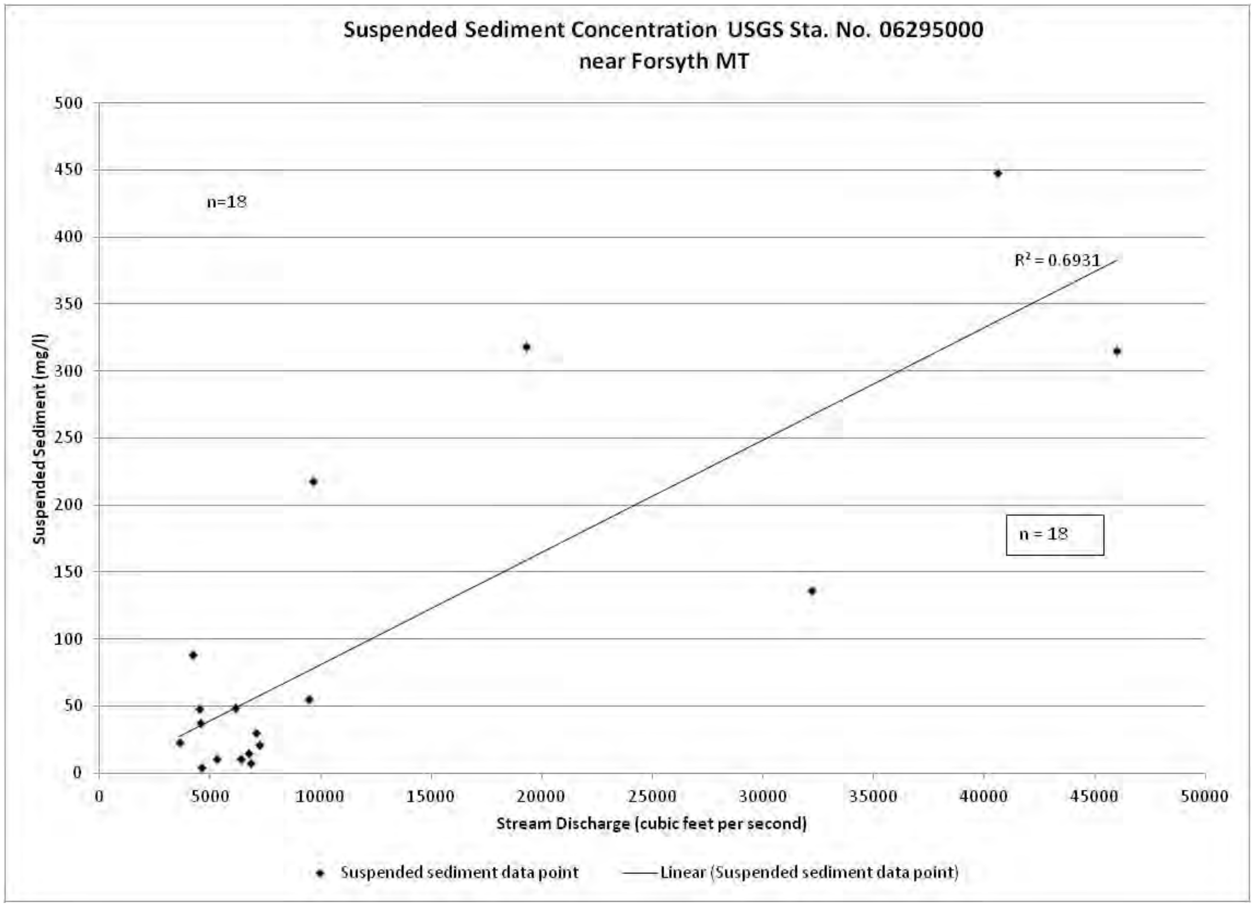


Figure 2-30 Suspended sediment concentrations in the Yellowstone River near Forsyth show a better correlation to discharge and are within expectations, if below historic levels following construction of Bighorn Reservoir which effectively cut off sediment delivered by the Bighorn River.

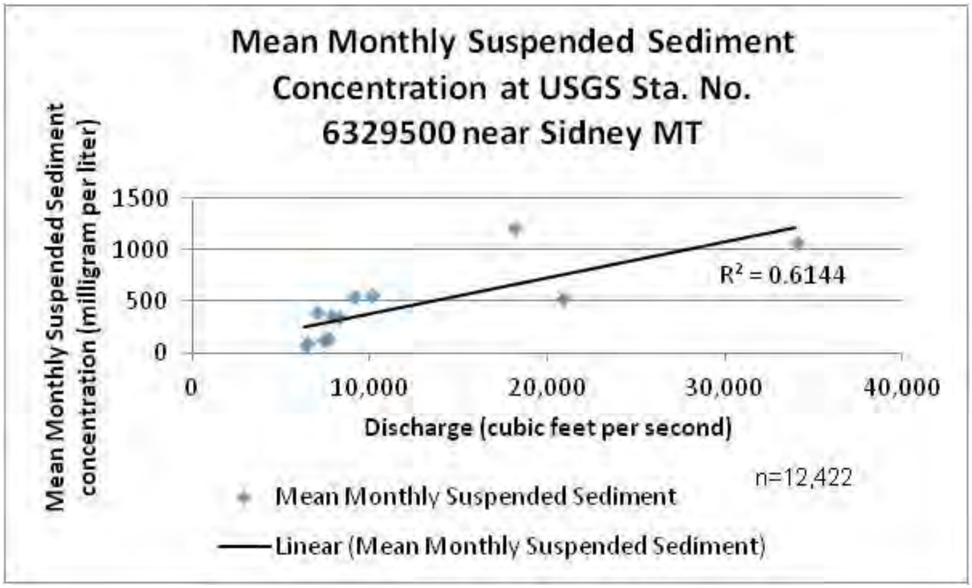


Figure 2-31 **The mean monthly sediment concentrations of the Yellowstone River near Sidney are fairly well correlated to discharge as evidence by the slope of the trend line in the chart above.**

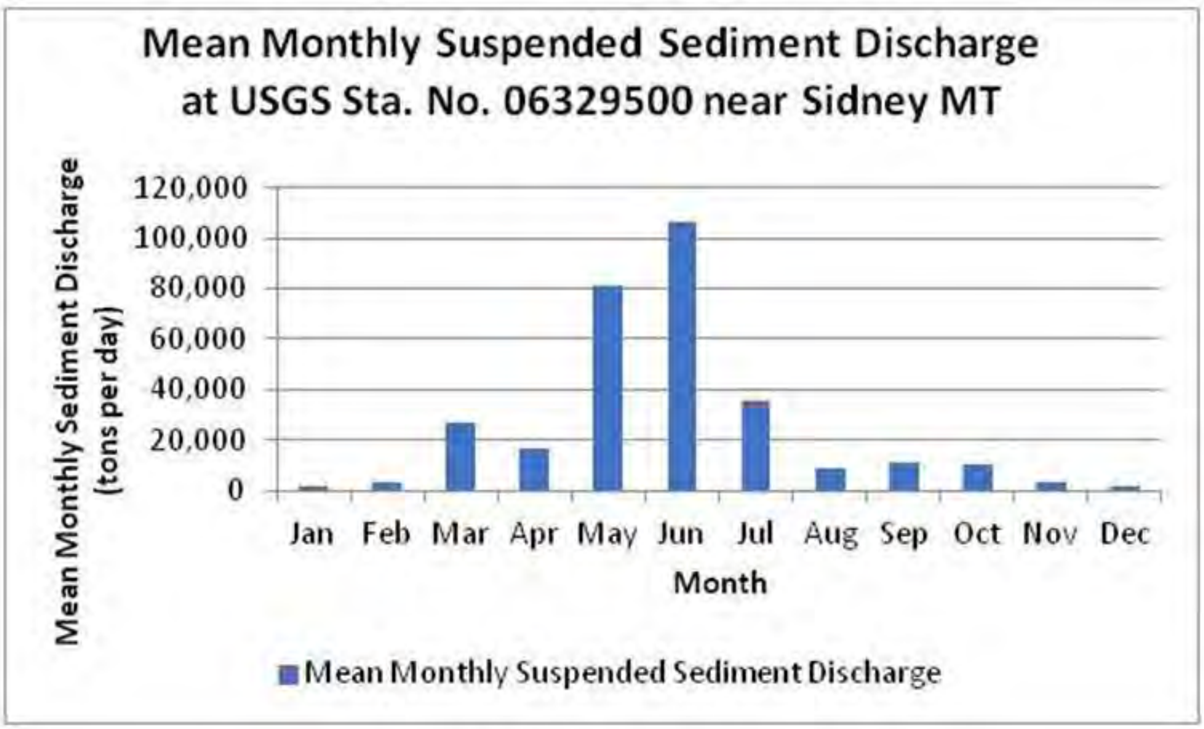


Figure 2-32 **The mean monthly sediment load carried by the Yellowstone River near Sidney peaks in June at maximum spring runoff and is influenced greatly by the load discharged by the Powder River. An estimated 30 percent of the annual sediment load at Sidney is contributed by the Powder River.**

2.4 Biologic Data

2.4.1 Periphyton

Algal biomass particularly that of periphyton chlorophyll *a*, is a key indicator of nutrient enrichment in the Yellowstone River. The state of Montana recognizes the threshold for algal biomass as an indicator of nuisance algal conditions and recreational use impairment as > 150 mg/m^2 (Flynn and Suplee, 2013). The NAWQA Program collected algal biomass samples during August 2000 at 11 sites along the Yellowstone River and at three tributary sites on the Clarks Fork Yellowstone River Yellowstone, Bighorn, and Tongue Rivers to determine their relationship to nutrient enrichment. Algal biomass was largest in the middle segments of the Yellowstone River near Billings and Forsyth (**Error! Reference source not found.**). Algal biomass was also high in the Clarks Fork Yellowstone River and Bighorn Rivers. The periphyton chlorophyll *a* concentrations in the upper segments of the Yellowstone River at Corwin Springs and Livingston were about 20–25 milligrams per square meter (mg/m^2). The maximum concentrations of chlorophyll *a* detected in the Yellowstone River were at Billings (800 mg/m^2) downstream from the confluence with the Clarks Fork Yellowstone River Yellowstone River, and at Forsyth (85 mg/m^2) downstream from the confluence of the Bighorn River. Chlorophyll *a* concentrations were less than 10 mg/m^2 in the lower segments of the river, from Miles City to Sidney. By comparison, chlorophyll *a* concentrations were 110 mg/m^2 in the Clarks Fork Yellowstone River Yellowstone River and 160 mg/m2 in the Bighorn River at the mouth (Peterson and Porter, 2002). Sources of nutrient enrichment at mainstem sites are thought to be natural (ammonia from geothermal springs) in the case of Corwin Springs and tributary inflows from natural, agricultural, and rural residential nutrient sources in the case of the Clarks Fork Yellowstone River Yellowstone and Bighorn River basins (Miller et al., 2004).

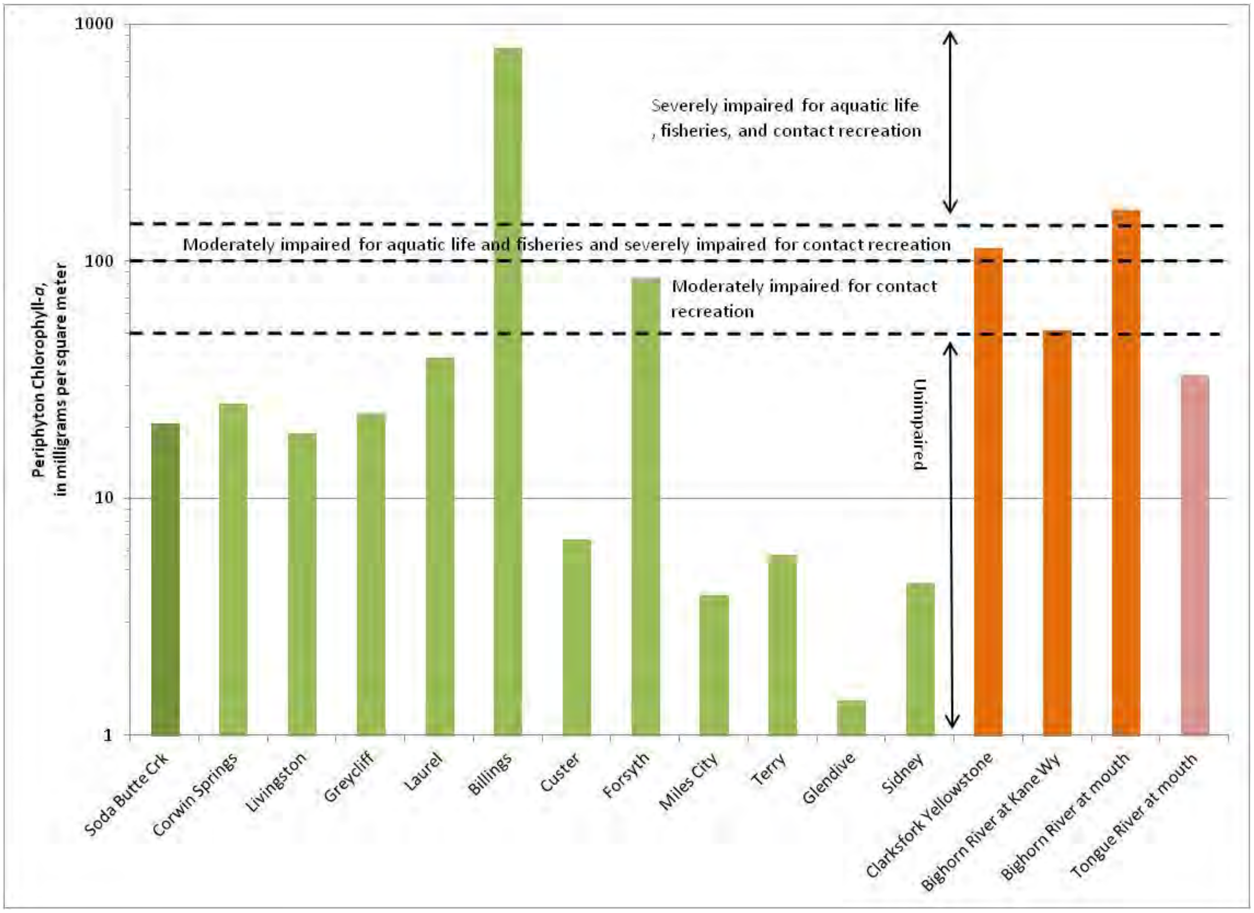


Figure 2-33 Periphyton chlorophyll-*a* concentrations from August 2000 in some Yellowstone basin streams exceeded criteria for the protection of beneficial uses according to criteria established by the Montana Department of Environmental Quality (2003). Yellowstone River sites in light green are upstream to downstream. Values reflect nutrient enrichment from natural, agricultural, and rural residential sources. Source: Peterson 2009.

The percent of eutrophic diatoms increased from very low levels at Corwin Springs to nearly 50 percent of the periphyton community in the middle segment of the Yellowstone River. The percentage of nitrogen autotrophs (species requiring dissolved inorganic nitrogen for optimal growth) increased from Corwin Springs to Custer and then decreased somewhat. Relatively large percentages of nitrogen autotrophs (species whose growth is enhanced by inorganic sources of nitrogen) were found in the Yellowstone River at Custer, Clarks Fork Yellowstone River Yellowstone River (at Edgar), and the mouth of the Bighorn River. Relatively large percentages of nitrogen heterotrophs (species whose growth is enhanced by organic sources of nitrogen) were found in the Yellowstone River at Sidney, Clarks Fork Yellowstone River Yellowstone River (at Edgar), and Bighorn River (at mouth). The relative abundance of algal species that require inorganic sources of nitrogen (autotrophs) corresponds closely with the abundance of eutrophic diatoms in the Yellowstone River and tributaries. Periphyton biomass was generally large at sites where nitrogen autotrophs were abundant. Periphyton biomass was generally low at sites where nitrogen fixers (primarily blue-green algae) were abundant. Excellent water clarity (low turbidity) also contributes to algal productivity upstream of Custer. In the lower Yellowstone River, turbidity likely limits algal growth as the system changes from a periphyton-dominated system to a phytoplankton-dominated system. Overall results of the report indicated that algal biomass and related measures of algal autoecology better reflect the trophic status of the Yellowstone River than do concentrations of dissolved or total nutrients (Peterson and Porter, 2002).

2.4.2 Macroalgae

The biomass of macroalgae (filamentous algae) results followed a similar pattern in that maximum values occurred in the Billings area (490 grams per square meter (g/m^2) and ranged from about 20 g/m^2 at Laurel and Forsyth to above 100 g/m^2 at Big Timber. Macroalgae biomass typically exceeded microalgae biomass by at least one order of magnitude at most sites and by two orders of magnitude at Miles City (Peterson and Porter, 2002).

2.4.3 Macroinvertebrates

Aquatic invertebrates (aquatic insects, worms, and snails) are commonly used to assess stream quality and reflect the impacts of eutrophication, alterations to long-term water chemistry, or physical disturbance of terrestrial and aquatic habitat (Barbour et al.,1999). Results are described in terms of various biotic indices calculated to reflect shifts in the abundance and composition of aquatic life communities relative to their tolerance of various disturbances. Results of the 1999-2001 NAWQA study of macroinvertebrates in the Yellowstone River indicated that mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisfly species (Tricoptera) also known as EPT were predominant in the upper segments of the Yellowstone River at Corwin Springs and Livingston, as well as in lower segments of the river from Miles City to Sidney (**Error! Reference source not found.**). Higher percentages of tolerant taxa in the middle segments of the river, however, indicate somewhat degraded conditions. Tolerant taxa dominated the invertebrate community of the Yellowstone River at Billings and Forsyth, sites immediately downstream from the two largest tributaries, the Clarks Fork Yellowstone River Yellowstone and Bighorn Rivers. Based on EPT abundance, the data indicated degraded conditions in the Clarks Fork Yellowstone River Yellowstone River, but relatively good conditions in mountain tributaries (Peterson et al., 2004; Peterson 2009).

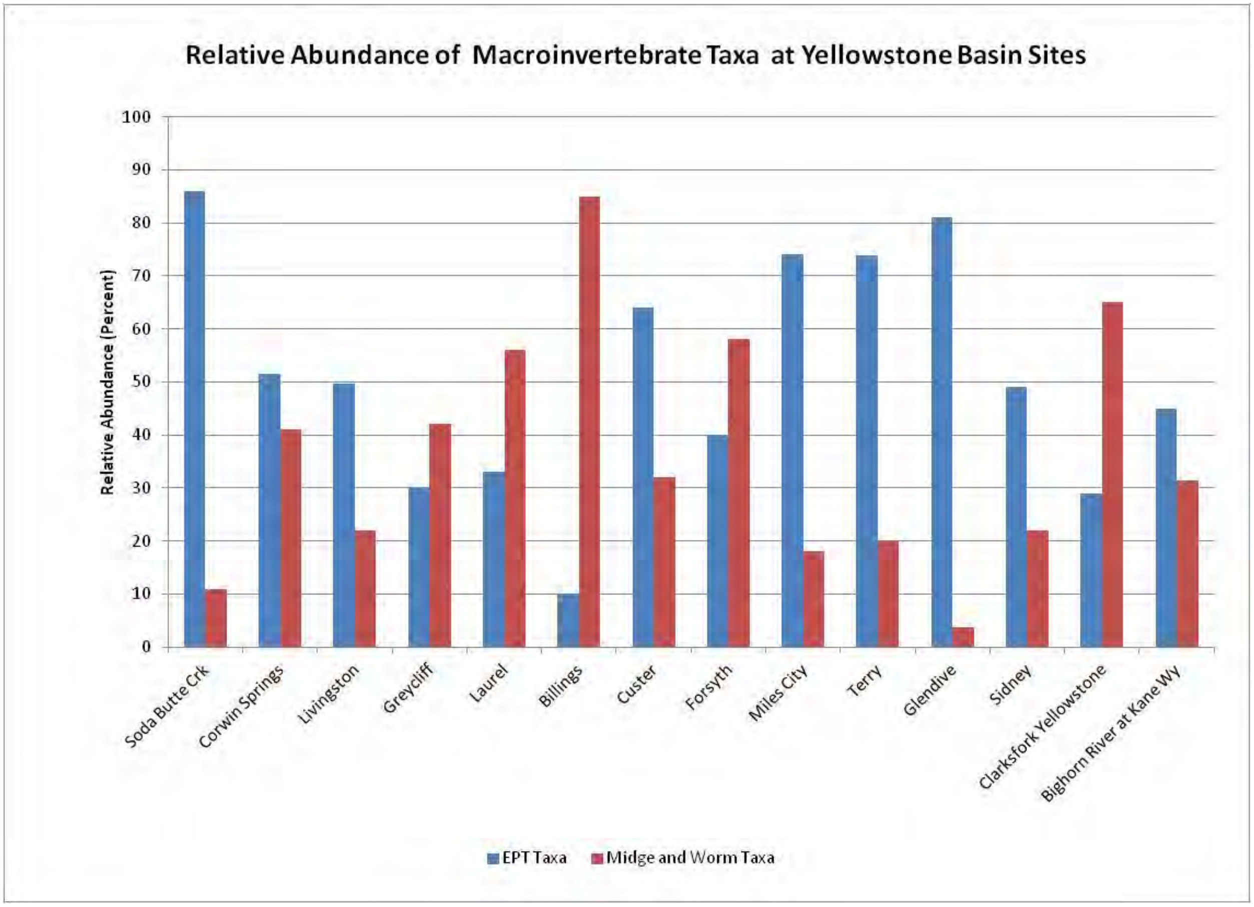


Figure 2-34 Pollution tolerant midges and worms dominate aquatic insect communities in the Clarks Fork Yellowstone River Yellowstone and at Yellowstone River sites below the confluence of the Yellowstone River and Bighorn Rivers. Greater percentages of pollution intolerant mayflies, stoneflies, and caddisflies (EPT) in the upper and lower Yellowstone River indicate better water quality and aquatic habitat. Lower percentages in the middle Yellowstone River indicate degraded conditions (Peterson et al., 2004).

2.4.4 Fish

Fish community composition and physical health are reflective of the quality of their environment similar to other forms of aquatic life (Barbour et al. 1999). The primary discussion of fish abundance and distribution and relationship to the CEA is contained Appendix 8. Results are presented here relative to water-quality considerations. Peterson and other's (2004) analysis of fish communities in the Yellowstone basin 1998 to 2001 indicated some differences in fish community composition. Species in the upper river are less tolerant of sediment while those in the lower river are more tolerant. Species diversity increased going downstream as did tolerance to warm, turbid water. The proportion of native species increased to some extent in the lower river compared to the upper river where rainbow, brown, and brook trout were introduced to enhance the sport fishery.

External anomalies such as skin lesions, deformities, eroded fins, and tumors were noted more frequently in some populations than others which may be a sign of chemical contamination or environmental stress in the respective habitats. The highest rates of external anomalies were noted in fish from Billings (Reach B2) and Forsyth (Reach C10) where about 15 to 20 percent of fish had skin lesions or abraded fins. The anomalies occurred at higher rates in members of the sucker family. Rates of anomalies noted in fish at Corwin Springs and Sidney were below five percent while those in the Clarks Fork Yellowstone River Yellowstone and Bighorn Rivers were both above 5 percent. Later fish sampling in 2002-2003 in Forsyth showed reduced rates in the neighborhood of 10 percent (Peterson et al., 2004), however comparable data was not available for the other Yellowstone sites.

Fish tissue sampled following the crude oil pipeline breaks in 2011 (Silvertip Pipeline near Laurel) and 2015 (Poplar Pipeline near Glendive) detected the presence of hydrocarbons or PAHs indicating that hydrocarbons had entered the food chain downstream of the releases.

2.5 Biological Summary for AUID and Reaches

Table 2-6 presents a summary of the biological characteristics discussed above and those taken from detailed assessment reports for specific Yellowstone River assessment units (AUIDs) accessed through the Montana Department of Environmental Quality's Clean Water Act Information Center (CWAIC) online at http://deq.mt.gov/wqinfo/CWAIC/default.mcpx. The information was collected and edited further to reflect major points regarding analysis and interpretation of the water-quality-related biological characteristics of the Yellowstone River.

2.6 Beneficial Use Support Matrices

Under the Federal Clean Water Act (CWA) all surface waters of the Yellowstone River in Montana and North Dakota are designated with specific beneficial uses (e.g., livestock and irrigation, drinking water, recreation, fish and aquatic life, etc.) and have been assigned to a "use class" which categorizes the associated beneficial uses. Water-quality standards are established to protect these beneficial uses (Mohr 2012). Each "use class" has associated standards for how clean the water must be to support the associated use. These standards are used as a measuring stick to indicate if waters are meeting or not meeting water-quality goals. Montana's and North Dakota's water-quality standards are both numeric and narrative in nature. Both states define narrative standards as "A narrative water-quality standard is a statement(s) that prohibits unacceptable conditions from occurring in or upon surface waters, such as floating debris, oil, scum, garbage, cans, trash, or any unwanted or discarded material. Narrative standards also prohibit the discharge of pollutants, which alone or in combination with other substances, can (1) cause a public health hazard or injury to the environment, (2) impair existing or reasonable beneficial uses of surface waters, or (3) directly or indirectly cause concentrations of pollutants to exceed applicable standards". Montana's water-quality use classes and associated beneficial uses may be found in the Annotated Rules of Montana 17.30.6. North Dakota's rules (North Dakota Administrative Code 33-16-02.1) are similar as they both mimic the CWA. The designated water-quality use classes and associated beneficial uses of the Yellowstone River within the Cumulative Effects Assessment (CEA) are shown in Table 2-6.

Table 2-6
Biological Interpretations for Yellowstone River AUIDs and CEA Reaches

AUID	CES Reaches	Description
MT43B001_011 Wyoming Border to YNP Boundary	PC 1	No fish population or fish habitat data available specific to this AUID. To be assessed at next opportunity
MT43B001_010 YNP Boundary to Reese Creek	PC1	No fish population or fish habitat data available specific to this AUID. To be assessed at next opportunity
MT43B003_010 Reece Creek to Bridger Creek	PC2 to A7	At Corwin Springs, the chlorophyll a was below ctriteria for contact recreation and aquatic life support. Fecal coliform and E. Coli concentrations also collected at the USGS site were below guidances. Fish samples, macroinvertebrates, and other biological data ok.

AUID	CES Reaches	Description
MT43F001_012 Bridger Creek to Laurel PWS	A8 to A17	Anecdotal information from the 1870s suggests that trout populations in this reach of the Yellowstone River could be quite robust. Today, MT FWP electroshocking surveys in the most recent decade showed that brown and rainbow trout have varied in relative abundance, in part a function of drought and flooding events. But overall trout numbers in 1999 were the highest in 12 years and the fishery biologist concluded that, in 2002, the trout population was "relatively intact" in spite of record low water levels. Algal Chl a levels were measured in 2000, and were below nuisance level thresholds. Benthic macroinvertebrates showed no particular problems (cumulative DEQ metric battery scored 80 percent of expected, EPT richness very high). There are apparently elevated proportion of eutrophic diatoms at this site relative to upstream sites, however it still appears to be below a problem level as the site does not also demonstrate the highly elevated Chla biomass and diel DO swings exhibited further downstream. In August 2000, benthic Chl a values were about 40 mg/m^2. Very low abundance of centric diatoms indicated that the site is NOT a phytoplankton dominated reach and, therefore, the use of benthic algal Chl a as an indicator is appropriate. In 1999, rainbow trout numbers rebounded due to major floods in 1996 and 1997. Brown trout numbers decreased 14 percent from 1997. Total trout numbers highest estimated in 12 years. Based on the DEQ's older biometric assessment method (Bukantis, 1998), the site at Laurel scored 80 percent of maximum, which would put it in the non-to- slightly impaired category. "The functional composition of the assemblage included all expected components in proportions that seemed appropriate for a higher order stream". Historical accounts of riparian and geomorphic conditions: In the 19th century this reach was heavily lined with trees, including large cottonwoods, and forest extended from 1-10 miles back from the river on both sides. Geomorphically, it was described by Lewis and Clark below the Shields River confluence as being full of many islands, both large and small. This island-filled condition continued through to the confluence with the Clarks Fork Yellowstone River of the Yellowstone (which is just below this reach). Physical features report shows armoring for some segments within this reach: Columbus: 10-25 percent; near Park City: 6 percent; near Laurel: 8 percent.

AUID	CES Reaches	Description
MT43F001_011 Laurel PWS to Billings PWS	A18 to B2	Older studies (1970s) indicate that river water quality, including nutrient concentrations, was greatly improved from the past, and that the river was generally mesotrophic. But nutrients from tributaries (Clarks Fork Yellowstone River of the Yellowstone) and wastewater in the mid-1970s had caused a 6-17 fold increase in periphyton production relative to upstream reaches. Benthic Chlorophyll a samples collected in 2003 were quite high (269 mg Chl a/m^2), which exceeds the recreational use impact threshold as well as the aquatic life threshold. Macroinvertebrate biometrics samples (2003) were collected at three different sites along the reach. The macro invertebrate metrics all scored in the 60-70 percent-of-maximum range, suggesting slight impairment to aquatic life. A sediment problem was only mildly indicated at one of three sites, however the two most downstream sites both lacked long-lived taxa. The latter finding suggested that periodic perturbations (e.g., lack of flow) might affect these sites and impede long-lived taxa. The percent EPT was notably lower at the middle site (YSR460). No useable fishery data was located for this reach in MRIS, or in documents, and therefore that beneficial use does not have SCD. 2003: Benthic Chl was 269 mg Chl a /m^2. This is a high values that well exceeds the recreational use threshold and also exceeds the aquatic life threshold. 2003 macroinvertebrate biometrics, Station Y06YSR460; Yellowstone River below Canyon Creek: Using Bukantis (1998) metric battery, scored 70 percent of max (slightly impaired). Biotic index score was 4.83, near the value of 5 where impacts are beginning to be noted. Presence of clinger taxa & mayflies suggested sediment deposition is minimal. Longlived taxa scarce, suggesting dewatering or other impacts that would abort long-lived taxa. 2003 macroinvertebrate biometrics, Station Y06YSR450; Yellowstone River above Duck Creek: Using Bukantis (1998) metric battery, scored 60 percent of max (slightly impaired). High biotic index suggests high water quality; however, "Very mild sediment deposition with some attendant limitation to the availability of stony substrate habitats cannot be ruled out". 2003 macroinvertebrate biometrics, Station Y06YSR470; Yellowstone River at Billings Ave Bridge: Using Bukantis (1998) metric battery, scored 67 percent of maximum (slightly impaired). Site had a very good biotic index (4), and good water quality is suggested. Sediment deposition was not suggested by the macroinvertebrate assemblage. Again, long-lived taxa were generally absent. PAHs detected in fish tissue as a result of 2011 Silvertip Pipeline break near Laurel.

AUID	CES Reaches	Description
MT43F001_010 Billings PWS to Huntley Div. Dam	B3 to B4	2010 Cycle: USGS NAWQA study provided a fairly comprehensive biological dataset from 1998-2001. There is some data to suggest fish populations in this reach are stressed, due to the large proportion of anomalies (eroded fins and lesions) found on their bodies in this river reach. Both macroinvertebrate and diatom population data indicated degraded and eutrophied conditions relative to other parts of the river. Benthic algal biomass was very high (800 mg Chl a/m2) and is much higher than the nuisance threshold (150 mg Chl a/m2) identified by the Montana public in a 2006 DEQ study. Similarly, biomass of Cladophora sp (filamentous algae that can grow to nuisance levels) was the highest along the entire river at this site. No exceedences of E. coli standards noted. Overall, biological impairment is evident from several lines of evidence; data suggest impairment due to eutrophication problems. Benthic Chl a measured in August 2000 at site USGS 06214500 as 800 mg Chl a/m2. This value greatly exceeds Huntley dam is most likely (along with dams at Intake and Cartersville) to deter fish migration. Huntley dam does have a natural bypass channel that may be used by migrating species during high discharge. USGS report Overall, the Billings site had the highest proportion of midges & worms (85 percent) and lowest proportion of EPT taxa (9 percent) for the study. the study concluded that this middle segment of the Yellowstone River had "somewhat degraded conditions".
MT43Q001_011 Huntley Div. Dam to Bighorn River	B5 to B12	2011 Silvertip Pipeline Spill. Further monitoring of the residue and its deterioration is planned. As a result of the break and documented oil, this segment is impaired for oil. Samples were collected in 2011 at several locations by Montana DEQ, EPA, Exxon and private land owners in response to the Silvertip pipeline break. No samples exceeded water-quality standards. Sediment sampling occurred as a result of the Silvertip Pipeline break. Elevated concentrations of both organics and inorganics were observed when compared to the NOAA Screening Reference Tables. In general, data and information regarding this reach are lacking. While there appear to be some fisheries data, macroinvertebrate and periphyton data are either from the 1970's or had no interpretation available. The only recent water chemistry data for this reach were nutrient data from 2003. Other water chemistry data including metals were available only from 1970-1981. A series of PFC analyses were conducted by the BLM in this reach, but only one site had any relevant information regarding the condition of the site.
MT42K001_020 Bighorn River to Cartersville Div. Dam	C1 to C11	Fish passage barrier (diversion dam) noted as source/cause of limited aquatic life function. Algal study by USGS in August 2000 noted high levels of algal biomass and other indicators of eutrophication at two sites in the Bighorn River, although nitrate concentrations in the Yellowstone are relatively low below Billings.
MT42K001_010 Cartersville Div. Dam to Powder River	C12 to C21	The fisheries data are generally good and there are, again at Miles City, accompanying aquatic life data, however due to the limited number of samples throughout the reach and time, there is not sufficient data available to assess any beneficial use.

AUID	CES Reaches	Description
42M001_012 Powder River to Lower Yellowstone Div. Dam	D1 to D9	Warm Water Fishery: Intake Dam (Lower Yellowstone Diversion Dam) partially restricts fish passage and is the stated reason for the aquatic life support limitation. EPT taxa were predominant in the lower segments of the river from Miles City to Sidney. Highest diversity of algal species was noted in this reach during August 2000 possibly related to immigration from tributaries. Dissolved nutrient concentrations are generally low. A shift from a periphyton dominated algal community to a phytoplankton dominated community associated with slow moving waters and reservoirs was noted along with increased turbidity in this unit. The Yellowstone River near the Powder River was listed in Montana Waters with Fish Consumption Advisories in 2012-2013 due to mercury contamination in fish. PAHs detected in fish tissue as a result of 2015 Poplar Pipeline break near Glendive.

MT42M001_011 Lower Yellowstone Div. Dam to Border	D9 to D13	Intake Diversion Dam creates a cascade with a 9-foot hydraulic head and diverts water for irrigation purposes. No fish passage structures are incorporated into this dam, movement of fish over or around this dam presumably occurs only at high river discharge during runoff May - June, and the dam may be a partial or complete barrier to the passage of certain native fish species. Adjustable fish and trash screens were recently installed on the Intake diversion structure to reduce fish entrainment. Modifications to the diversion dam are under study to provide bypass for aquatic life. EPT taxa were predominant in the lower segments of the river from Miles City to Sidney. From samples taken from the Yellowstone River at Glendive, approximately 81 percent were EPT (pollution intolerant species) and < 5 percent were midges and worms (pollution tolerant species). At the Yellowstone River near Sidney, 49 percent of the taxa sampled were EPT, while 23 percent were midges and worms. Bioassessment scores for macroinvertebrates indicated that the Sidney site was moderately impaired, but a low abundance of organisms in the sample complicated the evaluation. The habitat evaluation suggested that the inadequacy was likely due to a depauperate community at the site. Nearly half of the animals collected were midges; the only other groups represented in abundance were a few taxa of tolerant dipterans. This skew suggests that monotonous soft substrates severely limited the benthic community. Green algae, golden browns and cyanobacteria were present, but red algae were not. Diatoms accounted for most of the biomass in the periphyton community, and of these, Cymbella sinuate was the dominant species. All but one of the diatom metrics indicated excellent biological integrity when compared with biocriteria for prairie streams. Only a few deformed valves of Fragilaria vaucheriae indicated minor impairment of aquatic life uses at this site. Chlorophyll-a concentrations were less than 10 mg/m^2 in the lower segments of the river, from Miles City to Sidney. Chlorophyll-a concentrations near Sidney in August 2000 were approximately 4.5 mg/m^2. The Shannon Diversity Index based on six of Water's samples from August-November 1975 at Intake ranged from 0.83 - 2.46, and at Sidney ranged from 0.24 - 2.49. (Generally an index >3.0 illustrates a healthy, unstressed community, while an index <1.0 is indicative of a monospecific community under stress; an index from 1.0-3.0 seems to illustrate a community under some stress.) Stresses upon certain Yellowstone communities might be due to large amounts of inorganic sediments and non-diverse, uniform substrate types of the river bottom in some areas. Distribution and abundance of Plecoptera, Tricoptera, and Ephemeroptera and Diptera taxa are given for stations along the length of the Yellowstone River, including near Intake and at Sidney. Shannon diversity values for Hess samples taken in November 1975 for the stations near Intake and Sidney were 2.46 and 1.30, respectively. Sidney's value was the lowest of all the stations. Overall habitat conditions scored marginally at a site near Sidney, MT. The field evaluator described the site thus: "Good flow but very turbid". Poor riffle development was perceived, and some monotony of the benthic substrate was reported. Sediment deposition was accorded a marginal score. Overall habitat score: 50 percent. Human induced flood suppression is decreasing old-growth cottonwood abundance

AUID	CES Reaches	Description
		in riparian areas, and reduced flows are suppressing channel braiding in certain river sections, including downstream of Glendive. Mercury concentrations in sauger from the Sidney site were similar to the median and mean concentrations of mercury from a national study of chemical residues in fish. All fish from the lower Yellowstone River had DDT in their tissue; concentrations varied from 6.7-17 µg/kg, and were below the mean concentration of 260 µg/kg taken from samples across the US in 1984. Levels of DDT in fish tissue near Sidney decreased from approximately 50 µg/kg in 1984 to 13 µg/kg in 1998. No sites in the Yellowstone River had concentrations of chlordane, dieldrin, DDT or PCBs higher than the national recommended concentrations for protection of wildlife that eat fish. Of the 12 organic compounds detected in the fish-tissue samples over the entire Yellowstone River basin, p,p'-DDE was the only compound detected from the site near Sidney. Levels of DDT in fish tissue near Sidney have decreased from approximately 50 µg/kg in 1984 to 13 µg/kg in 1998. No sites in the Yellowstone River had concentrations of chlordane, dieldrin, DDT or PCBs higher than the national recommended concentrations for protection of wildlife that eat fish.
ND-1010000-001-S_00	D14-16	Same biological datasets as for previous AUID are representative for this AUID and reaches. No North Dakota specific data available. Oilfield wastewater spill in 2006 into Charbonneau Creek (tributary) caused fish kill and impacts from brine on aquatic life and livestock use. Impact on Yellowstone not known.

The Montana Department of Environmental Quality (DEQ) has divided the mainstem of the Yellowstone River into 11 segments (assessment units) for the purposes of establishing beneficial uses and conducting beneficial use assessments. North Dakota States are required to report the status and trends of the state's waters in the 305(b) Water-quality Assessment Report. States are also required to track and submit a list of impaired waters in need of Total Maximum Daily Loads (TMDLs). This list, known as the 303(d) list and the 305(b) reports for each state have been combined into an Integrated Report and submitted in even numbered years. The most recent integrated report for Montana was issued in May 2014. The North Dakota Department of Health's Draft 2014 Integrated Report is not yet finalized at the time of this writing. Detailed beneficial use support data for all 12 assessment units in Montana and North Dakota is provided in Table 2-7.

Numeric criteria define precise, measurable concentrations of pollutants that are allowable in a waterbody. Most of Montana's numeric water-quality criteria are found in Circular DEQ-7.

Regulations under both the federal CWA and Montana's Water Quality Act ((MCA § 75-5-102(1)) prohibit the discharge of wastes or pollutants from any point source without a valid permit authorized under the Montana Pollutant Discharge Elimination System (MPDES). The term "point source" includes any discernible, confined, and discrete conveyance from which pollutants are, or may be, discharged9. Typical point sources include publicly-owned treatment works, industrial facilities, storm sewer systems, and concentrated animal feeding operations. Return flows from irrigated agriculture and agricultural stormwater runoff are specifically excluded as point sources.

MPDES permits also provide a regulatory process for implementing a waste-load allocation (WLA) that has been developed for a point source as part of the TMDL for a watershed or specific waterbody. MPDES permits may be reopened to incorporate the WLA at any time, or the WLA may be incorporated in the next 5-year permit renewal process. In the absence of an approved TMDL for existing discharges into a water-quality limited segment, DEQ imposes effluent limitations that prohibit further decline in water quality.

Table 2-7
Summary of the 2014 Integrated Report Listings for the Yellowstone River in Montana and North Dakota.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT43B001_011	Wyoming Border to YNP Boundary	8.68	A-1	5	PC 1	The 2006 Montana 303(d) list reports that the cold water fishery and drinking water beneficial uses are partially supported due to metals, nutrients, siltation, and suspended solids likely caused by highway/road/bridge construction and natural sources. Additionally, the 2006 303(d) list added arsenic as a cause of impairment associated with the drinking water beneficial use. This segment will be reassessed following completion of the large river protocols. Not reassessed 2008, 2010, 2012, or 2014. Aquatic life and drinking water not supported. Ag and Contact Recreation not assessed.

AUID	Description	Length (mi.)	Use Class	Water-quality Category3/	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT43B001_010	YNP Boundary to Reese Creek	4.79	A-1	5	PC1	The 2006 303(d) list reports that the cold water fishery and drinking water beneficial uses are partially supported due to metals, nutrients (ammonia, NO3-NO2), siltation, and suspended solids due to highway/road/bridge construction and natural sources. Additionally, the 2006 303(d) list added the following three metals: arsenic, copper, and lead. It was noted that issues associated with nutrients and arsenic may be natural due to geothermic inputs from springs. Further analysis is necessary. This segment will also be reassessed following completion of the large river protocols. Not reassessed 2008, 2010, 2012, or 2014.
MT43B003_010	Reece Creek to Bridger Creek	119.0	B-1	4C	PC2 to A7	Limited data were available for this segment. Aquatic Life & Cold Water Fishery: The 1998 habitat assessment shows significant habitat impairment (streambank alteration) in this reach. Arsenic exceeded the human health standard, and since there are mines present on tributaries of this segment, non-natural source contributions are possible; thus the drinking water beneficial use is non-support as a result of the water-quality exceedances. Cold water fishery and aquatic life not supporting due to habitat alteration. Not reassessed since prior to 2006. Ag, Drinking Water, and Contact Recreation not assessed. Not assessed for 2014 cycle.
MT43F001_012	Bridger Creek to Laurel PWS	56.31	B-1	2	A8 to A17	1996 listings were unionized ammonia, salinity, TDS, chloride, and suspended solids but were dropped in 2006 cycle. Aquatic Life, Primary Contact Recreation and Agriculture: Fully Supporting. Drinking Water: Not Assessed due to insufficient information. Not reassessed 2008 thru 2014 cycles.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT43F001_011	Laurel PWS to Billings PWS	19.4	B-2	5	A18 to B2	Reach D described as heavily impacted, having lost (as a result of channel simplification) 24,000 feet (14 percent) of its channel length since 1950s. Study suggests that fisheries experts should evaluate the effect of such channel loss on the fishery. Bank armoring (riprap, etc.) is 39 percent in this reach. Geomorphic study defines the reach upstream of Billings as unconfined braided, with high modification and 34 percent bank armoring. 2010 Cycle: The 1996 listing for unionized ammonia, alkalinity/TDS/chlorides, and suspended solids was removed due to later sampling which showed these constituents are at acceptable values. 2012 Cycle: As a result of the 2011 Silvertip pipeline break and documented oil spill, this segment is impaired (Aquatic Life and Primary Contact Recreation) for oil and grease until monitoring shows that spilled oil has been bioremediated following the cleanup. Agriculture: Fully Supporting. Drinking Water: Not Assessed due to insufficient data. 2014 cycle: Not assessed.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT43F001_010	Billings PWS to Huntley Div. Dam	10.62	B-3	5,5N	B3 to B4	2006 Cycle: This general reach of the Yellowstone River was listed as only partially supporting its aquatic life, warm-water fishery, drinking water and recreation beneficial uses due to salinity/TDS/chlorides, suspended solids, and unionized ammonia. 2008 and 2010 Not assessed. Reach length redefined. 2012 Cycle: Aquatic Life and Primary Contact Recreation beneficial uses for this Assessment Unit are being listed for Oil and Grease as a result of the Silvertip Pipeline break. 2014 Cycle: User defined category updated from 2B to 5N during 2014 cycle. Aquatic Life, Primary Contact Recreation, and Drinking Water: Not Supporting. Agriculture: Fully Supporting.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT43Q001_011	Huntley Div. Dam to Bighorn River	58.31	B-3	5	B5 to B12	1996: This assessment unit was listed as only partially supporting its aquatic life, warm water fishery, drinking water supply and recreation beneficial uses due to salinity/TDS/chlorides, suspended solids and unionized ammonia likely caused by agriculture, industrial point sources, irrigated crop production, municipal point sources and natural sources. 2000-2004: Insufficient information to evaluate this reach. 2006: Because large river protocols are being developed but not yet applied, the 2006 303(d) list will conservatively report that the aquatic life, warm water fishery, drinking water supply and recreation beneficial uses are partially supported due to salinity/TDS/chlorides, suspended solids and unionized ammonia likely caused by agriculture, industrial point sources, irrigated crop production, municipal point sources and natural sources. This segment will be reassessed following completion of the large river protocols. 2008-2010: Not assessed these cycles. 2012: Aquatic Life and Primary Contact Recreation beneficial uses are being listed for Oil and Grease as a result of the Silvertip Pipeline break. 2014: Not assessed this cycle. Aquatic Life and Primary Contact Recreation: Not Supporting. Agriculture and Drinking Water: Not assessed due to insufficient data.
MT42K001_020	Bighorn River to Cartersville Div. Dam	59.51	B-3	4C	C1 to C11	2004: Aquatic Life: Not supporting; Agriculture: Fully Supporting. Drinking Water and Contact Recreation: Not Assessed due to insufficient data. Not Assessed 2006-2014 Cycles.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT42K001_010	Cartersville Div. Dam to Powder River	88.73	B-3	5	C12 to C21	1996: The segment code for this reach of the Yellowstone River was MT42K001-1. It was listed for metals, nutrients, other habitat alterations, pathogens, salinity/TDS/chlorides, suspended solids, and pH. 2000-2004: This segment was determined to lack sufficient credible data and therefore was not assessed for the aquatic life, warm water fishery, drinking water and contact recreation beneficial uses. It was considered fully supporting for agriculture and industry uses.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
42M001_012	Powder River to Lower Yellowstone Div. Dam	76.73	B-3	4C	D1 to D9	2006: There is still insufficient information to assess any use, including the agriculture and industry uses. All uses need to be evaluated with more updated information integrating the anticipated large river protocols. The 2006 303(d) list (as did the 1996 list) will conservatively report that the aquatic life, warm water fishery, drinking water supply, and contact recreation beneficial uses are partially supported due to metals, nutrients, other habitat alterations, alkalinity/TDS/chlorides, suspended solids, bacteria, and pH likely caused by agriculture, irrigated crop production, municipal point sources, natural sources, rangeland and streambank modification/destabilization. Regarding the pathogen listing in 1996: changes to water-quality standards prevent the general "pathogens" listing from being carried forward. The current bacteria Standard and ADB entry is E. coli, which is too specific to translate a general pathogen listing. Additionally, the original basis for the pathogen listing is unknown. At present, there are no E.coli data for this stream. Therefore, this segment will be flagged for E. coli monitoring in 2007. This segment will also be reassessed following completion of the large river protocols. 2008-2014: No further assessment. Aquatic Life: Not Supporting; Agriculture, Drinking Water, and Primary Contact Recreation: Not Assessed due to insufficient information. 2015. Crude oil spill due to break in Poplar Pipeline above Glendive results in non support of drinking water and contact recreation until impacts no longer detected.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
MT42M001_011	Lower Yellowstone Div. Dam to Border	53.67	B-3	5	D9 to D13	1996: This assessment unit was listed as only partially supporting its aquatic life, warm water fishery, drinking water supply, recreation and swimmable beneficial uses due to metals, nutrients, habitat alterations, pathogens, salinity/TDS/chlorides, suspended solids and pH likely caused by agriculture, irrigated crop production, municipal point sources, natural sources, rangeland and streambank modification/destabilization. 2000-2004: Insufficient information to fully evaluate this stream under revised use support determination procedures. 2006: In anticipation of large river assessment and sampling protocols, the 2006 303(d) list will conservatively report that the aquatic life, warm water fishery, drinking water supply, and recreation beneficial uses are partially supported. Aquatic Life limitations noted as due to alteration in stream-side or littoral vegetative covers, chromium (total), copper, fish-passage barrier, lead, sedimentation/siltation, total dissolved solids, pH, nitrogen (total), and phosphorus (total) due to flow regulation/ and modification, streambank modification, irrigated crop production, rangeland, natural, and unknown sources. The following specific metals were added on the 2006 303(d) list: copper, lead, arsenic, and chromium. Pathogen listing for Contact Recreation was removed due to change in assessment procedures and water-quality standards. Insufficient data at present. 2008-2014: No further assessment. Aquatic Life: Not Supporting; Agriculture, Drinking Water, and Contact Recreation: Fully Supporting. 2015. Crude oil spill due to break in Poplar Pipeline above Glendive results in non support of drinking water and contact recreation until impacts no longer detected.

AUID	Description	Length (mi.)	Use Class	Water-quality Category[3/]	Yellowstone CES Reaches	Beneficial Use Support Determinations
ND-1010000-001-S_00	MT/ND border to confluence with Missouri	21.3	1	2	D14-16	North Dakota's 1998 303(d) Report listed this assessment unit as impaired for Aquatic Life and Recreational Uses due to metals and bacteria, respectively. The 2002 303(d) report removed the Recreational impairment (bacteria) due to a lack of sufficient credible data and revised the Aquatic Life support impaired listing to Threatened (selenium). The 2004 303(d) report amended the listing to Fully Supporting but Threatened due to Trace Metals (copper, lead, selenium and zinc) and Pesticides (atrazine and simazine). The assessment unit was delisted in the 2006 303(d) report because water-quality data at the USGS Sidney gage (06329500) showed no exceedences for metals and pesticides. 2008 – 2014: No further assessment. Fully supporting all uses.

[1/] Montana waters classified A-1 Use Class are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities. Water quality must be maintained suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

[2/] Under the federal Clean Water Act, the U.S. Environmental Protection Agency (EPA) requires that total maximum daily loads (TMDLs) be developed for waters impaired by "pollutants," such as nutrients, sediment, or metals. TMDLs are not required for waters impaired solely by "pollution," such as flow alterations or habitat degradation. The Montana and North Dakota Integrated Reports place all waters into five categories based on assessment status as per guidance from the EPA. The five categories are defined as follows:

Category 1**:** Waters for which all applicable beneficial uses have been assessed and all uses have been determined to be fully supported.

Category 2: Waters for which those beneficial uses that have been assessed are fully supported, but some applicable uses have not been assessed.

Category 3: Waters for which there is insufficient data to assess the use support of <u>any</u> applicable beneficial use, so no use support determinations have been made.

Category 4: Waters where one or more beneficial uses have been assessed as being impaired or threatened, however, either all necessary TMDLs have been completed or are not required:

Subcategory 4A: All TMDLs needed to rectify all identified threats or impairments have been completed and approved.

Subcategory 4B: Waterbodies are on lands where *"other pollution control requirements required by local, State, or Federal authority"* (see 40 CFR 130.7(b)(1)(iii)) are in place, are expected to address all waterbody-pollutant combinations, and attain all water-quality standards in a reasonable period of time. These control requirements act "in lieu of" a TMDL, thus no actual TMDLs are required.

Subcategory 4C: Identified threats or impairments result from pollution categories such as dewatering or habitat modification and, thus, the calculation of a Total Maximum Daily Load (TMDL) is not required.

Category 5: Waters where one or more applicable beneficial uses have been assessed as being impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat.

Category 5N: Available data and/or information indicate that a water-quality standard is exceeded because of an apparent natural absent any identified manmade sources

[3/] Yellowstone River Beneficial Support Use interpretations extracted from several sources: detailed assessment reports accessed through the Montana Clean Water Act Information Center and within Montana's biannual Water-quality Integrated Reports (305(b) and 303(d) reports) both accessed online November 25, 2014 at http://deq.mt.gov/wqinfo/CWAIC/default.mcpx. North Dakota Beneficial Use Support interpretations summarized from North Dakota's Water-quality Integrated Reports (305(b) and 303(d) reports) accessed online November 25, 2014 at: https://www.ndhealth.gov/WQ/SW/A_Publications.htm.

Montana waters classified B-1 in Montana are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. The primary objective in treating surface water is to remove or inactivate microbiological contaminants (e.g., viruses, bacteria, and protozoa) that can cause disease. Water contaminated with animal or human waste can transmit diseases to humans; therefore, adequate treatment of microbiological contaminants is essential in order to avoid acute health effects. People with compromised immune systems, such as infants, the elderly, the ill, and HIV-positive individuals, may be especially vulnerable to water-borne diseases.

Montana waters classified B-2 are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

Montana waters classified B-3 Use Class are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

Use Class I streams in North Dakota shall be suitable for the propagation or protection, or both, of resident fish species and other aquatic biota and for swimming, boating, and other water recreation. The quality of the waters shall be suitable for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water-quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use.

3.0 TRANSPORTATION: IMPACTS ON WATER QUALITY

3.1 Roads: Runoff Pollution and Hazardous Material Spills

The matrix of transportation system features along and within the Yellowstone River 100-year inundation zonepotentially contributes to NPS pollution through contaminated runoff from roads and bridges, atmospheric deposition of nitrogen oxides, floodplain and river channel encroachment, accidental spills, road application of winter traction materials, and construction activities (MDEQ, 2012). Sediment, nutrients, dissolved solids, metals, and hydrocarbons (gasoline, oil, and grease products) are all potential pollutants of concern to surface waters that may be generated by the transportation system when adequate controls are not in place. Additionally, physical habitat loss and degradation is associated with the actual construction of transportation features while channel migration protection activities (e.g., levees and riprap) associated with transportation land uses adversely impact riparian and wetland habitat (see Appendices 6 and 7 and respectively for additional information on physical and functional impacts).

No specific data or studies pertinent to the Yellowstone River system directly measure or assess the impact of transportation systems on classic measures of water quality in the Yellowstone River, however increased levels of SVOC and PAHs were noted for the Billings area (Reach B2).. SVOCs are manufactured chemicals used in fuels, lubricants, solvents, and pesticides. Potential sources of elevated levels of SVOCs and PAHs may be transportation related in addition to industrial sources. For the purposes of this report, the transportation discussion considers impacts of railroads, county and state roadways and Interstate 90/94. Impacts of city and municipal roads and other transportation related impacts not addressed here are discussed under Urban/Ex-urban Development.

The extent of transportation facilities within the larger CEA project area and individual reaches is discussed in detail in Appendix 1 Land Use Change. The corridor contains over 40 miles of transportation features within the 100-year inundation zone with railroads being the dominant feature. Figure 3-1 depicts the relative share of transportation features by type.

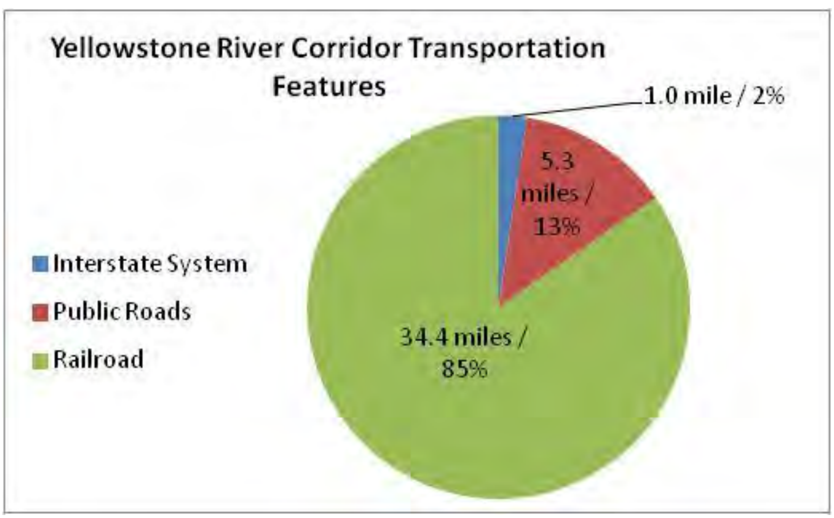


Figure 3-1 Transportation features within the Yellowstone River 100-year inundation zone total over 40.5 miles in length with the majority associated with the railroad.

Eighty-five percent of all transportation features within the 100-year inundation zone are related to the railroad. Given the railroad’s proximity to the channel and the hazardous nature of products transported by rail, there is a high potential for impacts to water quality due to collection and delivery of contaminated runoff or spills to the river. Currently, an unknown quantity of petroleum, industrial solvents, and other hazardous materials travel in tank cars daily along the State's roads, the Interstate system and Burlington Northern's train tracks. The industry has taken steps to minimize the hazard of spills but the possibility remains due to the extent of the railroad's proximity to the channel particularly in Reaches C10, C11, C12, C14, and D10.

Except where the Interstate highway and public roads cross the river at bridges, they offer less potential as they typically are situated at a greater distance from the river and have wider right of ways that may act as traps and filters for any contaminated runoff or spills. Poorly maintained bridges can sometimes be a sizeable source of sediment and road runoff delivered to a stream, however most bridges on the Yellowstone River are by nature larger structures and are constructed in a way that minimizes this potential.

Bridges by nature provide the highest risk of hazardous materials entering the river from road and rail facilities. The physical features inventory (2001) identified 54 bridges crossing the Yellowstone River. Figure 3-2 illustrates their relative distribution by county and type. Twenty of the bridges are owned by county government and an equal number by the state and interstate system. In general, due in part to the number and volume of materials transported, the greatest risk of spills is likely to occur at rail, state highway and interstate bridges. The Montana Department of Transportation's (MDOT) Motor Vehicle Safety Program office coordinates compliance with Montana and Federal Motor Carrier Safety Regulations and Hazardous Materials Regulations. MDOT's Emergency Operations and Disaster Plan (Taylor et al., 2005) outlines responsibilities and authorities in dealing with emergency situations like floods, fires, and hazardous waste spills. Local emergency management entities at the county and city level are usually the first responders and primary incident managers. Spill or release site investigation, enforcement, and cleanup is overseen by the Montana Department of Environmental Quality Enforcement Division which requires remediation reports from contractors or the responsible party.

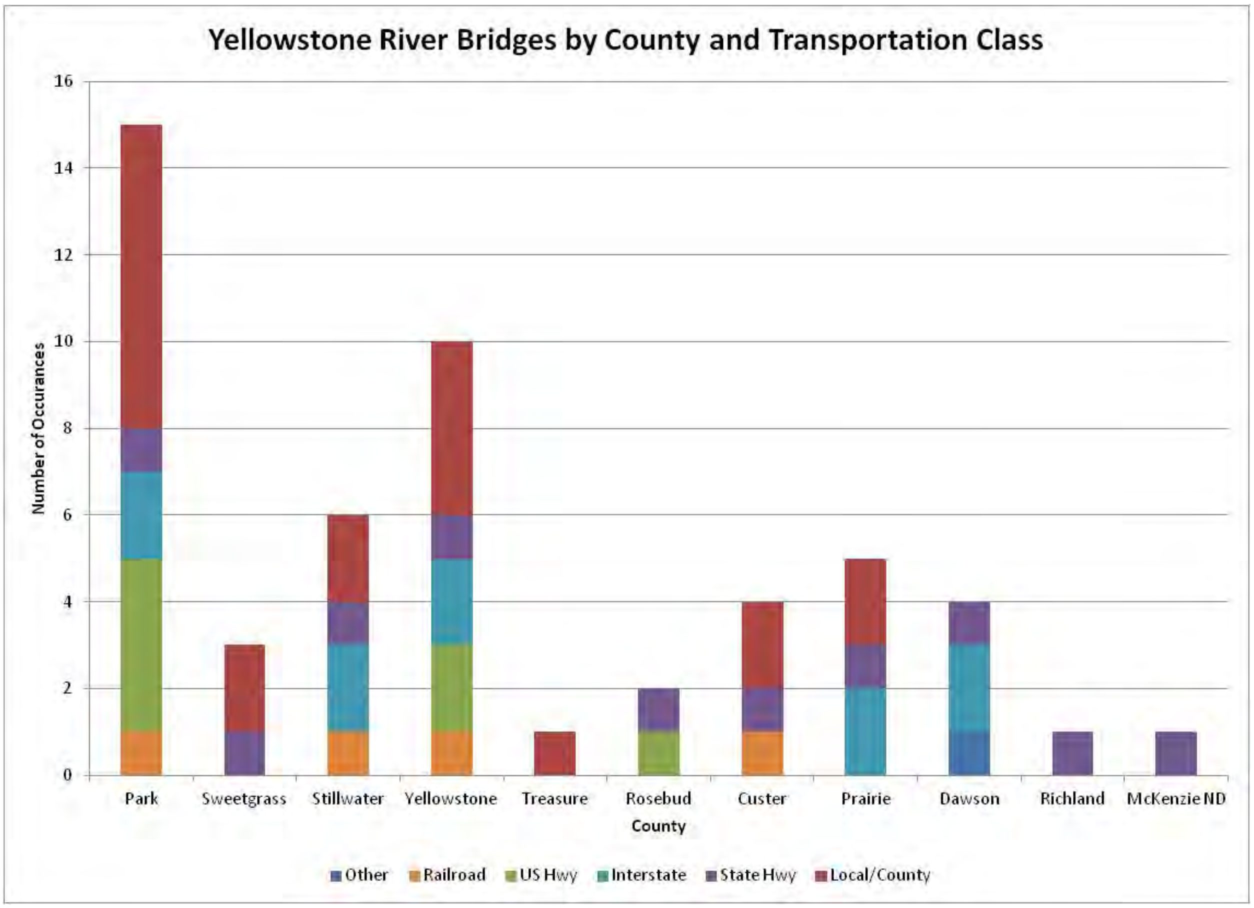


Figure 3-2 **About one-third of all Yellowstone River bridges are in Park County and about 20 percent in Yellowstone County. The number drops off in the less populated lower river where the greater width increases building and maintenance expenses relative to the number of users.**

According to the Burlington Northern Santa Fe Railroad (BNSF), the railroad is in the process of developing a Yellowstone Sub-Area Contingency Plan in conjunction with the US EPA Region 8 Emergency Response Unit and the Montana-Wyoming Oil Spill Cooperative (Winslow, 2015). The contingency plan will include development of shoreline response plans that take into consideration spatial and environmental characteristics of a spill site that may influence assessment and cleanup techniques. The BNSF railroad uses a three-part prevention program to reduce the risk and extent of material releases that includes track inspections/maintenance, training for shippers and railroad workers, and spill response time. Still, the Federal Pipeline and Hazardous Material Safety Administration (2015) reports that while train derailments dropped by half between 2004 and 2014, there were 141 unintentional petroleum releases last year, a record level. The organization predicts that 40 times more oil will be handled by rail in 2015 than in 2005 so due diligence and coordination is needed to protect Yellowstone River resources.

Investigations conducted in northern regions of the country by the USGS indicate that chloride toxicity is a growing issue in rivers and streams adjacent to transportation routes where magnesium and sodium chloride de-icing products are used. The products are used in traction sand and in liquid form applied to high hazard traffic areas such as intersections. The USGS report noted that chloride concentrations in winter doubled in the study streams between 1990 and 2011. Fifty-five percent of the streams sampled exceeded USEPA chronic aquatic life standards and 25 percent exceed acute standards for chloride

(Corsi et al., 2010). The streams studied are primarily near urban areas and are smaller in size so they lack the capacity to dilute concentrated contaminates. Many city, county and state road crews use the products on Montana's travel corridors.

While the Yellowstone River is likely too large to experience widespread impacts of chloride-laden runoff, appropriate location and incorporation of approved best management practices such as runoff detention and infiltration areas and rapid spill response plans helps to control potential pollution associated with transportation features that may locally affect aquatic life in receiving waters.

Permits for stormwater, Section 404 (aquatic disturbance), and Section 401 (standards certification) for transportation projects are reviewed by DEQ to ensure that appropriate decisions to "avoid, minimize, and mitigate" are made and that adequate attention is given to BMPs. Through the TMDL planning process DEQ also evaluates transportation system waterbody–pollutant specific concerns to address significant causes of impairment.

3.2 Pipelines: Rupture and Spills

A pipeline risk assessment report prepared for the Yellowstone River Conservation District Council (Atkins, 2012) indicates the presence of 39 pipelines intersecting the Yellowstone River Channel Migration Zone (DTM and AGI, 2012) at 21 crossings between Gardiner and the confluence with the Missouri River (Figure 3-3) .Thirty of the pipelines cross the channel while nine pipelines are located within a designated Channel Migration Zone. Exposure due to scour and channel migration were noted as the greatest threats to pipeline safety. Raw crude oil, petroleum products, liquefied natural gas, and natural gas are the products transported by pipelines within the corridor. Under criteria developed for the report, the study found that 32 of the pipelines represented low risk, one moderate, and six had no risk under their current operation as they are no longer in use. Figure 3-4 provides the number of occurrences by geomorphic reach ID respectively, with Reaches B1 and B2 in Yellowstone County having the greatest number of pipelines. Figure 3-5 provides the commodities carried by the pipelines identified in the Atkins report.

The pipeline risk assessment report was prepared as a result of the July 1, 2011 rupture of the Exxon Mobil Silvertip Pipeline near Billings, Montana.A reported 63,000 gallons of crude oil were spilled into the Yellowstone River near the peak 2011 discharge as a result of the rupture. More than 80 fish were found dead as a result, however, given the very high flows and long interval between the spill and the time fish recovery began, that many more fish and other aquatic and terrestrial organisms within the floodplain, which were not found, died as a result of the spill. Estimated cost of the spill and cleanup was in the millions of dollars. CEA Reaches below the spill site (A18 to B4) are listed on the 2014 Montana 303(d) list as having the aquatic life and contact recreation beneficial uses not supported due to the spill.

While recent samples have tested below state water-quality standards, it is apparent that there is still oil residing in the bed-sediment as a result of the Silvertip pipeline spill. Until the oil is dissipated by biological degradation, it will continue to be listed (MDEQ, 2014).

On January 17, 2015, the 12-inch Poplar Pipeline operated by the Bridger Pipeline Company experienced a break and crude oil leak about six miles above Glendive, Montana. The pipeline break occurred under the river bed and initially caused crude oil to enter Glendive's water supply. An estimated 30,000 gallons of crude oil was released into the river.Glendive's municipal water supply was shut down for several days. Due to extensive ice cover on the river, attempts to contain the spilled oil were largely unsuccessful. The spill impacted an area at least 90 miles in length and was confirmed as far downstream as Williston, ND. Tests of fish tissue below the break confirmed the presence of PAHs prompting MFWP to issue a fish consumption advisory due to the detection of the petroleum products (MFWP 2015).

While the threat to water quality posed by potential pipeline breakages cannot be quantified, it undoubtedly is high due to the immediate proximity of the pipeline crossings to surface water and the dynamic nature of the river. Both the Exxon Silvertip and the Poplar pipeline failures appear to be related to channel incision. Both lines were relatively old and had been installed by trenching rather than with newer directional drilling technology which can place the line deeper under the river bed and set back further from the bankline. Directional drilling should be considered as a BMP for all new and pipeline crossings older than 20 years on the Yellowstone River to insure they are properly installed and maintained as the river only has so much assimilative capacity to tolerate oil spills and maintain its ecological integrity.

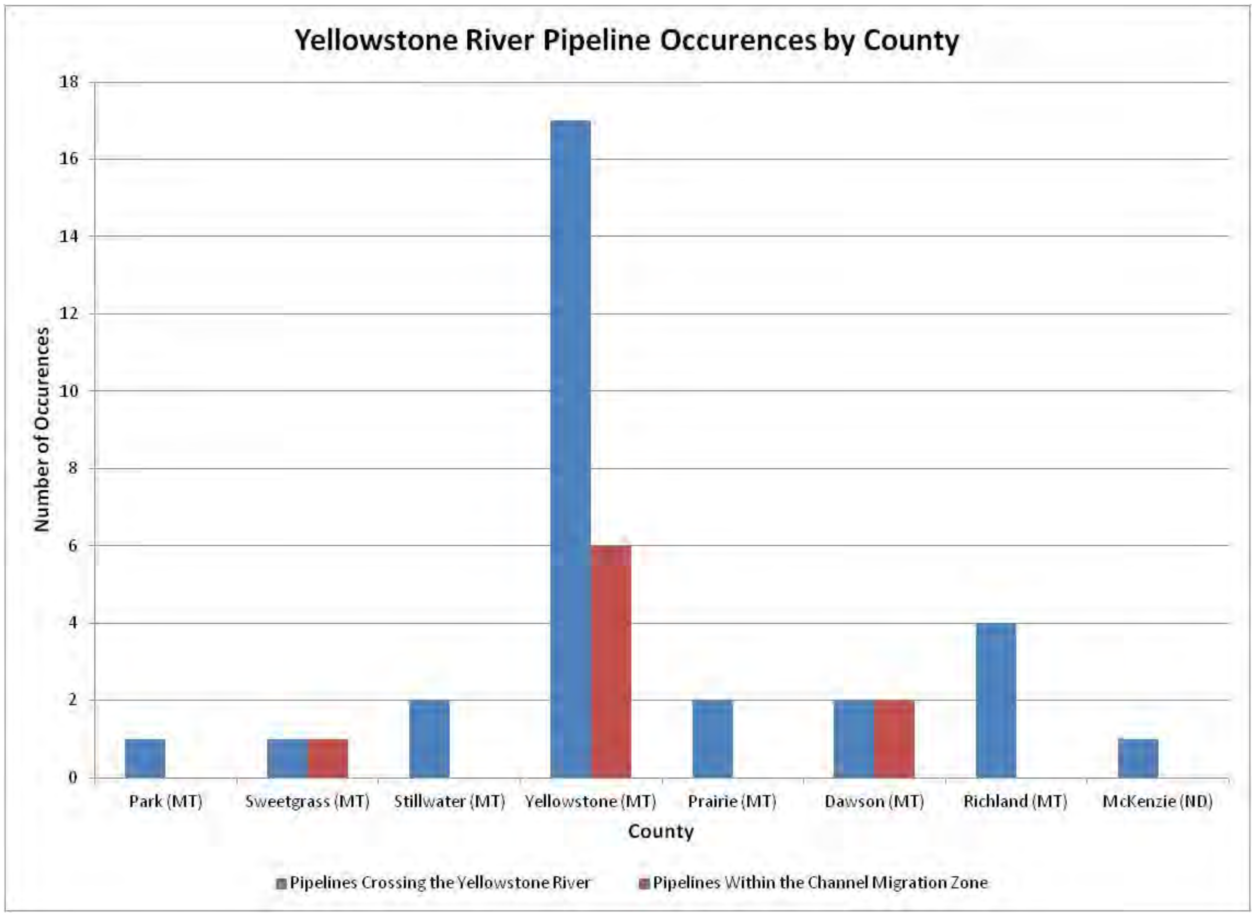


Figure 3-3 The number of pipeline crossings on the Yellowstone River is greatest in Yellowstone County. Data Source: Atkins 2012.

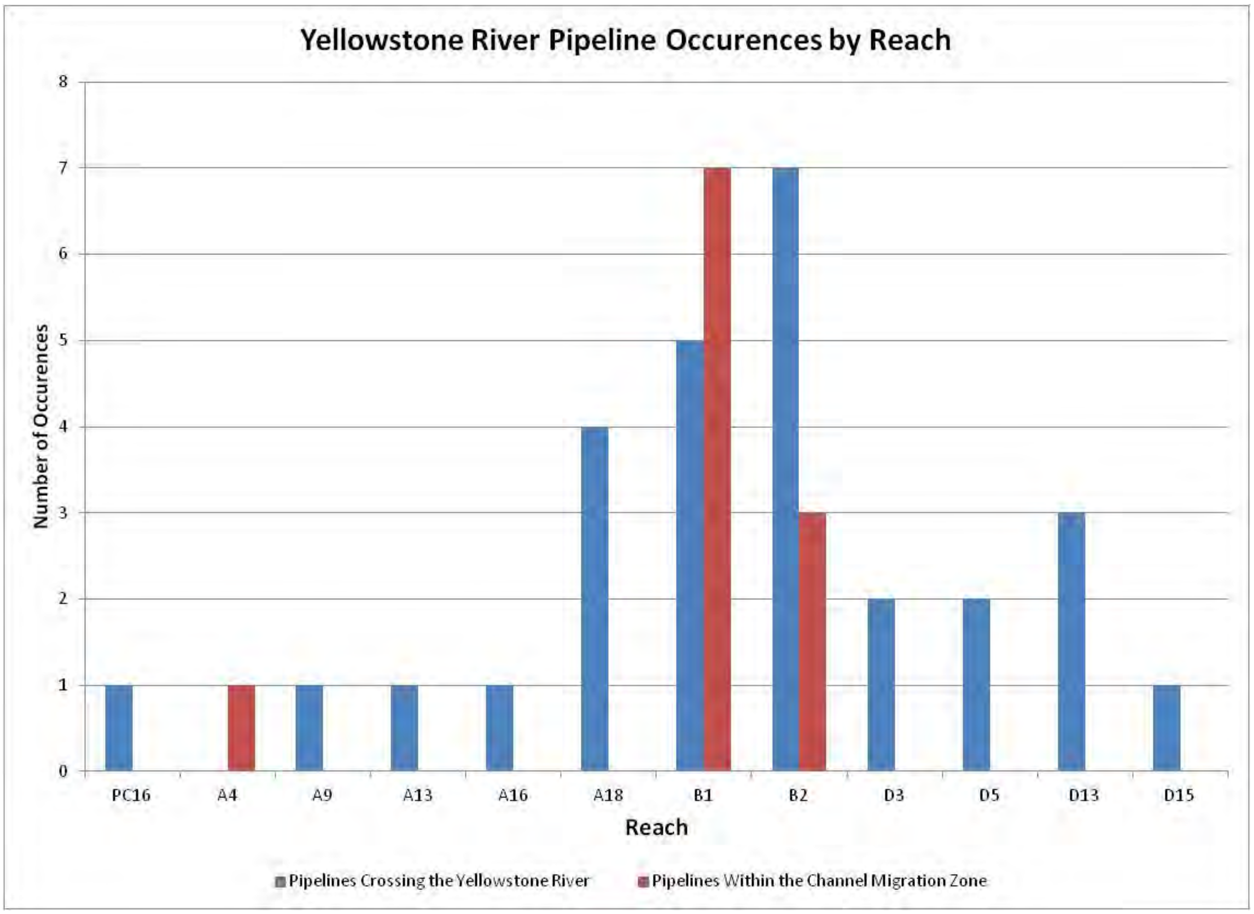


Figure 3-4 Reaches B1 and B2 contain the greatest number of pipeline crossings and within the CMZ.

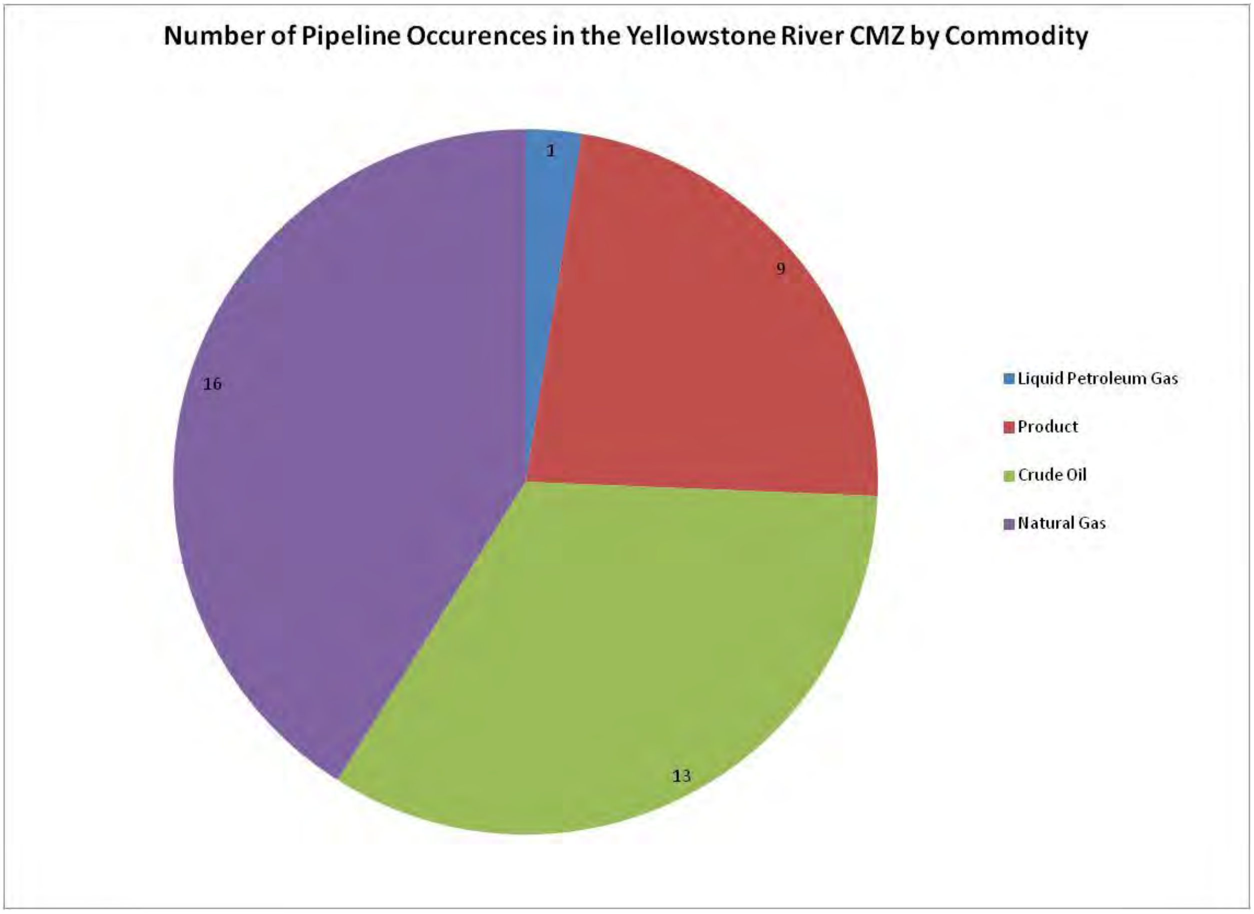


Figure 3-5 Types of commodities carried by pipelines within the Yellowstone River CMZ. Data Source: Atkins 2012.

Oil and gas production can also discharge pollutants to the river through the MPDES permit process or accidently from leaking pipelines and breached or flooded brine and water storage pits. The number of spills related to oilfield wastewater or brine (saltwater) has been increasing as the industry expands. A recent estimate in North Dakota calculated that there have been several thousand such discharges since 2006 (Guerin 2015). Contaminants include chloride, salts, heavy metals, petroleum, and even radioactive materials. The number of brine spills has been increasing as production ramps up since brine contaminated water is often a byproduct of production.

In 2006, a faulty plastic pipeline weld spilled an estimated one million gallons of brine into Charbonneau Creek, which discharges to the Yellowstone River in North Dakota killed aquatic life and vegetation. The water and soil remained contaminated for years impacting ranchers who used the water.

A recent brine spill of about three million gallons in North Dakota near Williston contaminated two creeks and reached the Missouri River (Washington Post 2015). A reported 74 brine spills occurred in North Dakota in 2013. As of the 2011 Yellowstone River land use mapping report, there were about 51 drill or production pads occupying a total of 140 acres located within the river corridor in Reaches D5 to D16. Reaches D14 and D16 have nearly 60 percent of the total pads. Likely this number has increased since 2011 given the rate of drilling activity in the area. Best management practices to include closed loop brine water storage and pipeline leak monitors and shutoff valves are recommended on wells close to the river in order to minimize a risk of a spill discharging into the river.

Petroleum hydrocarbons and volatile organic compounds (VOCs) are considered toxic substances with some noted as carcinogens (benzene and xylene) relative to water quality so the threat of petroleum pipeline spills and leaks can create extensive short and long-term damage to aquatic life and other uses (World Health Organization, 2014). Although not discussed further here, these products can also impact ground water via pipeline leaks and breaks. In addition to the impacts of hydrocarbons, a recent USGS study linked petroleum spills with elevated concentrations of arsenic in groundwater (Cozzarelli 2015).

A number of VOC compounds have been detected in surface and ground water and sediment in the Yellowstone corridor, albeit at low levels (Peterson et al., 2004). At least one VOC was detected in 85 percent of wells sampled from Quaternary aquifers, primarily VOC compounds associated with gasoline. Other samples of sediment near Billings had concentrations of related polycyclic aromatic hydrocarbon compounds that were high enough to pose a potential threat to aquatic life.

Natural gas and related materials offer less hazardous threats to aquatic life and human due to their relatively low solubility and propensity to volatize. Ignition is the primary hazard. Natural gas is not regulated by Montana or the Environmental Protection Agency (EPA) as a water pollutant (MDEQ 2012). The 2012 Atkins report also strongly recommended that regulatory authorities require the use of horizontal directional drilling technology as a BMP for installing future pipeline crossings and to relocate existing crossings in order to increase separation between pipelines and the river at crossings.

3.3 Agriculture: Impacts on Water Quality

Potential pollutants from agricultural sources include sediment, nutrients, salts, pathogens, and pesticides. Habitat alterations and agricultural runoff may also increase water temperature (MDEQ, 2012). Agricultural runoff and return flows are typically considered nonpoint sources. Agricultural point sources are regulated under the Clean Water Act (USC) or the Montana Water Quality Act (MCL). Point sources discharging to waters of the US or state waters within the Yellowstone River are discussed further under Urban/Exurban Development.

An array of best management practices (BMPs) are recommended to reduce pollution related to agricultural nonpoint sources under Montana’s Nonpoint Source Management Plan (2012). The following topics are discussed relative to the various forms of potential agricultural pollutants affecting the Yellowstone River.

3.4 Crop Production Runoff

Dryland and in particular irrigated agriculture within the Yellowstone River watershed has the potential to impact water quality due to discharge of salts, nutrients, bacteria, pesticides, and sediment in addition to altering water temperature. The USGS NAWQA Program reports suggest that observed increases in dissolved solids, nutrients, pesticides, and sediment is due in part to agricultural sources within the basin. Not all these sources are located within the corridor, in fact, most are located within tributaries far from the Yellowstone River.

Closer to the river, irrigated crop production, particularly furrow irrigation used for row crop production (corn, beans, and sugar beets) has the potential to transport salt, sediment, nutrients, and pesticides in runoff unless good irrigation and farming practices are utilized. Sprinkler irrigation has the potential to apply water with less leaching and runoff, however it is not suited to production of all crops nor to every producer. Use of appropriate irrigation BMPs through an irrigation management plan can significantly reduce pollutant transport and delivery to the Yellowstone River. While field specific water-quality studies are not available for the Yellowstone River, numerous herbicides and pesticides have been detected throughout the corridor in surface and groundwater in addition to observed increases in dissolved solids, suspended sediment and nutrients in major tributaries such as the Bighorn and Clarks Fork Yellowstone

River Yellowstone (Peterson et al., 2004). The results of these reach level studies demonstrate that relatively low to moderate levels of nonpoint source pollutants are being transported and delivered to the river in many parts of the Yellowstone watershed. Further targeted conservation education, demonstration, and outreach is necessary to eliminate these sources of pollution in the future before they cause long-term impairments to the multiple uses of the river.

3.5 Animal Feeding Operations (AFOs)

AFOs by definition are facilities where domestic livestock are confined, stabled, and fed for more than 45 days within a 12-month period resulting in a ground surface predominantly devoid of vegetation during the growing season or period of use (CFR, Federal Register, V. 68 No. 1, page 7265). Livestock producers often feed livestock to add value to crops raised on the farm. AFOs have the potential to discharge sediment, nutrients, organic waste (oxygen demanding substances), and water-borne pathogens (bacteria, viruses, and protozoans) to ground and surface waters (US Environmental Protection Agency, 2014). They may also release ammonia, odors, and other airborne pollutants that enter waterways. AFOs are considered non-point sources. Certain AFO facilities may be defined or designated as a Concentrated Animal Feeding Operation (CAFO) based on size and having a discharge to state waters. As point sources, CAFOs are regulated under Montana Pollutant Discharge Elimination System (MPDES) Permits in Montana (and similar permits in North Dakota. Both general and individual permits may be issued based on size and site factors. The permit defines when and how discharges are allowed from the CAFO and requires recordkeeping and other controls on potential sources of pollution from the facility. Properly sited and managed to avoid discharges, AFOs can operate without contributing pollutants to nearby waterways.

The 2013 land-use inventory and analysis (DTM) indicates that there are about 41 individual AFO operations on about 431 acres within the 100-year inundation boundary. These facilities are cattle operations for the most part. Figure 3-6 displays the relative distribution of mapped AFOs along the corridor. These sites range from very small to larger operations. Region C has the greatest number and spatial extent of AFOs containing about half of all AFOs in the inventory. Twenty-six feeding operations hold CAFO discharge permits issued under the Montana Pollutant Discharge Elimination System (MPDES) within one-mile of the Yellowstone River in Montana (DEQ, 2015).

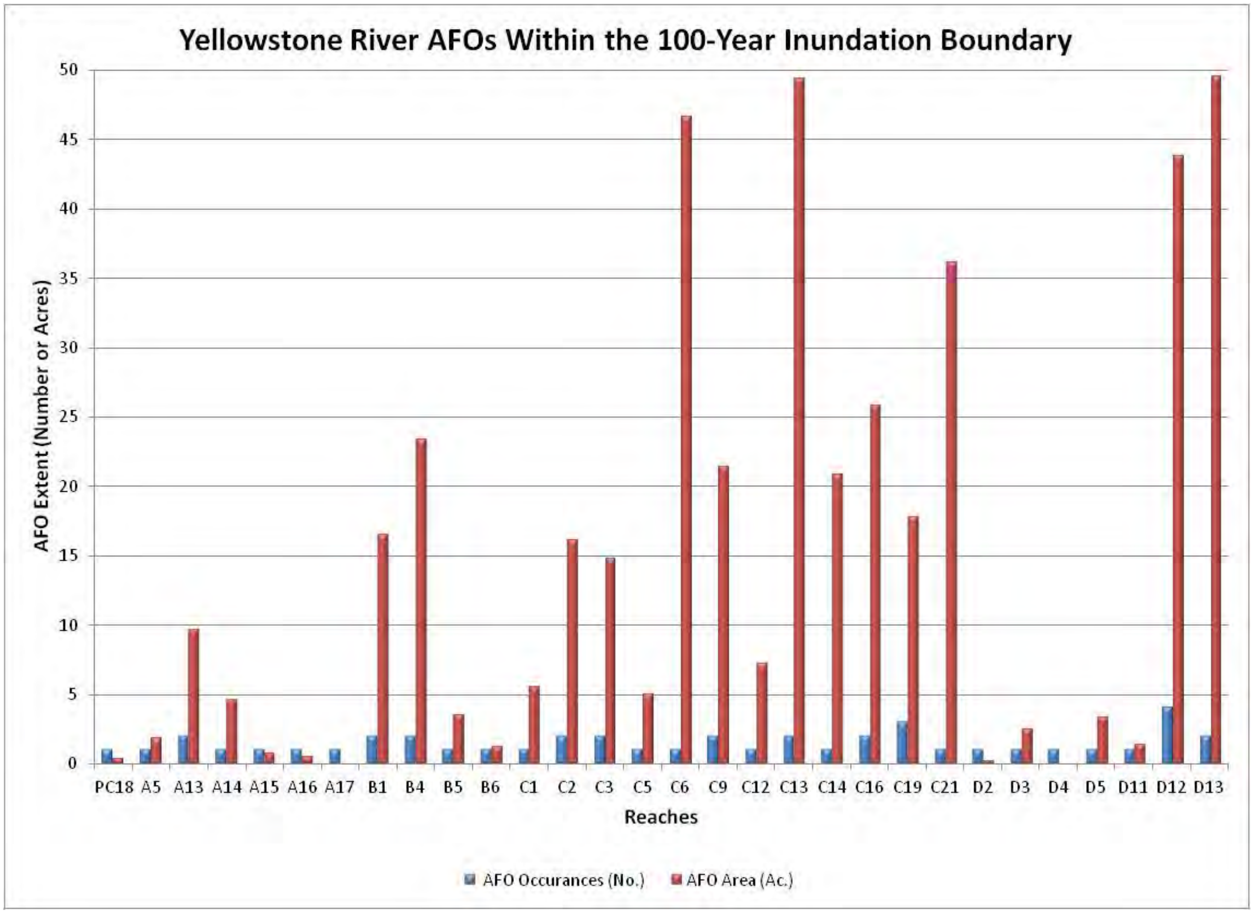


Figure 3-6 **Animal feeding operations by geomorphic reach within the 100-year inundation zone along the Yellowstone River are shown. The vertical Y-axis shows both the number and size (acres) of the operations based on the 2013 Land Use Mapping data. Most operations occur in the lower river where more corn and silage is grown and used for cattle feed.**

There is no data to directly relate AFOs, individually or collectively, to water-quality values measured in the Yellowstone River. Fecal coliform and *E. coli* bacteria occurred at the highest levels in urban and agricultural areas within the Yellowstone watershed likely due to sewage treatment plants, agricultural livestock, domestic animals, wildlife waste, and septic systems; however, most of the bacteria colony exceedences were noted to occur within tributaries and not in the Yellowstone River (Peterson et al., 2004).

3.6 Irrigation Withdrawals/Flow Depletion

Depletion of flows to the point that aquatic life is affected can be a serious impact of irrigation on water quality. Irrigation withdrawal is listed as the second leading agricultural cause of non-attainment of beneficial uses in Montana (MDEQ, 2012). Cumulative losses of water due to irrigation withdrawals described in Appendix 2 Hydrology potentially can affect summer low flows in the lower Yellowstone River to the point that the river's capacity to dilute pollutants is diminished, as well as the River's capacity to cool warmer water temperature inflows from return flows. Dilution capacity is important as the 7Q10 flow (minimum flow over seven consecutive days with a 10-year recurrence interval) is used to calculate allowable discharges for MPDES permits under the Clean Water Act. These permits are issued for 5-year periods under individual (major) and general permits and pollutant levels could potentially rise during low flow periods in the interim. Since the impact of some pollutants (toxins and bioaccumulated pollutants) are not affected by dilution, most classic indicators of water pollution benefit from additional solvent added to a known quantity of solute or as the saying goes, “The solution to pollution is dilution”. While not always true from a load standpoint, more water is better than less when it comes to evaluating the impacts of water-quality pollutants.

3.7 Conversion of Riparian Habitat to Agriculture Land Use: Increased Runoff/Leaching from Agricultural Lands

Conversion of riparian land cover to more intensive agricultural uses such as irrigated crop pasture or hayland may result in an increased potential for nutrients, salts, and sediment to enter the river due to removal of the vegetative buffer. Riparian and wetland cover provides a buffer zone for the attenuation of water pollutants (Klapproth and Johnson 2009; Lowrance et al., 1984; Parsons et al., 1994). Removal of riparian and wetland vegetation can provide accelerated pathways for these pollutants to enter the river (Ranalli and Macalady, 2010). Nutrients and salts are the primary pollutants of concern but pesticides are also important since many have been detected in surface and groundwater in the YR corridor (Miller et al., 2005; Peterson et al., 2004; Mulder and Schmidt, 2001).

The physical extent and functional implications of riparian conversions to agricultural land is discussed in Appendix 1 and 7. Restoration of riparian and palustrine wetland habitats in areas where they have been removed or their function altered can be used to reduce pollutant delivery and nutrient loads draining to the Yellowstone River. Protection of effective riparian habitat and processes that sustain riparian recruitment should be an objective of ongoing river management to protect water quality in reaches where agricultural lands adjoin the river.

3.8 Habitat Alteration Impacts on Water Quality: Grazing

Uncontrolled or unmanaged livestock grazing can degrade the integrity and function of riparian and floodplain habitats thereby increasing the potential for pollutants to enter waterways. Nutrients, sediment, organic matter, and pathogens are the pollutants of concern associated with livestock grazing. As noted in Appendix 7, livestock grazing may simplify riparian habitats by removing excess biomass, reducing woody cover, physically trampling banks, and removing understory vegetation resulting in loss of riparian function to trap and sequester pollutants (Belksy et al., 1999). Livestock grazing in riparian and shoreline zones is listed as the leading agricultural cause of beneficial use non-attainment in Montana affecting over 115 assessment units (MDEQ, 2012). The largest estimated source of nitrogen and phosphorus loading in the Yellowstone River watershed is non-agricultural lands, however by definition this land use includes rangeland. Point sources, crop fertilizers, livestock, and atmospheric deposition (for nitrogen) are other sources (Frankforter and Wright, 2015; Peterson, et al., 2004; Smith et al., 1997) estimated that fertilizer and manure contributed 45 percent of the phosphorus to the Clarks Fork Yellowstone River Yellowstone River. The Yellowstone SPARROW model predicted that animal manure is responsible for 22 percent of total phosphorus yield (Frankforter and Wright 2015) in the basin. Phosphorus occurs naturally in the igneous and marine sedimentary rocks that are prevalent in the YRB.

Prescribed grazing practices can focus the timing, duration, frequency, and intensity of livestock use in a manner that results in protection of riparian vegetation composition, diversity and residual cover which helps to maintain water quality and other important functions. Use of presecribed grazing practices is recommended for all grazing lands but in particular for grazing lands within the river’s valley corridor.

4.0 URBAN/EX-URBAN DEVELOPMENT: IMPACTS ON WATER QUALITY

As land use intensifies and urban/ex-urban development occupies an increasingly greater portion of the watershed and near channel landscape, there is greater potential for water quality to be adversely affected primarily due to on and offsite waste and sewage disposal/treatment and a concurrent decrease in the capacity of the landscape to infiltrate precipitation as impervious surfaces increase. The main areas of concern are related to nutrients, pesticides, pathogens, and sediment.

4.1 Conversion of Riparian Habitat to Urban/Ex-urban Development: Increased Runoff, Pesticides, and Nutrients.

Discussions regarding the extent and spatial distribution of riparian and wetland habitat conversion to urban and ex-urban development is addressed in the respective CEA chapters. **Additional detail concerning conversion of riparian habitat to urban/exurban development is found in Appendix 1 Land Use.** Table 4-1 summarizes the extent of conversion of riparian habitat to urban-ex-urban development between 1950 and 2011 within specific reaches. The analysis is not available for the PC Region. The extent of change indicates that the conversion is closely related to the proximity to large urban areas. Substantially lower extents of conversion are noted in areas near to smaller communities along the corridor (not depicted).

Table 4-1
Percent conversion of riparian cover in 1950 to urban-ex-urban land use in 2011.

Reach B1	Reach B2	Reach B3	Reach C17	Reach D6
5%	50%	17%	18%	9%

Loss of riparian cover to urban and ex-urban development can increase the potential for pollutants to enter waterways for largely the same reasons as discussed for agricultural conversions. Urban and ex-urban areas typically have higher proportions of impervious surfaces associated with roads, streets, parking lots and roofs which alter hydrology. While the relative size of the Yellowstone River renders it somewhat less sensitive to the impacts of impervious surfaces, large towns like Billings, Miles City and Sidney adjacent to the river with multiple stormwater discharges feeding either directly into the river or into tributaries a short distance from their mouths can locally impact the river through altered hydrology and discharged pollutants.

The USGS Yellowstone River NAWQA Program (Peterson et al., 2004; Peterson and Porter, 2002) identified nutrient enrichment and detected several other pollutant categories (SVOCs and pesticides in water, fish tissue, and sediment) in river segments downstream of the Clarks Fork Yellowstone River Yellowstone River through the Billings area. The related studies suggested that these pollutants originated from urban and industrial sources as well as agricultural sources in the Clarks Fork Yellowstone River. Many studies have noted that similar pollutants are often associated with urban development due to the increase in impervious surfaces and that urban stormwater systems often discharge directly to waterways bypassing water treatment facilities. Alteration of receiving streams' hydrologic regime, channel morphology, and water quality result (Klapproth and Johnson, 2009; May et al., 1997). The concurrent loss of riparian and wetland cover in areas near urban communities likely magnifies the impact of urban/ex-urban development on water quality due to the loss of near stream natural areas that can help to immobilize or sequester such pollutants before reaching the Yellowstone River. May et al. (1997) reported that as small as a 10 percent increase in urbanized area led to an altered hydrologic regime, channel morphology, and reduced measures of water quality in receiving waters.

Municipal wastewater treatment plants (WWTPs) and onsite sewage disposal systems have the potential to discharge excess nutrients and pathogens if not operated effectively. Typically, surface discharges to state waters from point sources like WWTPs are authorized through discharge permits issued through the Montana Pollutant Discharge Elimination System. The permits provide for discharge of designated pollutants under specific conditions outlined in the permit. Some 36 major MDPES dischargers issued under individual permits are located within Montana. Nearly half (17) of these major permits are in the Yellowstone watershed with 13 located within the Yellowstone River corridor. Five of these WWTPs are major dischargers with individual permits (Livingston, Billings, Miles City, Glendive, and Sidney). The USGS report by Peterson and others (2004) also noted that wastewater treatment plants along the river have continued to improve their technology and performance in removing sewage water-born pollutants, particularly nutrients, chlorides, and fecal coliform bacteria; thereby, greatly improving water-quality indicators over those observed in the Yellowstone River in the 1950s (Bahls, 1976; Karich and Thomas, 1977) although some degree of impairment continues. The Yellowstone SPARROW model predicted that some five percent of the total phosphorus delivered in the river is due to WWTPs. Of greater influence, the model predicted that in 2002 in the Upper Yellowstone-Pompeys Pillar HUC, WWTPs contributed nearly 40 percent of total nitrogen yield, although upgrades could have since reduced this proportion (Frankforter and Wright 2015).

Poorly designed or neglected septic disposal systems can be sources of excess nutrients and pathogens. Standard design septic systems do not effectively remove nitrate and therefore contribute to elevated concentrations of nitrate in groundwater (MDEQ, 2012) Elevated levels of nitrate were found in ground and surface water draining developments in the Billings area by Mueller and Schmidt (2011). The use of best management practices to design, install, and maintain approved septic systems is needed to eliminate excess pollutants entering surface waters via groundwater return flow.

About 124,000 household sewage disposal systems (i.e., on-site septic systems) are utilized in Montana (MDEQ 2014). While it is not known how many septic systems are located within the Yellowstone River corridor at any one point in time, a septic tank density tool was developed by the Montana Natural Resource Information System (NRIS) to allow estimation of septic system density risk factors along Montana's waterways (2015). Data was not available for Reaches D15 and D16 in North Dakota. The tool uses population census blocks and municipal boundaries (where municipal sewer systems are presumed available) to map estimated septic system densities assuming one septic system for every 2.5 people. The estimated densities and ratings themselves do not necessarily indicate pollution but do help to look at the risk potential that occurs with higher densities of septic systems closer to the river. The ratings could be used to target outreach on septic tank maintenance requirements and related best management practice information.

To help understand trend in the basin, a comparison was made in the changes between a 1990 rating and a 2010 rating for the entire river corridor using a one-half mile buffer along the river (one-mile wide corridor). The acreage of the high, medium, and low septic density ratings were normalized by valley mile to aid in comparison since reaches are variable in acreage. Figure 4-1 depicts those river reaches where change in excess of 0.2 acres per valley mile was noted.

Table 4-2 provides the raw 2010 risk category acreages for the CEA regions showing that Region B has the largest acreage in the medium risk and high risk categories as a result of the population growth there and number of farms. The Park County (PC) Region is not far behind given the expansion of rural/exurban developments that have taken place there over the past 20 years or so. Low risk acreage basically represents the area of the one-mile wide corridor that is not medium or high risk area.

Table 4-2
Acreages of septic tank density risk ratings for Yellowstone River regions (2010).

Region	Low Risk Ac.	Low Risk No. Reaches	Medium Risk Ac.	Medium Risk No. Reaches	High Risk Ac.	High Risk No. Reaches
PC	55,305	21	1,178	12	238	9
A	57,372	18	894	14	76	9
B	49,846	12	2,122	5	364	5
C	86,642	21	340	6	76	2
D	80,010	14	289	5	102	3

Landfills, particularly unlined solid waste disposal facilities, pose a threat to surface water and groundwater-quality as harmful and toxic substances can leach into shallow groundwater aquifers or surface waters. Water-borne pollutants from land disposal include nutrients, pathogens, pharmaceutical compounds, and personal care products (National Association of Clean Water Agencies, 2005). Landfills are regulated by the Montana Department of Environmental Quality. There are at least three currently operating landfill facilities within one-mile of the Yellowstone River corridor. The landfill database at NRIS's Digital Atlas of Montana (2014) shows there are five closed facilities within one-half mile of the river: Big Timber, Columbus, Lockwood, Custer, and Forsyth. Additionally, there is an old closed facility adjacent to the river near Livingston not included in the database. The 2001 Physical Features inventory identified a number of dump sites adjacent to the river that pose potential risk for leaching of pollutants into the river but no data is available by which to qualify the potential pollution risk. State regulations are in place that address the proper placement of waste dumps on private land and should be enforced to minimize this source of pollution risk to the Yellowstone River.

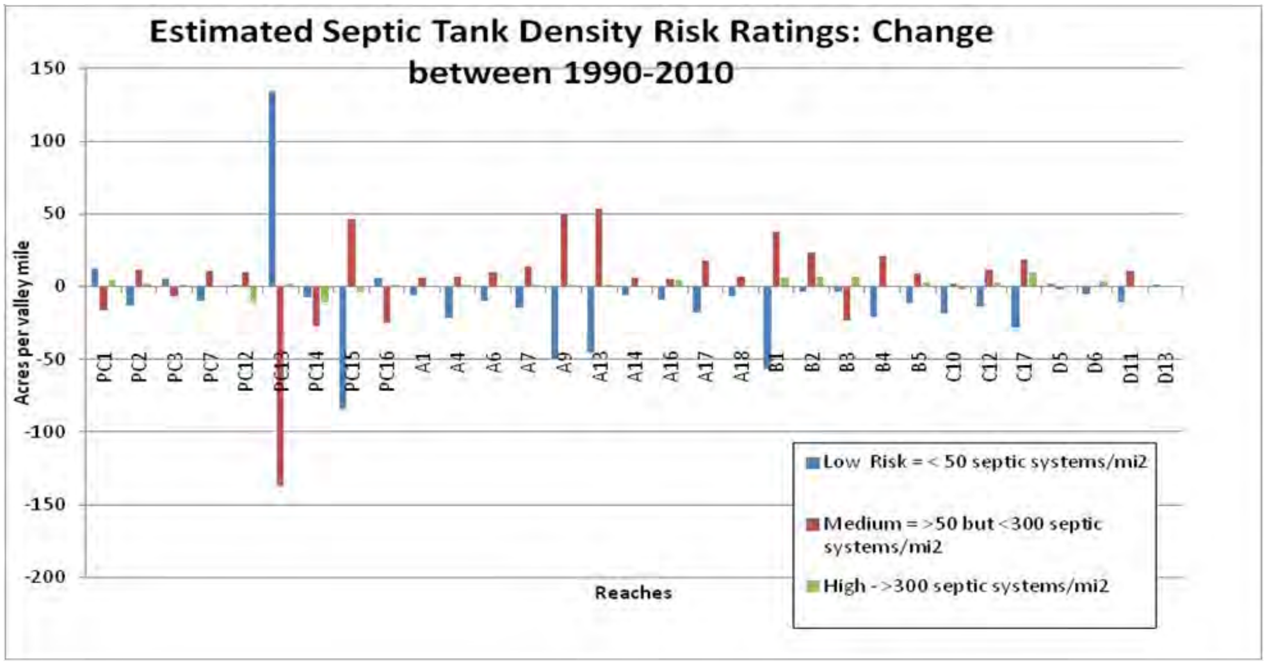


Figure 4-1 **The change in acreages (per valley mile) of estimated septic tank density risk ratings that occur within CEA reaches are shown. In Park County (PC reaches), densities are the highest in Reach PC13 (Carters Bridge to Interstate and PC15, Mayors Landing area. Other areas with elevated risk ratings are A9 and A13, Reed Point and Columbus, respectively. B2 is in the Billings area. Smaller but regular changes are seen going downstream near existing communities. Losses in acreage generally represent a shift from low risk to medium or high, although in some cases lower population in 2010 led to decreases in risk value and acreage. Note that reaches not shown in the chart had very low to no change evident in risk ratings between 1999 and 2010.**

When complex riparian systems are simplified or reduced by changing the vegetation, soils, and/or water-flow patterns, their ability to filter pollutants is greatly diminished. Riparian and wetland areas that have been converted to lawns or small acreage pastures for domestic livestock suffer from higher levels of nutrients, sediment, and bacteria. This can also lead to nuisance or toxic algae blooms, elevated water temperatures, greater channel erosion, and greater damage to property from flooding.

Stormwater runoff from urban and ex-urban areas, particularly during construction can carry sediment and other pollutants at orders of magnitude higher than background levels. Sediment yields from construction site runoff can be 1,000 times greater than from forestland (Owen, 1975). MPDES general discharge permits require contractors to protect state waters from construction activities that disturb more than one acre as part of a project (MDEQ, 2012). DEQ provides information and educational materials regarding how construction activities can harm water resources and what efforts and requirements contractors and private citizens can, or must, take to minimize the effects of construction activity. See Administrative Rules of Montana, Title 17, Chapter 30, Subchapters 11 and 13 pertaining to Small MS4 Storm Water Discharge Permitting.

Over 260 MPDES stormwater permits are currently in place for construction activities within one mile of the Yellowstone River in Montana (MDEQ, 2014d). Sixty-five permits are for subdivision and ex-urban development. Stormwater runoff from urban and industrial areas is a significant source of pollutants such as oil and grease, pesticides, fertilizers, bacteria, and metals (e.g., lead, copper, zinc). In the Yellowstone

River corridor, pollution from stormwater runoff is relatively localized because the number and scale of urban areas is limited. Point-source discharge permits for municipal storm sewer systems are currently required for seven urban areas in Montana: Billings, Bozeman, Butte, Great Falls, Helena, Kalispell, and Missoula. Additionally, portions of Yellowstone County and Montana Department of Transportation facilities (within the designated urban areas that require permits) hold discharge permits requiring six minimum measures: public education and outreach, public involvement, illicit discharge detection and elimination, construction site runoff controls, post-construction stormwater management, and pollution prevention (MDEQ, 2012).

Smith et al. (1997) estimated that about 60 percent of the average total nitrogen yield in the Yellowstone River Basin was from non-agricultural sources, including rangeland. The use of constructed or restored wetlands in agricultural and urban/ex-urban areas to capture and treat surface and groundwater flow to remove nitrate-nitrogen is suggested. Collins and Gillies ((2014) showed a 17-percent reduction in nitrate-N in receiving streams with use of constructed wetlands. Harrison et al. (2014) showed that oxbow wetlands adjacent to restored urban streams were capable of serving as sinks for N and P. Design of wetlands needs to balance connectivity to stream and residence retention time if nutrient removal is the objective. Anaerobic conditions can lead to release of available P due to mineralization of organic P in wetland particularly if development in uplands has led to accumulation of P in wetlands. Low Impact Development (LID) practices can be used to mitigate impacts of impervious surfaces. Long and Dymond (2014) demonstrated that bioretention ponds can be used to reduce peak stormwater runoff by 51 percent and runoff temperatures an average of 8.6^{0}C, particularly if used in a BMP ‘train’ of LID practices in series to reduce and detain stormwater runoff.

Urban and ex-urban development requires adequate sources of high quality water to serve residents and businesses. Figure 5-1 shows the location of over 80 Public Water Supply (PWS) systems within one-mile of the Yellowstone River in Montana (MDEQ, 2014b). Data for North Dakota was not available. These PWS systems serve nearly 165,000 people using ground and surface water sources. Municipal systems drawing on surface water from the Yellowstone River serve nearly 90 percent of these customers. The communities of Billings, Lockwood, Laurel, Hysham, Forsyth, Miles City, and Glendive depend on surface water quality and quantity to meet their residents water needs (MDEQ, 2014b). Alterations to water quality and quantity in the Yellowstone River would negatively impact these communities. Late summer limitations in streamflow have affected PWSs drawing on surface water in drought years in the Billings area. Suspended sediment, algal residue, pathogens, TDS, metals, and alkalinity have the greatest impact on water-quality treatment by increasing treatment costs.

5.0 INDUSTRIAL DEVELOPMENT: IMPACTS ON WATER QUALITY

5.1 Industrial Wastewater Discharge: Surface and Groundwater Pollution from Return Flows

Wastewater discharge returns water to the Yellowstone River. Eight MPDES-permitted industrial facilities discharge process wastewater to the Yellowstone River following treatment (MDEQ 2014). These Individual (major) MPDES permitees in the corridor are the Montana Rail Link Yard – Livingston; Corette Thermal Plant - Billings (presently offline); Exxon Mobile refinery- Billings; Phillips 66 refinery - Billings; Cenex Harvest States refinery - Billings; Western Sugar Cooperative – Billings; MDU Lewis and Clark Steam Electric Power Plant - Sidney; and Sidney Sugars - Sidney. Twelve smaller community waste water treatment systems are considered minor MPDES dischargers to the Yellowstone River.

Another Individual MPDES Permit holder, East Rosebud Coal Mine – Decker, withdraws water from the Yellowstone River, but discharges runoff and wastewater into a number of small tributaries before reaching the Yellowstone River. An additional four mineral or coal mining operations are MPDES permitted in the watershed but do not discharge directly to the Yellowstone River. Open cut coal mining can cause an increase in dissolved salts (TDS) inputs to surface and ground water due to exposure of the coal seam and spoil piles. The mining process shatters geologic material and exposes reactive minerals to accelerated weathering and oxidation which releases salts, primarily SO_4^{2-}, HCO_3^{-}, Ca^{2+}, and Mg^{2+}. The weathering and leaching process has been shown to last two to three decades before these ions return to original pre-mining salinity levels (Evans, et al. 2014).

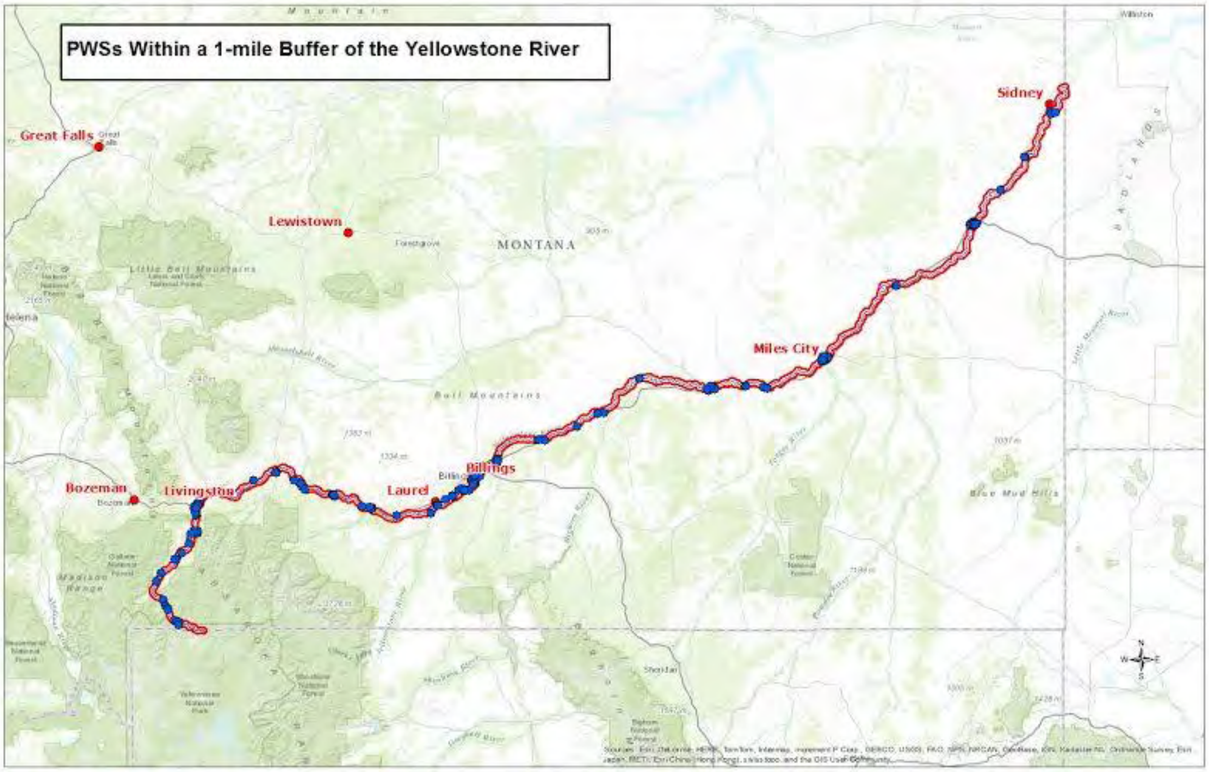


Figure 5-1 Map of the more than 80 Public Water Supply Systems (PWSs) within one-mile of the Yellowstone River in Montana. Eight of these systems including seven communities draw and treat surface water from the Yellowstone River to serve about 145,000 people. The source of the other systems is ground water within the river corridor. Maintaining clean ground and surface water in the Yellowstone River corridor is extremely vital to a healthy economy and public. Map source: Montana DEQ, Water Protection Bureau, Helena, MT.

Industrial discharges can potentially affect water quality by contributing manufacturing or processing waste products such as ammonia, SVOCs, PAHs, solvents, nutrients, chlorides, sulfates, metals, grease and other pollutants. Effluent limits are placed on the appropriate effluent parameter, however, permits often provide for a mixing zone below the permitted outfall. The size of the mixing zone is dependent on the nature of the discharge and its constituents, and the quality and quantity of the receiving water. In some cases, mixing zones in the river may be up to several miles long or not permitted. Industrial discharges can often require cooling before discharge in order to meet state water-quality temperature standards applicable to the classification of the receiving water. All MPDES permits require water-quality monitoring and compliance reporting to insure conformity with effluent limitations specified in the individual permits.

The mapping DEQ's data application (2015b) has a total of 27 gravel pits that are located within about one-half mile of the Yellowstone River. Gravel pit operators disturbing more than 10,000 cubic yards cumulative are regulated by MDEQ under the state's open cut mining laws (MCA 82-4-434 (3)(l)) (MDEQ 2013b). Gravel pits may also be required to obtain and follow a MPDES stormwater discharge permit if they discharge to state water. Gravel pits that discharge are prohibited from negatively impacting water quality or associated resources. Operators following approved best management practices and properly reclaiming disturbed ground generally are not a risk to water quality.

5.2 Industrial Water Use: Water Withdrawals/Flow Depletion

As noted previously, increased water depletions in the Yellowstone River that diminishes discharge have the potential to affect the assimilative capacity of the river in diluting and degrading pollutants. As noted in Appendix 2, industrial water use consumes an estimated 11 million gallons per day (Mgal/Day) of Yellowstone basin water (2000 data) which is relatively minor compared to irrigated agriculture's use of water (3,012 Mgal/Day). Thermoelectric powerplants are the second highest users of Yellowstone basin water using about 110 Mgal/Day.

Coal mining uses relatively less water than power production but development facilities proposed in the lower Yellowstone River basin (and Powder River basin) could measurably add to water demand in the future. If additional proposed coal mines and production facilities are built that result in increased water use and consumption, they may impact the lower river's capacity to meet demand and not impair uses in July, August, September and October (Montana Department of Natural Resources and Conservation, 1977; Klarich and Thomas, 1981).

CBNG production produces water if production water is discharged to the surface. As such, ground water levels may be locally depleted within the cone of depression created by pumping a well field. CBNG production water typically has elevated TDS and SAR levels (Clark, 2012; Clark and Mason, 2006). Elevated SAR and TDS levels can have detrimental impacts on soil. Montana has enacted the Coal Bed Methane Protection Program (MCA, 2014) (Mont. Code Ann.§ 76-15-901, et seq.) that provides a process in which claims to damage of land and water quality or availability related to CBNG wells are assessed by local conservation districts. In some cases, production water is treated, infiltrated (land applied), or deep injected in order to meet water-quality standards. Discharging CBNG wells in Montana require a MPDES permit to discharge with the permit setting effluent limits for the pertinent constituents. The declining price of natural gas has reduced the development and permitting of CBNG wells in the Powder River basin in Montana in recent years so production water has declined and the current degree of water production is not known. No CBNG wells currently discharge directly into the Yellowstone River. Existing Montana CBNG wells discharge into the Tongue River. Large numbers of CBNG wells discharge into the Powder and Tongue Rivers in Wyoming, although recent studies have shown no steady statistical trends in major ions over time (Sando et al. 2014). Until the price of natural gas rises, additional wells are not anticipated.

The recent expansion of oil and natural gas drilling and production into the lower Yellowstone River valley near Sidney and Glendive as part of resource extraction activity in the Bakken and Williston Basin in North Dakota and Montana creates additional demand for water resources. The 'fracking' process used to enhance extraction of natural gas and oil from shale formations requires abundant water resources. Several million gallons of water are utilized per well. Alternate technologies are being tested to use air pressure, CO_2, or other inert materials for this purpose but at present, water is the most effective and economical medium. Once used and extracted, the water is contaminated with drilling materials and is typically deep injected to dispose of it. As this water is not directly returned to the drainage it is removed from, the process constitutes a consumptive use. Should extensive oil and gas development continue in the lower Yellowstone River, this industrial use could result in substantial water consumption relative to other uses.

In summary, industrial related activities that lead to increased consumption of Yellowstone River water in the future may affect late season flows in the middle and lower river to the point that concentrations of common water-quality constituents and physical properties like water temperature are elevated and negatively affect aquatic life and other beneficial uses. Water conservation practices and reuse technologies can help to reduce the impact of future water demand on Yellowstone River resources.

5.3 Invasive Species: Impacts on Water-quality

Invasive species are primarily a threat to the species composition, structure, and health of native vegetation in uplands, wetlands, and riparian habitat adjacent to the river as discussed in Technical Appendix 6 Biology: Terrestrial Plants (Riparian Systems) and Technical Appendix 7 Biology: Aquatic Plants (Wetland Systems). A few invasive species also have potential to impact water quality in that the plants contain compounds that are soluble in water. Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix* spp.) are two invasive species discussed here that have been shown to affect water quality.

5.4 Russian Olive and Saltcedar

Saltcedar plants have been shown to accumulate salts (sodium, calcium, and magnesium) and metals (lead and cadmium) in their leaves and exude these elements on the leaf surface (Kadukova et al., 2008). The elements are then shed with the leaf and collect at the ground surface where they can affect water quality and native riparian species germination (USFS, 2015) (Jacobs and Sing, 2007). In the southwestern U.S., a single saltcedar plant has been reported to transpire as much as 200 gallons of water per day but this does not seem to be the case here in Montana (Meridith and Wheaton, 2011) so impacts on the quantity of water resources may not be so severe in this climate.

Russian olive has been found to affect water quality in several ways. Research shows that the plant's roots are associated with a nitrogen-fixing bacteria that accumulates nitrogen in the soil (Mineau et al., 2011) Dense Russian olive stands adjacent to streams subsidize delivery of organic nitrogen to surface and ground water. The added nutrients have the potential to alter biochemical cycling in the receiving water causing a chain reaction of impacts to aquatic organisms ranging from biofilms to fish. Secondarily, the increased organic load added by Russian olive leaves and olive fruits in surface water can increase the biological oxygen demand and reduce DO levels. A study underway in Idaho suggests that the increased food source provided by Russian olive leaves and fruits may favor the growth of exotic aquatic species like common carp (Cyprinus spp.) (O'Connell, 2014).

5.5 Aquatic Invasives

A number of aquatic invasive species have the potential to affect water quality by altering the amount of organic material in the carbon cycle that is decomposed in the river. Growth of dense masses of submerged and emergent invasive aquatic species are benefited by elevated nutrients in water. These species (see the invasive species chapters in Technical Appendices 6 and 7 for additional information) can reduce streamflow and alter DO levels and water temperature. The added load of decomposing organic materials created by invasives can then tie up DO harming aquatic life. Floating, single celled algae and phytoplankton can increase the turbidity of water which allows the water to absorb more solar energy. Some invasive species such as zebra mussels (*Dreissena polymorpha*) can alter water clarity and the nutrient balance (turbidity) through the process of filtration. In any case, invasive species by nature reset chemical, physical, and biological thresholds thereby creating a new 'normal' for an ecosystem.

In summary, invasive species have the potential to alter water quality of the Yellowstone River through both chemical, physical, and biological processes. Added emphasis on the role and threat posed by present and future invasive species will help to insure that these potential threats are not fulfilled in the Yellowstone River basin.

6.0 OFF CORRIDOR IMPACTS

6.1 Yellowtail Dam: Altered Hydrograph, Stream Morphology, Water Temperature, and Sediment Alterations

Impacts of the Bighorn River on the hydrology of the lower Yellowstone River have been discussed throughout many of the CEA Technical Appendices and individual river element narratives. A few additional points relative to Yellowtail Dam are worth mentioning in terms of water-quality impacts:

- The Bighorn River is a low sodium, high salinity water and presents some hazards for irrigators using that water (Soltero et al., 1973). Because of the operation of the Dam in regulating flows, this water is diluted sufficiently that it does not impact the water quality of the Yellowstone River below the confluence during summer months when irrigation is taking place. Should upstream water uses in the Yellowstone increase resulting in diminished summer discharge below the Bighorn, there is the potential that TDS in the Yellowstone could be measurably affected during low-flow periods.

- Yellowtail Dam discharges water that is cooler than natural conditions. This discharge supports a Blue Ribbon cold-water trout fishery below the Dam. Summer water temperatures below the mouth of the Bighorn do not seem to be appreciably affected by this cold-water discharge. Anecdotally, winter water temperatures in the Yellowstone River below the confluence and as far downstream as Forsyth, are thought to be warmed by Bighorn River water inflow. However, data and studies analyzing the possible impacts of this potential effect are lacking.

- Mercury accumulation in fish in Bighorn Lake does not appear to affect fish downstream given the chemical process that facilitates biologic uptake of mobile mercury.

- Yellowtail Dam has a history of gas bubble trauma in trout caused by the supersaturation of nitrogen in discharged water under certain flow conditions. The condition is most prominent in the Afterbay pool and in the upper three miles of river below the Afterbay Dam. Fish are temporarily affected to varying degrees and in some cases do die. The problem does not seem to persist into the Yellowstone River as the nitrogen gas saturation levels decline to where they are no longer injurious to fish.

- Sediment retention in Bighorn Reservoir has been previously addressed in this document. Reduction of the sediment load delivered to the Yellowstone River is thought to adversely affect the habitat requirements of some fish species, specifically sauger (*Sander canadensis*) (Jaeger, 2004). Sauger are designated a "S2" species of special concern by the Montana Natural Heritage Program, Montana Department of Fish, Wildlife & Parks, and the Montana Chapter of the American Fisheries Society.

6.2 Climate Change

Specific climate projections and analyses have not been made as part of the Yellowstone CEA, because of limitations in time and resources but are encouraged to be undertaken as resources are available by those who follow this work. Following are impacts suggested by a review of climate change literature relative to water quality in the Yellowstone ecosystem.

Climate change can potentially impact water quality in the Yellowstone River and its tributaries through a number of climate-related mechanisms altering the timing, distribution, and volume of stream discharge (Leppi et al., 2011; Stewart et al., 2004; Mote, 2003). These mechanisms are directly related to variability in climate, primarily precipitation and temperature. Less precipitation and warmer winter temperatures may be more the norm in the Yellowstone basin. In the northern Great Plains area, which encompasses the Yellowstone River Basin, precipitation has decreased by 10 to 20 percent since 1990 (IPCC, 1998). Graumlich et al. (2003) used tree rings to study climatic variation in the upper Yellowstone watershed. A much drier climate may better represent long-term conditions in the Yellowstone watershed based on their results. Warmer air and water temperatures coupled with reduced stream flow can be expected to negatively affect water quality in the Yellowstone basin (Miller, 2008).

Decreased flows during past drought periods have lessened the diluting effect of streams on inflows (including surface and ground water), resulting in increased concentrations of dissolved pollutants. For example, substantial increases in nitrate nitrogen (NO_3-N) concentrations were noted during drought years (2000-2001) due to less dilution of nitrate-rich ground water discharges (Miller, 1999). Lower dissolved-oxygen levels and higher stream temperatures also may occur during extended periods of low flows, adversely affecting aquatic life (Matthai, 1979; Miller, 2008). Similar or even greater pollutant concentrations may be expected in a drier climate when demand for water resources in the Yellowstone River may be heightened.

A warming and drier climate likely will create conditions more suitable for invasive species and amplify the negative impacts of invasive species discussed in the previous section of this report. As the impact of invasive species may alter the function of riparian and wetland habitats the capacity of these areas to trap and sequester pollutants will decline with potential increases in pollutant loads from adjacent ex-urban and agricultural land. Riparian buffers have been shown to reduce groundwater nitrate by 76 to 92 percent as nutrient laden water moves through the riparian buffer (Wiseman et al., 2004). Boggs (1984) showed that carbon, nitrogen, sodium, and potassium were stored in riparian habitat reaching highest sequestration levels in mid-seral stages compared to grasslands. The nutrients stored in converted or degraded riparian habitat will leach out as the organic material is decomposed altering the nutrient flux in adjacent waters. Wetlands also have been shown to provide effective removal of nitrates in groundwater, stormwater volume reduction, and to moderate runoff water temperature from impervious surfaces (Lang et al., 2014; Collins and Gillies, 2014; Harrison et al., 2014). Reduction in the extent and function of riparian and wetland habitat, whether through the impact of invasive species or conversion to other uses, will alter these functions that presently benefit water quality.

The impacts of climate change on water quality in the Yellowstone River basin may be different for upper and lower segments of the river due to differences in elevation, precipitation, air temperature, land cover and use, and the contribution of return flows from irrigation. The recommended approach to best accommodate the impacts of climate change is an adaptive management approach that utilizes effective monitoring, flexibility, and collaborative planning to protect water quality and quantity in the basin (DNRC, 2015).

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 6

Biology: Terrestrial Plants (Riparian Systems)

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1.0 INTRODUCTION

The following Appendix summarizes the Biology: Terrestrial Plants (Riparian Systems) data and analysis used in support of the Yellowstone River Cumulative Effects Assessment (CEA). The analysis is based on the following series of existing primary data sources as well as information extracted from supporting references. The objective of this document is to provide an overview and summary of the riparian resource that can be used to help evaluate results that have been reached in other components of the CEA. This Appendix presents only a portion of the riparian vegetation statistics developed for the Yellowstone River. The intent is to provide a basic synopsis of the primary results of the analyses, and to help establish pertinent information for use by other disciplines in the evaluation of human impacts in the Yellowstone River corridor. All supporting documents referenced are available for public review and evaluation.

Data analysis and discussion in this riparian technical reference is presented primarily for the 67 geomorphic reaches delineated within the four physiographic regions (A-D) between the Park County (Montana) county line near Springdale and the river's confluence with the Missouri River in McKenzie County, North Dakota. Ten geomorphic classifications were used to designate the reaches. The reach designations reflect geomorphic differences in stream condition such as pattern (number of side channels and sinuosity) and confinement status that influence riparian potential, among other attributes. Descriptions of the regions and geomorphic reach types are found in Chapter 3 of the CEA report. Reach descriptions describing a summary of attributes for all reaches are located in Chapter 3. Reference to data and analysis for the Park County (Montana) portion of the river is made when appropriate, primarily for purposes of comparison to the upper river.

The primary data sources used include the following documents:

1. **Yellowstone River Riparian Vegetation Mapping. (DTM and AGI, 2008, updated 2012**). This report evaluates the extent and change in four riparian vegetation classes in the Yellowstone River between the Park County line (Springdale) and the mouth of the river in North Dakota at three relative points in time: 1950, 1976, and 2001. In addition to the basic vegetation polygon metrics evaluated by reach, region, and channel type, the mapping includes determination and evaluation of spatial complexity (polygon counts, perimeter/area ratio, and nearest neighbor distance). The 100-year inundation boundary with a one-tenth-mile buffer added was used to define the lateral extent of the riparian mapping in each of the 67 geomorphic reaches established between Springdale and the river's mouth. The riparian mapping effort did not extend to Park County since it had previously been mapped and analyzed under an earlier effort (see No. 6 below).

2. **Yellowstone River Land Use Mapping and Analysis, (DTM ,2013).** This report provides results of land use mapping of digitized polygons using 1948-1950s, 1976-1977, 1999-2001, and 2012 aerial imagery. Four tiers of nested land use attributes were delineated within the GIS-modeled 100-year inundation boundary plus a buffer of 500 meters.

3. **Avian Habitat Relationships: A Literature Review and Assessment, (Jones, 2014).** This report provides a review of pertinent literature on observed relationships between riparian birds and land use/riparian habitat resources and invasive species. The report also evaluates the potential impact of human induced land use changes along the Yellowstone River on forest habitat loss and fragmentation, structurally complex cottonwood forest habitat, and the impact of habitat changes on population dynamics of an invasive bird species: Brown-headed Cowbird.

Russian olive and saltcedar research provide some insights into possible impacts on avian species.

4. **Yellowstone River Wetland/Riparian Change Detection Pilot Study, (Kudray and Schemm, 2006).** This report provides the results of a pilot study to determine if wetland and riparian vegetation in two representative reaches (A16 and D6) could be accurately mapped using digitized historical aerial photography (30s, 50s, 70s, 90s, and 2001). General Land Office surveyor's notes were also used to evaluate their potential to assess historic vegetative conditions.

5. **Russian olive (Elaeagnus angustifolia L.) Distribution Mapping for the Yellowstone River and Tributaries Using Feature Analysis Software, an Extension for ArcMap, (Combs and Potter, 2011).** This Technical Guide document describes a NRCS project to delineate the distribution and extent of Russian olive along the Yellowstone River and its major tributaries in Montana. A variable-width project area was delineated that encompassed the floodplain and valley floor. Feature Analyst, an ArcMap extension, was used to identify and delineate individual plants and polygons using National Agriculture Imagery Program (NAIP) imagery. Manual editing was used to further refine the mapping product for which county level metrics were calculated.

6. **Temporal patterns of channel migration, fluvial events, and associated vegetation along the upper Yellowstone River, Montana, (Merigliano, M.F. and M.L. Polzin, 2003).** College of Forestry and Conservation, University of Montana, Missoula, Montana. Available on the internet at: http://upperyellowstonerivertaskforce.org/pdf/RiparianTrendFinal.pdf. This study was conducted for the Governor's Upper Yellowstone River Task Force and looked at the relationship between fluvial geomorphic processes and flood plain vegetation for the Yellowstone River between Gardiner and Springdale, Montana.

7. **Yellowstone River Historical Retrospective Completion Report, (Confluence Consulting, Inc., 2003).** This report summarizes a review of historical information for the Yellowstone River mainstem regarding fish, water quality, fluvial geomorphology, vegetation, and wildlife activity prior to 1900. Academic studies, historical records, archival documents, photographs, and maps, interviews, and other sources were used to create the summary and accompanying database of annotated comments. The information is useful in gaining a large scale view of conditions pre- and post-settlement.

8. **Russian Olive Data Analysis and CEA Database Integration, (DTM, 2013).** January 16, 2013 Memo to TAC. This document presents the results of an effort to integrate the NRCS Russian Olive inventory into the CEA process as well as the associated reach narratives. Summary tables are provided that relate the inventory to reaches, the CMZ, 1950s banklines and channel, 2001 fisheries habitat, 2001 riparian vegetation cover classes and 2001 physical features. The presence of linear features such as tributaries, ditches, canals, and old channels, where Russian olive has preferentially invaded tends to skew the data at the reach level.

9. **Upper Yellowstone River Watershed Land Cover Assessment – Final Report (Pick and Potter, 2013).** This report describes land cover within the 2.4 million acre Upper Yellowstone River Basin (4th Code Yellowstone Headwaters (10070001) and Upper Yellowstone (10070002) Hydrologic Unit Codes) at two periods in time. Landsat satellite images from 1985 and 1999 were evaluated and classified into 15 land cover classifications to determine change over the time period. An additional analysis looked at land cover within a ½ mile-wide corridor bisected by the river channel. Evaluations of land cover related to hydrologic function, water quality and wildlife

habitat were also presented and discussed. Broadleaf riparian cover represented 0.7 percent of the area within the Upper Yellowstone HUC and about 14 percent of the ½ mile-wide river corridor.

10. **Upper Yellowstone River hydrogeomorphic functional assessment for temporal and synoptic cumulative impact analyses - Hauer, F.R., B.J. cook, M. Millar, C. Noble, and T. Gosner. 2001.** The hydrogeomorphic (HGM) approach was developed to evaluate wetland ecosystem function. This HGM assessment was conducted in 2000 on three reaches of the Yellowstone River between Emigrant and Livingston. Floodplain areas were assessed where cut-and-fill alleviation has been particularly active, resulting in a number of permitting activity for bank stabilization structures. This assessment results documented an increase in barbs and jetties, and the use of rock riprap, which approximately doubled in extent within the study area between 1976 and 2000. A decline in Functional Capacity Indices (FCI) between 1976 and 2000 was due to the increased riverbank and floodplain stabilization structures. Ecological integrity of the riparian vegetation was also affected according to the study. In summary, the HGM assessment noted negative cumulative impacts to the floodplain along the Upper Yellowstone study sites due to an increase of riverbank and floodplain stabilization structures, land use practices and the invasion of nonnative vegetation.

1.1 Major Findings in Support of Cumulative Effects Analysis

The primary findings of the wetland and related land use analysis that may support multiple aspects of the CES include the following:

1. Riparian areas provide important ecological services critical to the integrity of the river's short- and long-term function. Potential impairment to hydrologic, geomorphic, and biological functions are noted to occur where riparian removal or degradation exceeds a threshold that is not quantified as of yet for the Yellowstone.

2. Historical records indicate that much of the Yellowstone River floodplain in the early 1800s (pre-settlement) consisted of abundant stands of cottonwood timber and attendant shrubs along with extensive herds of wild ungulates. Early agricultural development and removal for fuel (transportation) and construction likely led to the conversion of locally significant stands of woody vegetation. Most of the large-scale conversion was likely completed by the 1950s.

3. Riparian mapping shows a fairly complex, non-linear trend in cumulative extent and distribution over the time scale analyzed. Overall, riparian classes constituted an average of 20 percent of cover within the mapping boundary between 1950 and 2001, fluctuating from 22 percent in 1950, 19 percent in 1976 to 21 percent in 2001. This indicates that cumulative losses on one bank about equal gains on the other bank which matches the hypotheses that in healthy river systems, a dynamic equilibrium is in place over time which balances channel movement-induced losses and gains equally.

4. The relative extent of riparian within the project area varied a great deal. Riparian communities made up as much as 44 percent of land cover in Reach D11 in 1950 (Richland Co. – partially confined - anabranching) to as low as 2.7 percent in Reach D1 in 2001 (Prairie Co. confined - meandering).

5. Changes in riparian extent are much more dramatic within individual reaches, particularly net loss in Region A (A1, A2, A4, A5, A10, A11, and A13), and Region C (C14).

6. Changes in the relative composition of specific riparian vegetation classes in reaches A1, A2, A10, A14, A15, B4, B9, B11, C1, C3, C6, C8, C18, C20, D3, D13, and D15 commonly exceeded 100 percent; and up to 600 percent change (A10 and A14).

7. Over 6800 hundred acres of 1950s woody riparian vegetation was converted to another land use by 2001. Over 5,500 acres of this cover was converted to irrigated agriculture, with 2,900 acres in Region D alone. Reaches where irrigated conversion took place in excess of 20 percent of 1950s riparian are A5, A6, C14, C15, D6, D13, and D14. Relatively little riparian area was converted to Agricultural Infrastructure, Urban, Exurban, or Transportation land uses.

8. Over the 1950 to 2001 time period, Shrub (S) habitat declined by 24 percent while Closed Timber (TC) increased by 10 percent and Open Timber (TO) increased by 2 percent indicating that some shrub habitat was replaced by another cover type or land use without a corresponding gain in new S cover.

9. Loss of Shrub (S) and Open Timber (TO) riparian cover in regions C and D are more extensive, indicative of a skew in age class distribution. Continuation of this trend over time will result in a greatly diminished cottonwood community.

10. In all regions, more acres of 1950s Non-Irrigated Herbaceous riparian areas were converted to Agricultural fields (Irrigated and Non-Irrigated) than any other riparian vegetation category.

11. Both 1950s TC and TO riparian were converted to both Irrigated and Non-Irrigated fields. This occurred in the greatest amounts in Regions C (8,265 acres) and D (5,927 acres)

12. Reach B2 lost 50 percent of its mapped riparian area to urban land uses, though it started out with only 625 riparian acres in the 1950s mapping making the change significant at the local reach level.

13. The remaining highly-impacted reaches saw a majority of their conversions of riparian area to Irrigated land use, with C14, D6, D13, and D14 being the most impacted.

14. Reaches classified as geomorphically confined or straight and therefore less dynamic have lower relative composition of riparian vegetation compared to more dynamic reaches with multiple channels and active meanders or braids.

15. There appears to be a temporal decrease in the number of riparian polygons with the exception of reaches in Region D.

16. Below the Powder River, the number of TO polygons has increased while TC polygons have decreased indicating a possible maturation of riparian forests in this Region without commensurate regeneration in response to diminished channel migration and hydrological alteration.

17. Much of the apparent stability in riparian vegetation extent over time is due to encroachment of riparian vegetation into former seasonal side channels below the mouth of the Bighorn River in response to the reduction in peak flows similar to what has occurred on the Bighorn River below Yellowtail Dam.

18. Woody riparian vegetation shows a correlation to channel type but a stronger correlation to the channel. The total extent and diversity of woody cover tends to be lowest in reaches that are either straight or confined by erosion-resistant geology. In region C, the confined and straight channel types support a much lower extent of woody riparian cover relative to more dynamic, unconfined channel reaches. The resultant reduced channel migration rate observed in confined reaches is correlated as well to an increase in distances between similar riparian polygons.

19. While the overall extent of S cover type polygons has not changed significantly, their shape appears to have become larger and more simplified when evaluating Perimeter Area Ratio Analysis (PARA) values.

1.1.1 Floodplain Isolation –

20. Main cause of riparian mapping being isolated is identified as Ag related (56 percent) and Railroad prisms (33 percent).

21. About 20,000 riparian acres have been isolated, 80 percent with herbaceous cover.

22. Floodplain isolation along with channel restrictions have the greatest impact on riparian habitat in reaches that are less confined; that is multi-channel and braided reaches and with wide floodplains and extensive riparian habitat present.

23. Indirect alteration of riparian areas is primarily due to agricultural-related activity. Of some 20,000 acres isolated from the floodplain by fills, 56 percent are related to agriculture. Transportation features affect about 33 percent of the total with urban and exurban features about equally responsible for the balance.

1.1.2 Channel Migration

24. Some 11,000 riparian acres occur within Restriction Migration Areas (RMAs) mapped under the Channel Migration Zone (CMZ) program. As a result, these riparian areas are at heightened risk of reduced function and conversion to other uses.

25. Agriculture is a major cause of riparian conversion (however channel migration causing riparian turnover actually has altered more 1950s riparian acres than agricultural conversion. Railroads and urban conversion are minor factors on a broad scale, but important locally.

26. Beginning at Region C which is where the Bighorn River enters the Yellowstone, exchange from channel to riparian becomes more prevalent in the magnitude and difference of exchange with the exception of between Reaches C15 and D4, which has quite a bit less of both measures of change. Nearly all reaches (except as noted) in these two regions show over 20 acres per valley mile in riparian cover gains and a loss of channel.

27. The disparity between gains and losses in Regions C and D indicates that turnover rates are out of balance and have shifted since 1976. These reaches are also now less dynamic based on the direction of exchanges (channel to riparian) since 1976.

28. Over 60 percent of the gain in riparian cover in all Regions occurs in Region D alone (see below). A greater percentage of riparian gain due to conversion (encroachment) of 1950s side channels occurs below the mouth of the Bighorn River in Regions C and D. The rate of floodplain turnover has slowed substantially since 1976 compared to the 1950 to1976 turnover rate.

1.1.3 Invasive Species – Russian Olive

29. Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix* spp.) have become common naturalized plants in many riparian areas along the Yellowstone River and its tributaries. The infestations will alter the composition, structure, and function of riparian plant communities as they continue to spread.

30. There are slightly more than 3,000 acres of Russian olive mapped within the 100-year inundation boundary showing a preference for the moist, slightly saline soil found in the 100-year inundation area. These primarily occur within the Shrub (S) and Closed Timber (TC) riparian classes.

31. Russian olive exhibits an increasing trend in presence and density in a downstream direction from Gardiner to Region D where its density is much reduced from the upper Regions. This positive trend is related to the generally increasing floodplain extent, abandoned channels, and disturbed areas going downstream. Reasons for the reversed trend in Region D are not entirely clear but may be related to less suitable habitat and the reduction in idle land in the intensively irrigated floodplain in this Region or the relatively low extent of riparian habitat and relatively significant loss of the Shrub riparian class in Region D between the 1950s and 2001.

32. Russian olive exhibits its greatest presence (nearly 2500 acres) in Region C (nearly half of the total) with its uniformly wide floodplain and size providing abundant suitable habitat. Proportionally, Russian olive constitutes a larger percent of the land cover in Regions A and B due to the smaller area of these corridors. No data is available on historic or current extent of saltcedar within the Yellowstone River corridor.

33. Russian olive occurs in greatest extent within disturbed areas and old channels within unconfined channel types in Region C where the side channel loss has been extensive (see Hydro Chapter). A majority of Russian olive is found in un-restricted portions of the CMZ except in Region D where the majority of Russian olive occurs outside of the CMZ. This finding concurs with current research that finds that Russian olive has an adaptive advantage in controlled river systems with limited flooding.

34. In Region C, Russian olive has invaded the 1950's channel and islands aggressively. Over 10 percent of 1950s island area and channel habitat has been occupied by Russian olive.

35. Some conflict exists in research evaluating impacts of Russian olive on avian species composition, abundance and richness. In Russian olive dominated riparian communities, the overall density and richness of bird species was found to peak between 50 and 70 percent total woody vegetation cover. Other studies have suggested that increasing composition of Russian olive may be detrimental to avian species density and richness, particularly for cavity nesting species.

36. RO extent is related to channel type in the same manner that the potential for riparian vegetation and floodplain extent are greater where the channel is unconfined by geologic control. Nearly 30 percent of Russian olive acreage occurs in the PCM/I channel type with Russian olive occupying islands. Confined reaches have substantially less presence of Russian olive.

37. A significant majority (66 percent) of all mapped Russian olive occurs within the 100-year inundation boundary showing its adaptation to the moist, slightly saline soil within the River's floodplain.

38. Russian olive correlates highly with mapped riparian areas since it is likely that the plant was mapped as part of the shrub category and occurs within cottonwood stands where it may or may not have been identified under the canopy. A majority of Russian olive occurs in the Shrub class and secondarily in the Timber closed category. Russian olive occurs in all categories, however relatively less so in the herbaceous class, as might be expected. As note earlier, a majority of the extent occurs in Region C where it makes up as much as 30 percent of the Shrub category in Reaches C10 and C19. Russian olive makes up nearly 4 percent of the total riparian in these Reaches.

39. While there is not a significant overall relationship between Russian olive and bank stabilization features, for Russian olive within 100 meters of a feature, more acres are located closer, rather than further away. This is likely due to Russian olive preference for near channel sites.

40. The proximity of Russian olive to the channel border (along with saltcedar) poses a possible issue for a cascade of effects due to potential modification of channel migration rates due to increased root armor and stem density.

41. This evaluation identified a lack of qualitative data in relation to better understanding trends in riparian condition or health within the Yellowstone River corridor and the response of the riparian vegetation resource to human influenced alteration. The development and implementation of a long-term riparian monitoring and assessment plan is recommended to facilitate a better understanding of this resource and implications.

1.1.4 Invasive Species – Saltcedar

42. No basin-wide systemic mapping has been completed for saltcedar so no metrics are available. Individual county weed district control and outreach approaches are in place and appear to be working with variable levels of success. A coordinated mapping and control monitoring approach is needed, however to guide future targeting efforts.

43. Saltcedar is more adapted to disturbance than Russian olive and for this reason appears to be a greater threat to early successional stages of riparian vegetation.

44. Genetic diversity in saltcedar facilitates its adaptation to colder, higher elevation climates and may also benefit from warmer temperatures predicted through climate change.

1.1.5 Other Invasive Species

45. Public awareness of other existing and potentially noxious invasive species is needed. In particular, those that are known to be present and well adapted to the Yellowstone River's riparian environment such as common buckthorn (*Rhamnus cathartica*) should be targeted.

1.1.6 Related Issues

46. The limited availability of Yellowstone-specific studies regarding the scope and scale of projected climate change does not allow much to be concluded as part of the CES other than additional reductions in the extent and timing of discharge will only exacerbate observed negative trends and impacts on riparian habitat regardless of cause.

47. Increased water use by domestic and industrial sources of water will place added stress on riparian habitat in reaches that have incurred impacts due to irrigation water withdrawals and the effects of Yellowtail dam operations.

48. Further reductions in stream flow have the potential to increase concentrations of water quality contaminants that potentially can alter riparian species composition, stand structure, and increase susceptibility to invasion by exotic species tolerant of elevated levels of salt and nutrients.

1.2 Temporal and Spatial Changes in Riparian Vegetation

1.2.1 Quantitative Change

No historic data is available to represent the extent of riparian vegetation prior to 1950 within the Yellowstone River corridor so the analysis is limited in looking back in time. Early records and historical documents do indicate that the pre-settlement (early 1800s) Yellowstone River corridor supported abundant stands of cottonwood and other woody species throughout the project area except where the floodplain was naturally constrained by geology (Confluence 2003). The United States Fish & Wildlife Service's National Wetland Mapping program conducted wetland and riparian mapping within the Yellowstone River corridor in the mid-2000's using their respective mapping systems (USF&WS 1997). Unquestionably, riparian habitat extent has been reduced since the area was settled. Various authors have estimated that between 66 to 95 percent of riparian habitat has been converted to other uses in the western United States (National Academy of Science, 2002; Braatne et al., 1996; Krueper, 1993; Swift, 1984). Similar development histories and patterns have occurred throughout the west along major rivers so it is reasonable to assume that at the minimum, such conversion may have also occurred in the Yellowstone corridor. Northern deciduous cottonwood forests occurring primarily as riparian communities now make up around 1 percent of the Yellowstone River Basin in 2002 (Zelt et al., 1999).

Table 1 presents the summary results for woody riparian cover of the Yellowstone River Riparian Mapping project (DTM and AGI, 2008). This analysis was conducted using the 100-year floodplain plus a 1/10 mile buffer as the mapping project area. Total riparian acres between 1950 and 2001 did not change appreciably, declining by 2.9 percent. More variation is seen within the classes of riparian cover over time reflecting the ebb and flow of temporal riparian succession driven primarily by channel migration. This variation for the most part reflects active flooding and migration provided by the relatively uncontrolled aspect of the upper Yellowstone's free-flowing hydrology. Riparian cover constitutes a relatively stable 20 percent of the land cover within the project area but varies between 3 and 44 percent at the reach level primarily due to geomorphic attributes of the channel and floodplain.

Statistical analysis of the four woody riparian cover classes evaluated shows no definite spatial or temporal trends other than a slight overall loss in riparian cover over time (Table 1-1). Please see the referenced report for specific, reach-based details. Figure 1-1, Figure 1-2 and Figure 1-3 depict changes in riparian cover types (S – Shrub; TC – Closed Timber; and TO – Open Timber) for all Regions. A number of reaches show that losses on one bank are matched by gains in riparian extent on the other (A3, B11, C10, and D5) again reflecting a dynamic equilibrium in channel migration. Other reaches, however, show net losses in riparian vegetation (DTM and AGI, 2008).

Table 1-1
Yellowstone River (Springdale to mouth) Riparian Extent (1950, 1976 and 2001). Source DTM and AGI, 2008.

Year	S (ac)	TC (ac)	TO (ac)	Total (ac)	All Land (ac)	Riparian Composition	High %	Low %	Reach High	Reach Low
1950	25332	38889	12319	76600	347841	22%	44	3%	D11	C21
1976	19360	36289	10661	66310	347850	19%	42%	4%	D11	D1
2001	19144	42620	12595	74363	347841	21%	42%	2.70%	D11	D1

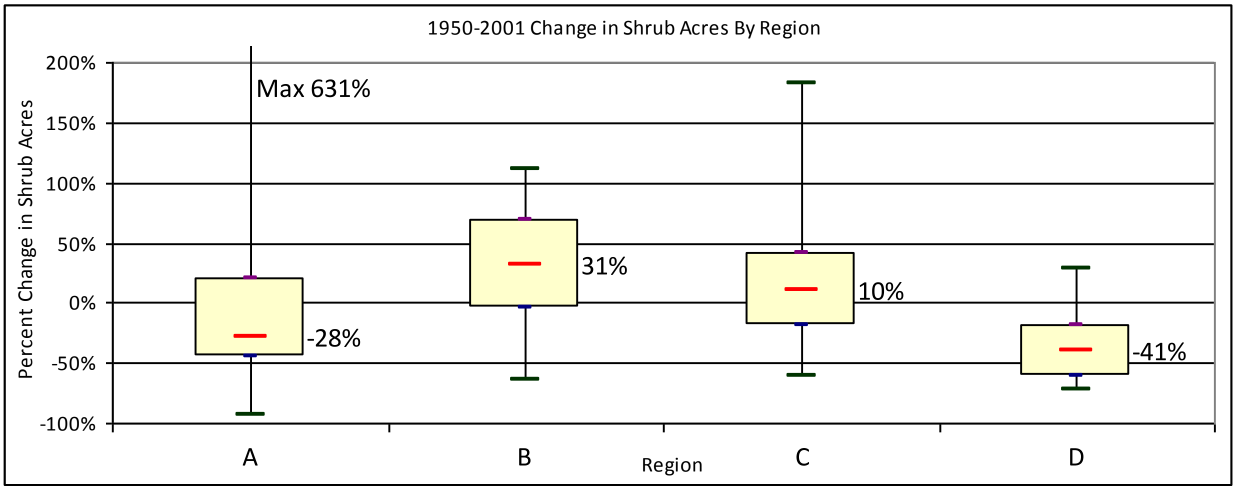

Figure 1-1 **Statistical summary of reach-based change in (S) acres from 1950-2001.**

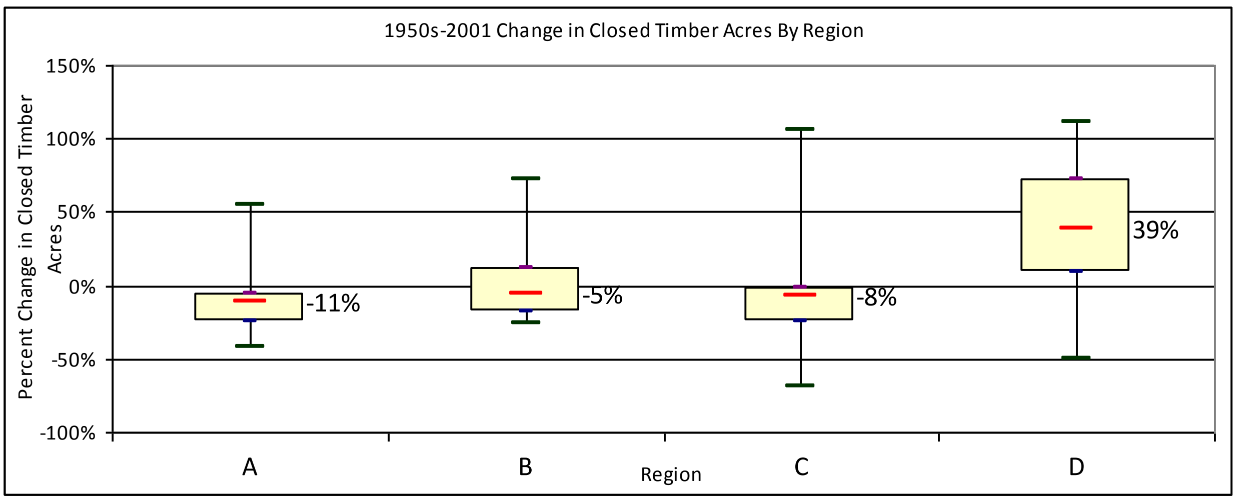

Figure 1-2 **Statistical summary of reach-based change in TC acres from 1950-2001.**

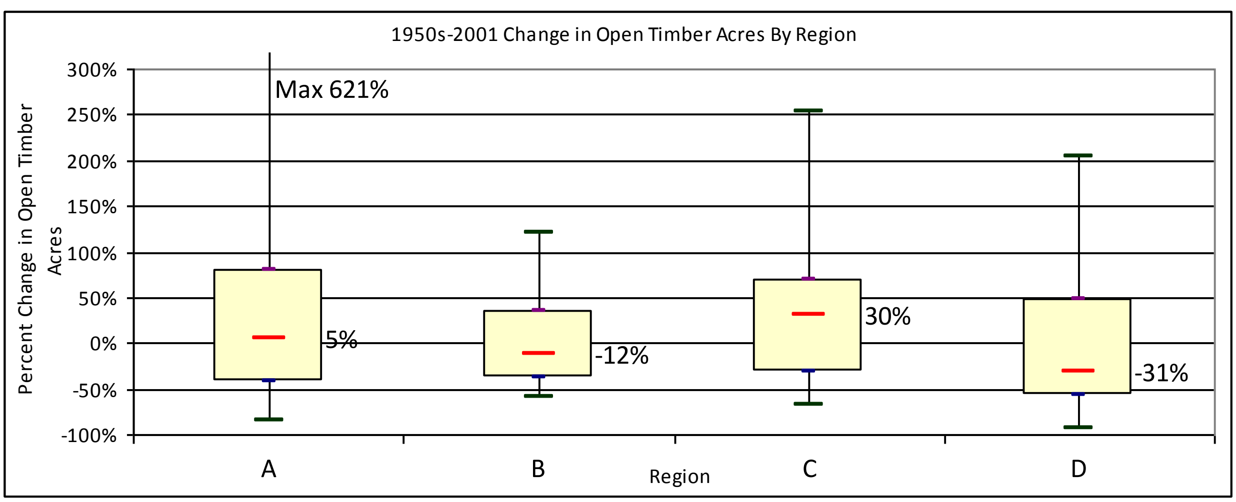

Figure 1-3 **Statistical summary of reach-based change in TO acres from 1950-2001.**

In general, Region A has several reaches which exhibited large (600 percent) gains in riparian cover due to colonization of open channel and herbaceous areas by shrubs. Overall, however, the average change in S acres was -28 percent. The mean change in TC acres was -11 percent while Open timber (TO) extent showed the least degree of change over time declining by -5 percent.

Similar results are found for Region B but with a net gain in S extent (31 percent). A majority of reaches show an overall loss of riparian cover but with a net gain for the Region due to large gains in S and TO in several reaches. TC again shows the least change over time (-5 percent).

In Region C, gains about equaled losses of riparian cover acreage. The change in S acres increased with the median being 10 percent although some reaches increased over 100 percent. The extent of TO change in acreage increased in most reaches above Forsyth (C10) between 1950 and 2001 indicating isolation of the stands due to floodplain dikes and bank armoring preventing channel migration and establishment of colonizing shrubs on open channel bars. Below Forsyth, TC typically declined.

Within Region D, a series of reaches with losses in S and TO cover and consistent gains in TC 1950-2001 is evident between D6 to D15. This data suggests that the cover is maturing with TO becoming decadent and falling out of a riparian class with little new establishment of shrubs and young trees. A possible cause of the noted trend in addition to agricultural conversion is related to changes in the hydrograph downstream of the Bighorn River or of the effect of Russian olive invading open stands and giving them the appearance of closed stands. The Regional change in S extent shows a -41 percent mean change.

As noted earlier, the reduction in TO in Region D (Figure 1-4) suggests that maturation of the plains cottonwood forest stands or several other possible causes may be responsible. Further study and analysis is needed to fully understand the cause and implications of the observed change over time.

Riparian class percent cover does not appear to show exceptionally strong relationships to any one channel type, however, the partially confined and unconfined reaches generally have a higher percentage of riparian cover than do confined reaches. Confined reaches also have higher percentages of bedrock outcrops which limit riparian cover establishment. Figure 1-4 through Figure 1-7 depict woody riparian cover percent change through three time periods for Regions A through D. The positive relationship of riparian cover extent to less confined channel type was also noted by Merigliano and Polzin (2003) in their study of the Park County portion of the Yellowstone River. Figure 1-8 shows the relationship of all riparian percent cover over time to channel types present in Region C as an example of this manner of evaluating the relationship.

DTM and AGI also evaluated spatial characteristics of riparian cover by calculating polygon counts, a size –perimeter relationship called Perimeter Area Ratio (PARA), and the Nearest Neighbor Distance (NND). Figure 1-9 depicts the change over time (1950 to 2001) in the number of riparian polygons by Region and cover type. Regions A and B exhibit fairly moderate but consistent losses in numbers of polygons in all riparian cover classes. Region C shows both losses in Shrubs and gains in Open Timber and Closed Timber. It is apparent that in Region D, this analysis again confirms the loss of number of shrub polygons on both banks as well as the loss of Open Timber. The net gain in Closed Timber is substantially different.

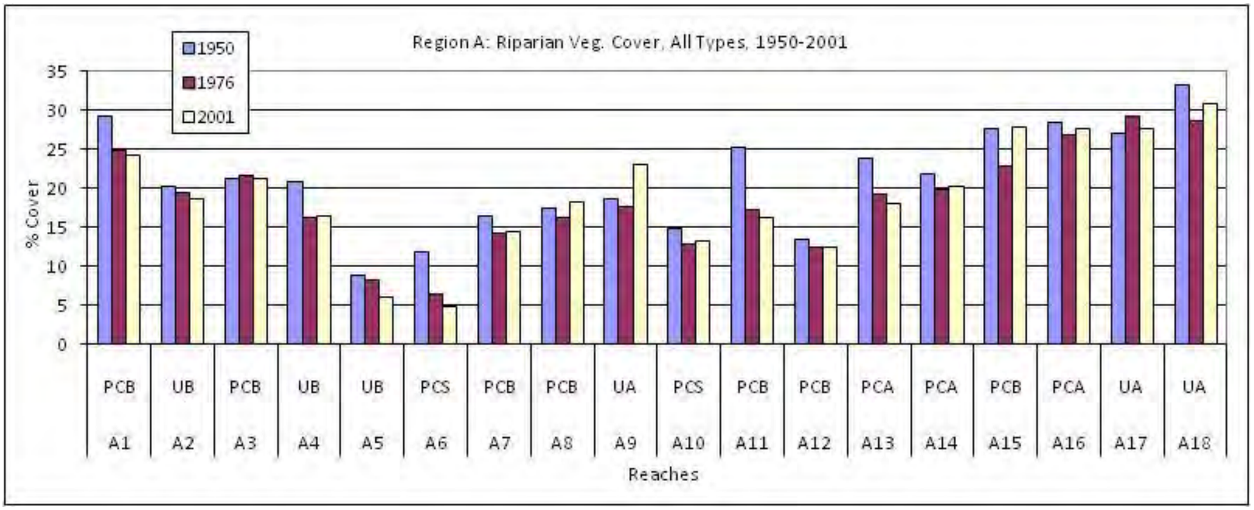

Figure 1-4 **Relationship of woody riparian cover extent to geomorphic channel type in Region A through time.**

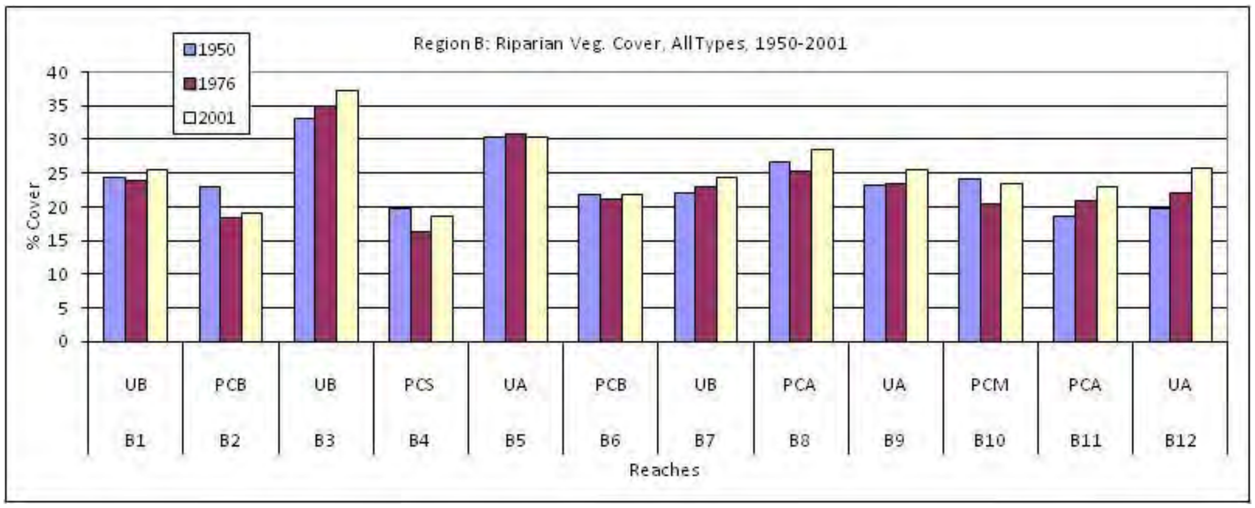

Figure 1-5 **Relationship of woody riparian cover extent to geomorphic channel type in Region B through time.**

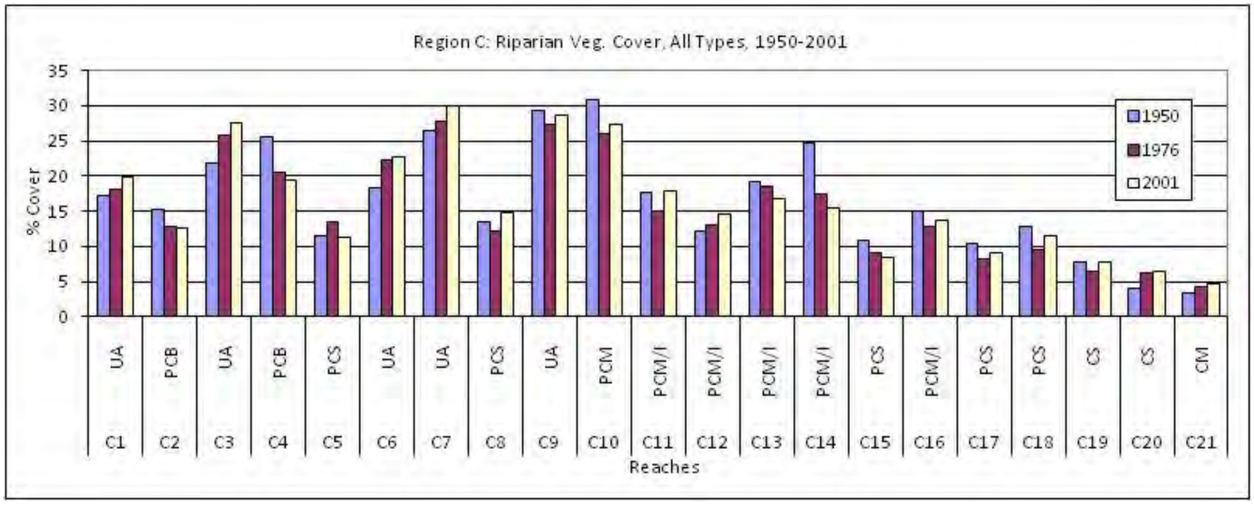

Figure 1-6 **Relationship of woody riparian cover to geomorphic channel type in Region C through time.**

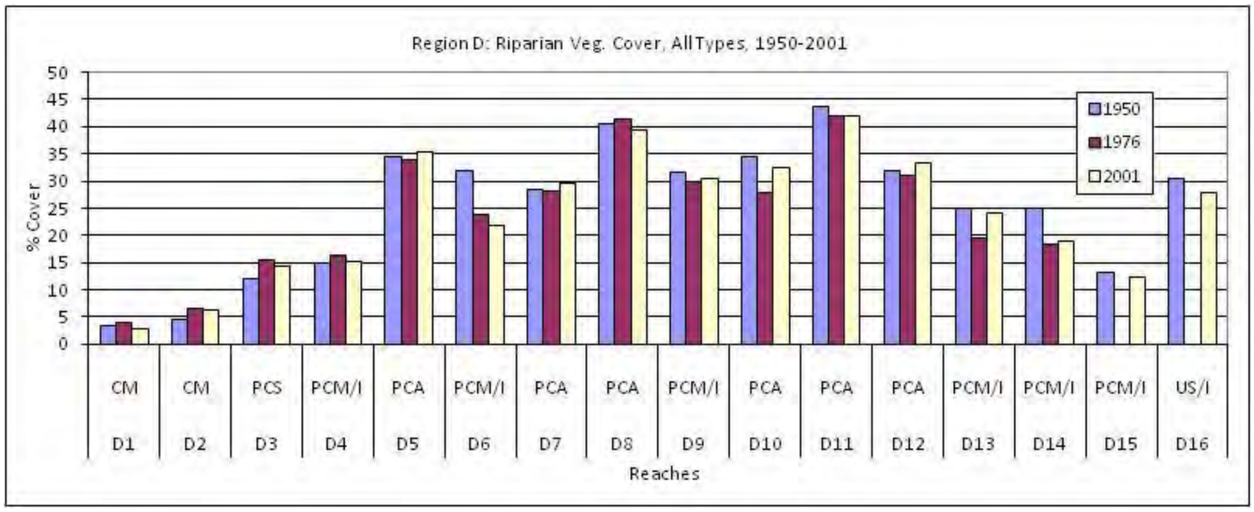

Figure 1-7 **Relationship of woody riparian cover to geomorphic channel type in Region D through time.**

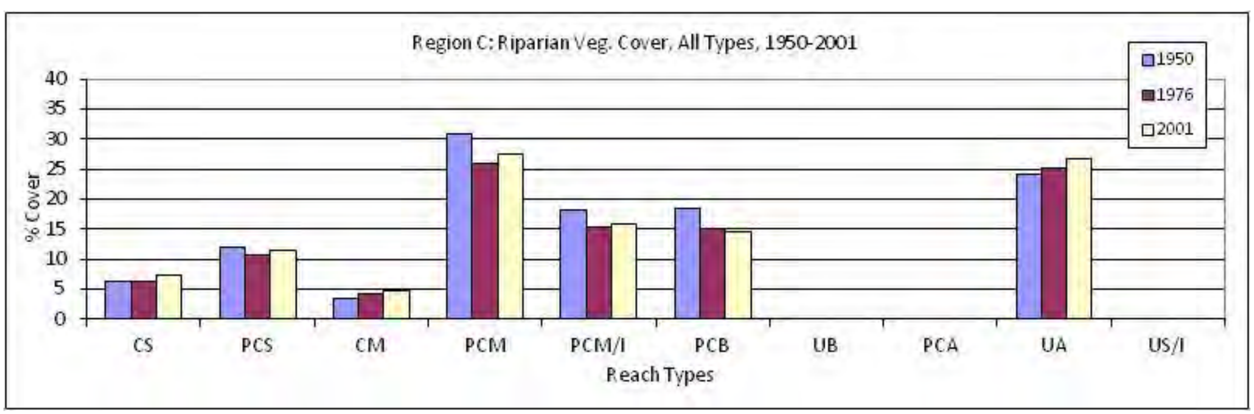

Figure 1-8 **Riparian cover extent as a function of channel type in Region C. Note that channel types UB, PCA, and US/I are not present in Region C.**

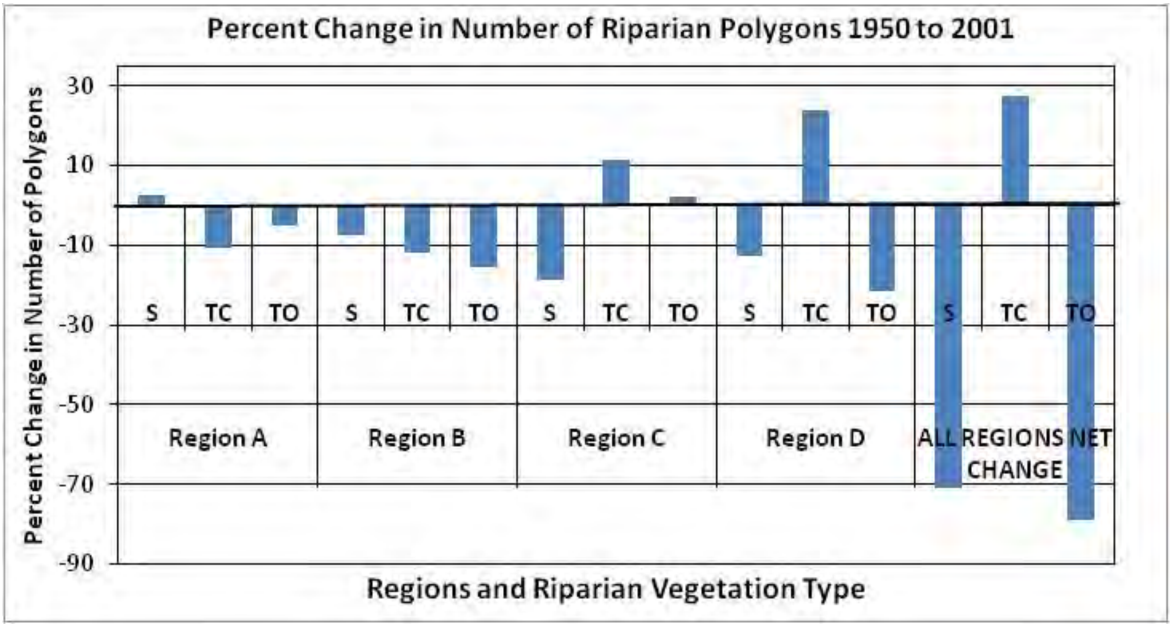

Figure 1-9 **Percent change in riparian cover polygon count from 1950 to 2001 shows sharp decline in shrub (s) and open timber (TO) classes and gain in closed timber class in Region C and D.**

PARA values calculated for riparian cover patches help to illustrate the complexity of their shape (DTM and AGI 2008). The calculated PARA values for Shrub, Closed, and Open Timber riparian cover classes do not show any significant spatial or temporal trends. Shrub values tend to be greater that Closed and Open Timber PARA values in general, but within the cover class do not show consistent, significant differences between regions or reaches. One exception is that values for the Shrub class in most Region A reaches (15 of 18 reaches) appear to show an increase since 1950 but then a subtle decline since 1976 indicating that isolated shrub patches in Region A may have consolidated and become less complex since then. To illustrate, the calculated PARA values for Shrubs in Region A are shown in Figure 1-10. PARA values in other Regions don’t appear to show any consistent trends over time and so are not depicted here.

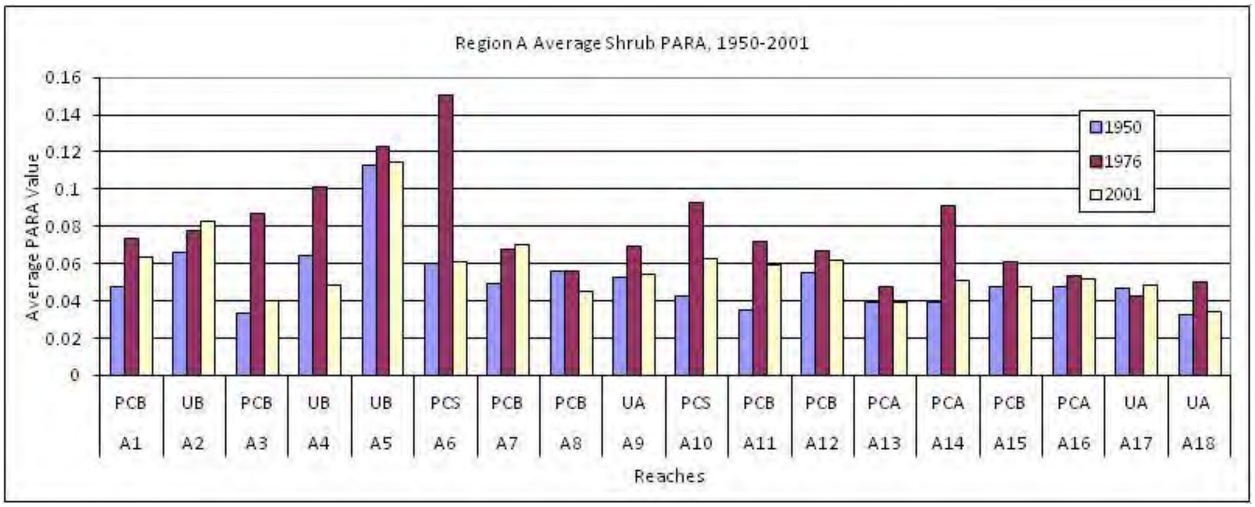

Figure 1-10 Region A Average Shrub PARA values, 1950 to 2001 illustrates the general increase in PARA values in 1976 for most reaches followed by decline in 2001. Note that no 1977 images were available for interpretation in Reaches D15 and D16.

NND analysis represents the straight-line distance between polygons of a similar riparian class and can be used to reflect the relative connectivity or accessibility of nearby riparian cover patches of a similar type. Higher NND values represent greater distance between patches of a similar riparian class. Lower values reflect closer proximity between similar riparian patches.

In general, Open Timber classes have higher NDD values than do Shrub or Closed Timber polygons throughout all Regions which coincides with their less frequent occurrence in number of polygons and later successional status. DNN values for most Regions don't show any consistent spatial or temporal trends. Open Timber in Region D does reflect a large increase in NDD value between 1950 and 2001. To illustrate this relationship, Figure 1-11 depicts Region D's calculated NNDs. Otherwise, the Region D results are similar to the other Regions in that the values for the Shrub and Closed Timber classes are consistently flat over time. These findings suggest that in Region D, the Open Timber class has either been cleared or has declined in size through mortality leading to greater distance between Open Timber patches. The greater distance also correlates to Region D's loss in the number of Open Timber polygons over time and the decline (-31 percent) of Open Timber acres between 1950 and 2001.

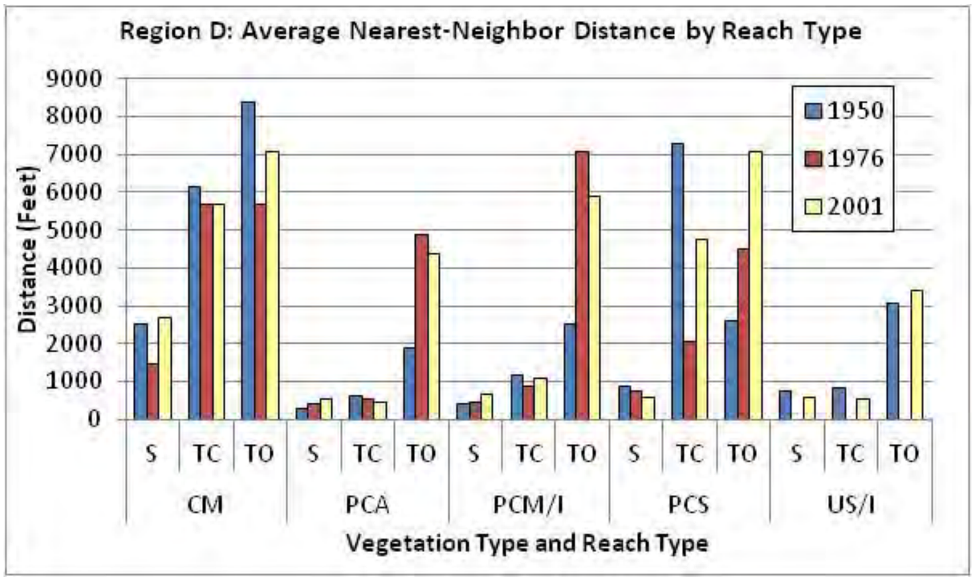

Figure 1-11 NND values for Region D indicate that the distance between Open Timber patches is greater than for Shrub and Closed Timber and has increased between 1950 and 2001.

In contrast to PARA values, the orientation of riparian polygons expressed by NND are well correlated to channel geomorphology. NND values typically show that similar riparian patches are closer together in unconfined channel types suggesting that the more frequent channel migration and riparian turnover that occurs in less confined channel types creates more complexity and proximity of riparian cover patches. The relatively infrequent channel migration exhibited in confined reaches results in larger NND values. To save space and with similar results in other Regions, only NDD values for Region D are shown in Figure 1-12 to illustrate the discussion above.

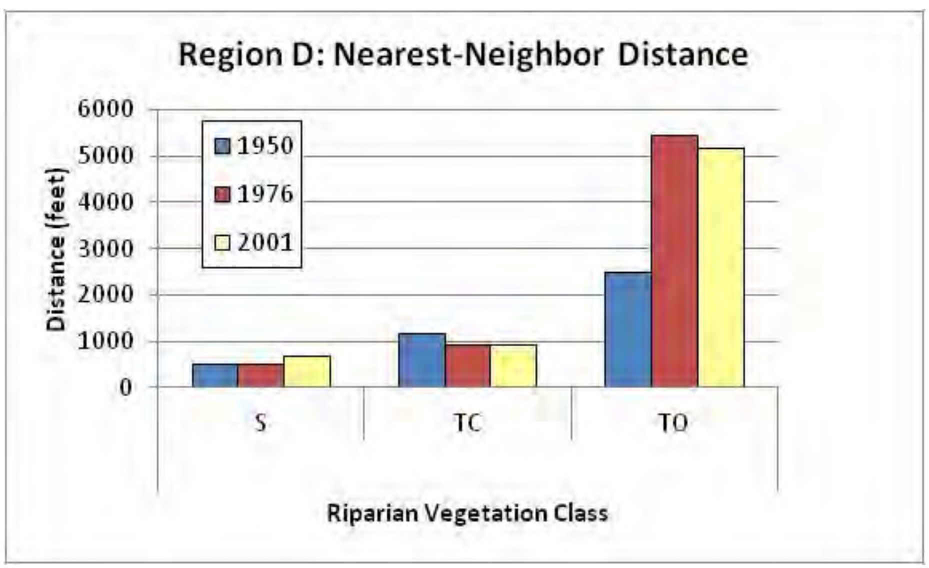

Figure 1-12 Nearest Neighbor Distance (NND) values for Region D, 1950 to 2001.

1.3 Sources and Causes - Direct

The Yellowstone River Land Use Mapping and Analysis data update (DTM, 2013) provides an approach to evaluate the source of loss in riparian land cover; that is, to answer the question, “Where riparian cover change has occurred between 1950 and 2011, what land use has replaced the1950s riparian cover?”

Table 1-2 provides the results of an analysis of the conversion of 1950s riparian woody cover classes (S,TO, and TC) to 2011 non-riparian land uses showing that the sources of change vary by reach and are dependent on the predominate local land uses. Figure 1-13 depicts these values. All reaches show instances of conversion to some other non-riparian related land use. Fifteen of the 52 reaches examined exhibited change in 1950s riparian cover greater than 10 percent. The average over all reaches was approximately 10 percent. Approximately 6,850 acres of 1950s riparian woody cover was converted to other land uses by 2011 representing about 10 percent of the total 1950s woody riparian cover.

Transportation as a source of direct conversion contributes relatively little to post-1950s conversion since the railroad was in place prior to this time and the majority of the Interstate and newer local roads are located outside of the immediate riparian corridor. No reach sustained more than 0.75 percent loss of 1950s riparian acres due to transportation factors. Region A had the greatest extent of transportation-related riparian conversions.

More recently, oil and gas development in the Williston Basin in North Dakota has expanded into Montana in the lower Yellowstone River corridor (Board of Oil and Gas Conservation, 2013). Land use mapping completed within the 100-year inundation zone plus a one-half mile wide buffer identified 51 active drilling/well pads occupying about 144 acres within the river corridor in Region D in 2011 (DTM, 2013). Many of these pads and access roads are located within agricultural fields but an unknown number have been built within riparian areas. Given the rapid development in the Sidney and Glendive areas, the number of pads and associated access roads has likely increased since the land use mapping was completed.

Agriculture - Early settlers located near waterways and began to develop farms and ranches in association with the water source so it stands to reason that agriculture is very prevalent in proximity the river corridor. Conversion to agricultural uses is presumed to be the largest cause of permanent riparian conversion prior to 1950 simply because agriculture is the most prevalent land use in the Yellowstone River corridor, comprising approximately 72 percent of the 716 square mile river corridor evaluated (DTM, 2013). Within the greater Yellowstone River watershed, agricultural land uses occupy about 54 percent of the total land area (Zelt et al., 1999). On a broader scale, agricultural land uses make up about 66 percent of Montana’s total land area (NASS, 2013).

Change in 1950s riparian cover in largely rural reaches (Regions A, C, and D) appears to be driven by agricultural efforts such as clearing for irrigated fields. Nearly 5,600 acres of 1950s riparian land was converted to irrigated agriculture by 2011, with 2,900 acres in Region D alone. Reaches where irrigated conversion took place in excess of 20 percent of 1950s riparian are A5, A6, C14, C15, D6, D13, and D14.

More recently, oil and gas development in the Williston Basin in North Dakota has expanded into Montana in the lower Yellowstone River corridor, particularly impacting Richland and Dawson counties. Land use mapping completed within the 100-year inundation zone plus a one-half mile wide buffer identified 51 active drilling/well pads occupying about 144 acres within the river corridor in Region D in 2011 (DTM, 2013). Many of these pads are located within agricultural fields but an unknown number have been built within riparian areas. Given the rapid development in the Sidney and Glendive areas, the number of pads has likely increased since the mapping was completed.

Channel Migration/Hydraulic Alteration – Channel migration is a source of a significant change of 1950s riparian cover. The loss of riparian cover to agriculture and other land uses has been mitigated by the net gain of riparian cover over time due to channel migration and abandonment. One measure of the rate of channel migration-induced riparian turnover is the trend in exchange or turnover of area between channel and riparian vegetation. Generally, healthy riparian areas will exhibit an equilibrium between the two classes with a balance between gains (conversion of channel to riparian cover) and losses (conversion of riparian cover to channel). Areas potentially out of balance in sediment and water supply that drive erosion and depositional processes, will have a greater difference between gains and losses.

Table 1-2
Conversion of 1950s woody riparian cover to another land use by 2011. Source DTM 2013. Shaded boxes indicate greater relative conversion.

Reach	2011 Land Use Conversions from 1950s Riparian (Acres)						Total 1950s Riparian Acres	Conversion of 1950s Riparian to Another Use				(Percent Change)	
	Irrigated	Urban	0.1	Interstate	Public Road	Total		Irrigated	Urban	Exurban	Interstate	Public Road	Total Change
A	216.6	4.5	69.0	17.4	21.0	328.6	8894.3	2.44%	0.05%	0.78%	0.20%	0.24%	3.69%
A1	3.7					3.7	363.3	1.02%	0.00%	0.00%	0.00%	0.00%	1.02%
A2	4.3				0.8	5.1	524.7	0.83%	0.00%	0.00%	0.00%	0.14%	0.97%
A3	3.6					3.6	487.8	0.75%	0.00%	0.00%	0.00%	0.00%	0.75%
A4	2.4	4.4	2.9		0.9	10.6	336.6	0.72%	1.30%	0.85%	0.00%	0.27%	3.15%
A5	16.6		1.4			18.0	73.4	22.58%	0.00%	1.90%	0.00%	0.00%	24.48%
A6	16.9		0.0	0.8		17.7	63.9	26.39%	0.00%	0.02%	1.22%	0.00%	27.63%
A7	22.8			5.4	4.4	32.5	599.0	3.80%	0.00%	0.00%	0.90%	0.73%	5.43%
A8	1.1		1.4	0.0	2.2	4.7	391.9	0.29%	0.00%	0.36%	0.00%	0.55%	1.21%
A9	16.2					16.2	319.2	5.09%	0.00%	0.00%	0.00%	0.00%	5.09%
A10	4.3				1.1	5.4	258.8	1.66%	0.00%	0.00%	0.00%	0.41%	2.07%
A11	26.6		1.1	11.3	2.5	41.5	563.2	4.72%	0.00%	0.20%	2.00%	0.45%	7.37%
A12	5.3					5.3	298.1	1.79%	0.00%	0.00%	0.00%	0.00%	1.79%
A13	18.9	0.1	33.8		2.8	55.6	386.7	4.88%	0.04%	8.73%	0.00%	0.74%	14.38%
A14	11.7				3.2	14.9	825.8	1.41%	0.00%	0.00%	0.00%	0.39%	1.80%
A15	9.1				0.1	9.3	606.9	1.50%	0.00%	0.00%	0.00%	0.02%	1.52%
A16	7.2		2.9		0.6	10.6	994.2	0.72%	0.00%	0.29%	0.00%	0.06%	1.07%
A17	6.0		0.8			6.8	1021.8	0.59%	0.00%	0.08%	0.00%	0.00%	0.66%
A18	39.9		24.7		2.5	67.2	778.8	5.12%	0.00%	3.17%	0.00%	0.33%	8.62%
B	290.0	369.3	248.7	5.9	12.1	925.9	11341.8	2.56%	3.26%	2.19%	0.05%	0.11%	8.16%
B1	57.0	12.6	101.4		9.0	176.4	2191.6	2.60%	0.57%	4.63%	0.00%	0.25%	8.05%
B2		313.6		2.2	1.4	317.3	624.7	0.00%	50.21%	0.00%	0.36%	0.22%	50.78%
B3	29.6	43.1	123.1			195.8	944.0	3.13%	4.57%	13.04%	0.00%	0.00%	20.74%
B4	11.4					11.4	431.2	2.64%	0.00%	0.00%	0.00%	0.00%	2.64%
B5	65.9		19.9		2.2	88.1	1262.9	5.22%	0.00%	1.58%	0.00%	0.18%	6.97%
B6	1.9				1.0	2.8	647.6	0.29%	0.00%	0.00%	0.00%	0.15%	0.44%
B7	37.7		4.3		0.7	42.6	1007.8	3.74%	0.00%	0.42%	0.00%	0.06%	4.23%
B8	46.9					46.9	1251.4	3.75%	0.00%	0.00%	0.00%	0.00%	3.75%
B9	4.9				0.5	5.4	632.0	0.77%	0.00%	0.00%	0.00%	0.08%	0.85%
B10	24.9			3.7		28.5	926.8	2.68%	0.00%	0.00%	0.40%	0.00%	3.08%
B11	9.9		0.0		0.1	10.1	884.4	1.12%	0.00%	0.00%	0.00%	0.02%	1.14%
B12					0.6	0.6	537.5	0.00%	0.00%	0.00%	0.00%	0.12%	0.12%
C	2178.3	78.6	45.1	8.3	17.2	2327.6	22297.9	9.77%	0.35%	0.20%	0.04%	0.08%	10.44%
C1	31.9			5.1	0.5	37.5	806.3	3.95%	0.00%	0.00%	0.63%	0.07%	4.66%
C2	161.7					161.7	896.8	18.03%	0.00%	0.00%	0.00%	0.00%	18.03%
C3	75.3		0.6		1.8	77.7	1031.0	7.30%	0.00%	0.06%	0.00%	0.17%	7.53%
C4	116.0				3.3	119.3	661.3	17.53%	0.00%	0.00%	0.00%	0.50%	18.03%
C5	22.8					22.8	386.9	5.90%	0.00%	0.00%	0.00%	0.00%	5.90%
C6	5.9					5.9	991.3	0.59%	0.00%	0.00%	0.00%	0.00%	0.59%
C7	29.7				0.4	30.1	2412.2	1.23%	0.00%	0.00%	0.00%	0.02%	1.25%
C8	75.4					75.4	837.2	9.00%	0.00%	0.00%	0.00%	0.00%	9.00%
C9	253.9					253.9	3268.2	7.77%	0.00%	0.00%	0.00%	0.00%	7.77%
C10	230.0	17.1	2.4		1.0	250.5	1623.8	14.16%	1.05%	0.15%	0.00%	0.06%	15.43%
C11	123.5				1.7	125.1	1651.2	7.48%	0.00%	0.00%	0.00%	0.10%	7.58%
C12	45.4	1.4	0.9		0.2	47.9	1076.1	4.22%	0.13%	0.08%	0.00%	0.01%	4.45%
C13	133.3					133.3	1176.0	11.33%	0.00%	0.00%	0.00%	0.00%	11.33%
C14	755.3			3.2	1.6	760.1	2550.3	29.61%	0.00%	0.00%	0.13%	0.06%	29.80%
C15	48.0					48.0	236.3	20.32%	0.00%	0.00%	0.00%	0.00%	20.32%
C16	1.2	8.0			0.4	9.5	909.9	0.13%	0.88%	0.00%	0.00%	0.04%	1.05%
C17	21.6	52.1	23.4			97.1	423.8	5.10%	12.30%	5.53%	0.00%	0.00%	22.92%
C18	31.8		12.3		0.8	44.8	261.4	12.16%	0.00%	4.69%	0.00%	0.29%	17.15%
C19	10.4		5.0		3.3	18.8	660.8	1.58%	0.00%	0.76%	0.00%	0.50%	2.84%
C20	5.4		0.5		1.1	7.0	203.8	2.65%	0.00%	0.23%	0.00%	0.53%	3.41%
C21					1.2	1.2	233.4	0.00%	0.00%	0.00%	0.00%	0.52%	0.52%
D	2902.8	151.9	174.2	11.8	35.1	3275.8	25973.8	11.18%	0.58%	0.67%	0.05%	0.14%	12.61%
D1	1.2				0.2	1.4	195.9	0.61%	0.00%	0.00%	0.00%	0.13%	0.74%
D2	2.4			2.4	0.4	5.2	263.4	0.89%	0.00%	0.00%	0.92%	0.15%	1.96%
D3	5.3					5.3	617.1	0.86%	0.00%	0.00%	0.00%	0.00%	0.86%
D4	3.1				0.2	3.3	1070.4	0.29%	0.00%	0.00%	0.00%	0.02%	0.31%
D5	114.0	38.8	0.0		7.9	160.8	2639.8	4.32%	1.47%	0.00%	0.00%	0.30%	6.09%
D6	274.9	113.0	4.4	9.4	7.4	409.2	1290.0	21.31%	8.76%	0.34%	0.73%	0.58%	31.72%
D7	57.6		19.8			77.4	1511.6	3.81%	0.00%	1.31%	0.00%	0.00%	5.12%
D8	151.6		18.1		5.1	174.8	2913.4	5.20%	0.00%	0.62%	0.00%	0.17%	6.00%
D9	73.2					73.2	953.4	7.68%	0.00%	0.00%	0.00%	0.00%	7.68%
D10	455.3		2.2			457.5	3001.3	15.17%	0.00%	0.07%	0.00%	0.00%	15.24%
D11	46.2				0.2	46.3	3002.5	1.54%	0.00%	0.00%	0.00%	0.01%	1.54%
D12	353.9				0.8	354.7	3906.4	9.06%	0.00%	0.00%	0.00%	0.02%	9.08%
D13	424.0		10.9		8.5	443.4	1662.0	25.51%	0.00%	0.65%	0.00%	0.51%	26.68%
D14	940.2		118.7		4.4	1063.3	2946.5	31.91%	0.00%	4.03%	0.00%	0.15%	36.09%
Total	5587.7	604.3	537.0	43.5	85.5	6858.0	68507.8	8.16%	0.88%	0.78%	0.06%	0.12%	10.01%

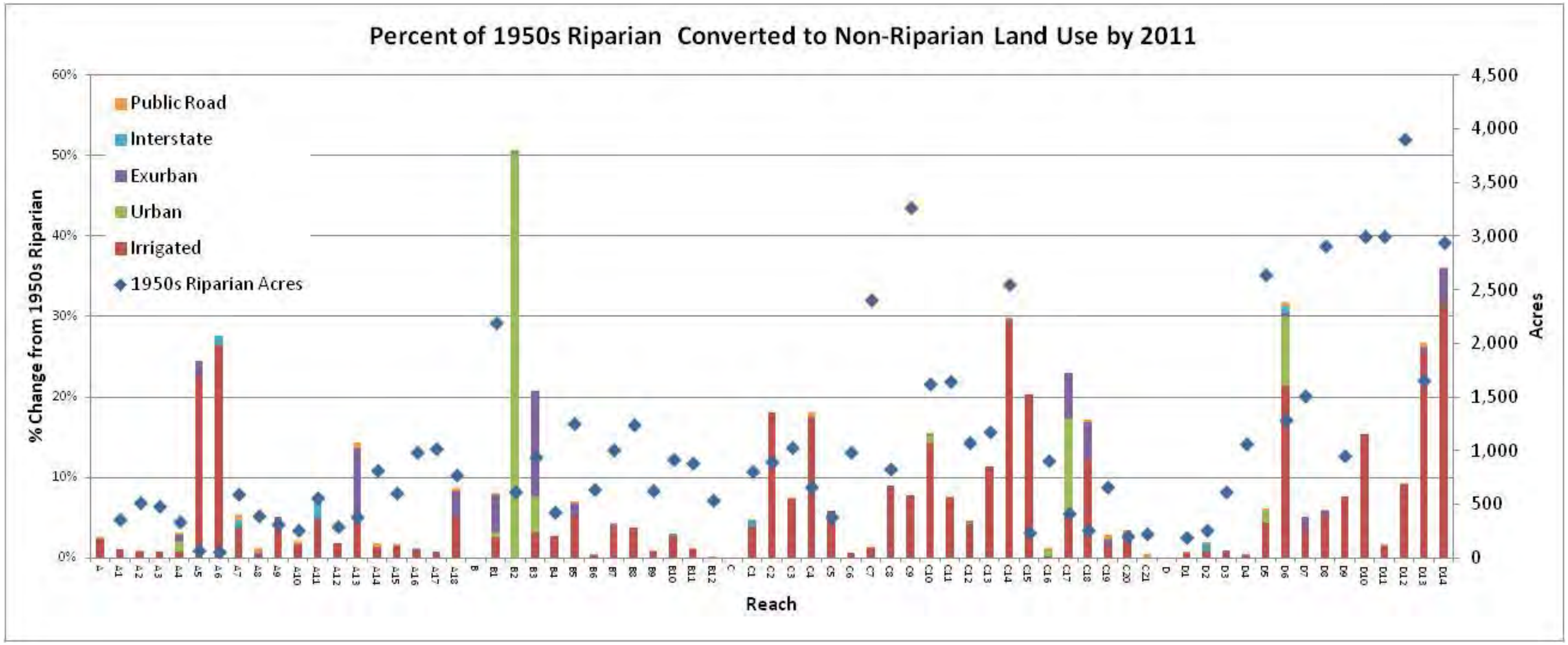

Figure 1-13 Percent change of 1950s woody riparian vegetation converted to 2011 non-riparian land use. Source: Yellowstone River Land Use Mapping and Analysis (DTM, 2013).

Dynamic reaches will have more acres exchanged while controlled or restricted reaches will typically have less acres exchanged. Figure 1-14 illustrates how channel migration creates floodplain turnover through the erosion and deposition process. Additionally, channel migration provides large woody debris (LWD) to the aquatic environment when trees fall into the channel. LWD helps to create multiple types of aquatic habitat such as scour pools, spawning habitat, temperature refugia, and hiding cover (Ellis, 2008). LWD debris jams often initiate sediment deposition for island formation in the Yellowstone River (Bollman, 2014).

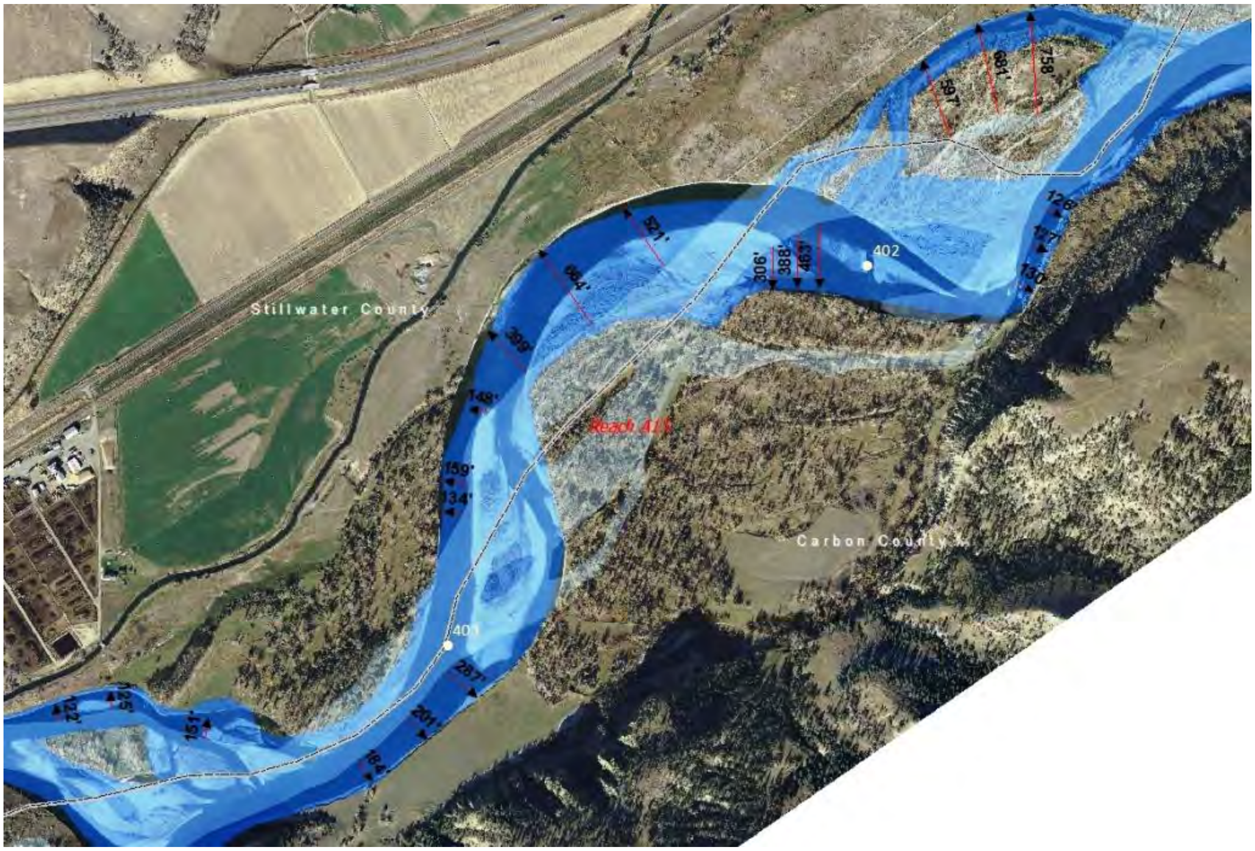

Figure 1-14 The location of the 1950 channel in Reach A15 (partially confined, braided) is shown in light blue shading while the 2011 channel location is shown in darker blue. The arrows indicate the direction and extent of channel movement since 1950 (61 years). The agricultural and riparian areas eroded away as the channel migrated are now a mosaic of wetland and riparian sites providing a variety of aquatic and terrestrial habitats. Note that the current channel area approximately equals the area of the abandoned 1950 channel, indicating a dynamic equilibrium in this section of river. At the rate of channel movement indicated here, the floodplain turnover rate is between 400 and 600 years. This rate is compared to the calculated rates for braided reaches in Park County of between 550 and 1,700 years (Merigliano and Polzin, 2003).

In the Bighorn River below Yellowtail Dam, USBR investigations (Godaire, 2010 and 2009) learned that the reduction of peak discharge by 55 percent as a result of regulation by Yellowtail Dam resulted in a loss of 72 percent in side channel complexity in the 16 miles below the dam. The stable conditions were characterized by the reduction in peak flow and sediment supply. This resulted in less lateral channel migration causing side channels to be at risk of abandonment as a result of vegetative encroachment. Plans to active the affected side channels are underway.

In sum, the findings from our analysis strongly suggest that the braided and *anastomosed* reach classifications have experienced declines in riparian turnover rates, reduced new riparian recruitment rates, and lost side channel length and area, primarily below the Bighorn River at rates that suggest these lower river reaches no longer exhibit a steady-state process over the time period studied. Upper river reaches in Regions A and B demonstrate more equality between spatial and temporal changes in riparian area cover class during the period of study. The reductions in discharge events (around 15,000 cfs reduction in mean daily discharge below the Bighorn River confluence) detailed in Appendix 2 Hydrology (Chase, 2013 and 2014) has led to reduced channel area and opportunity for riparian recruitment since fewer sand and gravel bars are created and maintained each year. Specifically, upstream of the Bighorn River confluence, typically less than 20 percent of the 5-year floodplain has been isolated; downstream of the confluence over 40 percent of the 5-year floodplain is now inaccessible by a 5-year flood. Isolation of the 2-year floodplain has resulted in reduced seasonal high flow channel activation during that event. The extent of 2-year floodplain isolation has been most significant between the confluences of the Bighorn and Tongue Rivers, where the developed 2-year inundation footprint is on the order of 40-percent smaller than that under undeveloped conditions. Similar reductions and impacts have been noted for other streams in the western U.S. (Knight, et al., 2014). Additionally, altered duration of high flows and low flows has been found to significantly alter riparian community composition and cover types even though mean annual flow is not changed (Auble et al., 1994)

Three aspects of riparian turnover were analyzed for the CES: extent of change from riparian to channel and vice versa; magnitude of the changes; and the difference between gains and losses for two time periods. Figure 1-15 depicts riparian exchange values between 1950 and 2001. Figure 1-16 shows the net change in riparian exchange and Figure 1-17 shows the floodplain turnover rates for the two time periods (1950-1976 and 1976 to 2001). Figure 1-18 provides results of correlation analysis between riparian turnover and bank stabilization features. Figure 1-19 depicts riparian turnover rates by channel classification for the 1950 and 2001 time periods.

Following are the main points of the turnover analysis:

1. Riparian gains as a result of channel conversion exceeded losses by about 55 percent throughout Regions A, B, C, and D.

2. Gains and losses show variability between Reaches but there is a general trend in greater gains going downstream as well as greater magnitude of exchanges.

3. Reaches in Region A and B generally show a relatively lower magnitude of exchanges between the two covers with the exception of Reach A18, an Unconfined Anabranching (UA) channel type. Most of these reaches also show relatively slight losses of riparian to channel cover (negative values) except for Reach A18 which had about 27 acres of riparian cover per valley mile converted to channel cover. Reaches in Regions A and B exhibit more classic equilibrium conditions with more parity between riparian loses and gains.

4. Beginning at Region C, which is where the Bighorn River enters the Yellowstone, exchange from channel to riparian becomes more prevalent in the magnitude and difference of exchange with the exception of between Reaches C15 and D4, which has quite a bit less of both measures of change. Nearly all reaches (except as noted) in these two regions show over 20 acres per valley mile in riparian cover gains and a loss of channel. Studies in similar river basins (Snake, Bighorn,

and Yakima Rivers) found that hydrologic alterations due to river damming led to a transition away from a flood-pulse driven, patchy mosaic pattern of riparian vegetation to a more terrestrial-like pattern which has implications for biodiversity and wildlife and aquatic habitat (Braatne et al., 2007; Akashi, 1998).

5. The disparity between gains and losses in Regions C and D indicates that turnover rates are out of balance.

6. The rate of riparian cover converted to channel (riparian turnover) has declined since 1976 below the ‘Bighorn River in Regions C and D compared to the same rate between 1950 and 1976 (Figure 1-15).

7. Over 60 percent of the gain in riparian cover (formerly channel) in all Regions occurs in Region D alone.

8. The extent of channel migration correlates poorly to the density of bank stabilization features ($R^2 = 0.0095$) indicating that bank stabilization is not driving the observed changes in turnover rates.

9. The extent of riparian change (gain vs. loss) between 1950 and 2001 correlates poorly to the density of bank stabilization features.

10. The rate of riparian turnover has declined (riparian areas converted to channel) when comparing 1950-1976 rates to 1976 to 2001 rates. Reaches with more dynamic channel classifications have experienced a more severe decline in this rate, especially in Regions C and D below the mouth of the Bighorn River. The reason(s) for the decline is not known for sure but appears to be related to declining high spring flows since they do not appear to be directly related to bank stabilization features, another possible source of the decline.

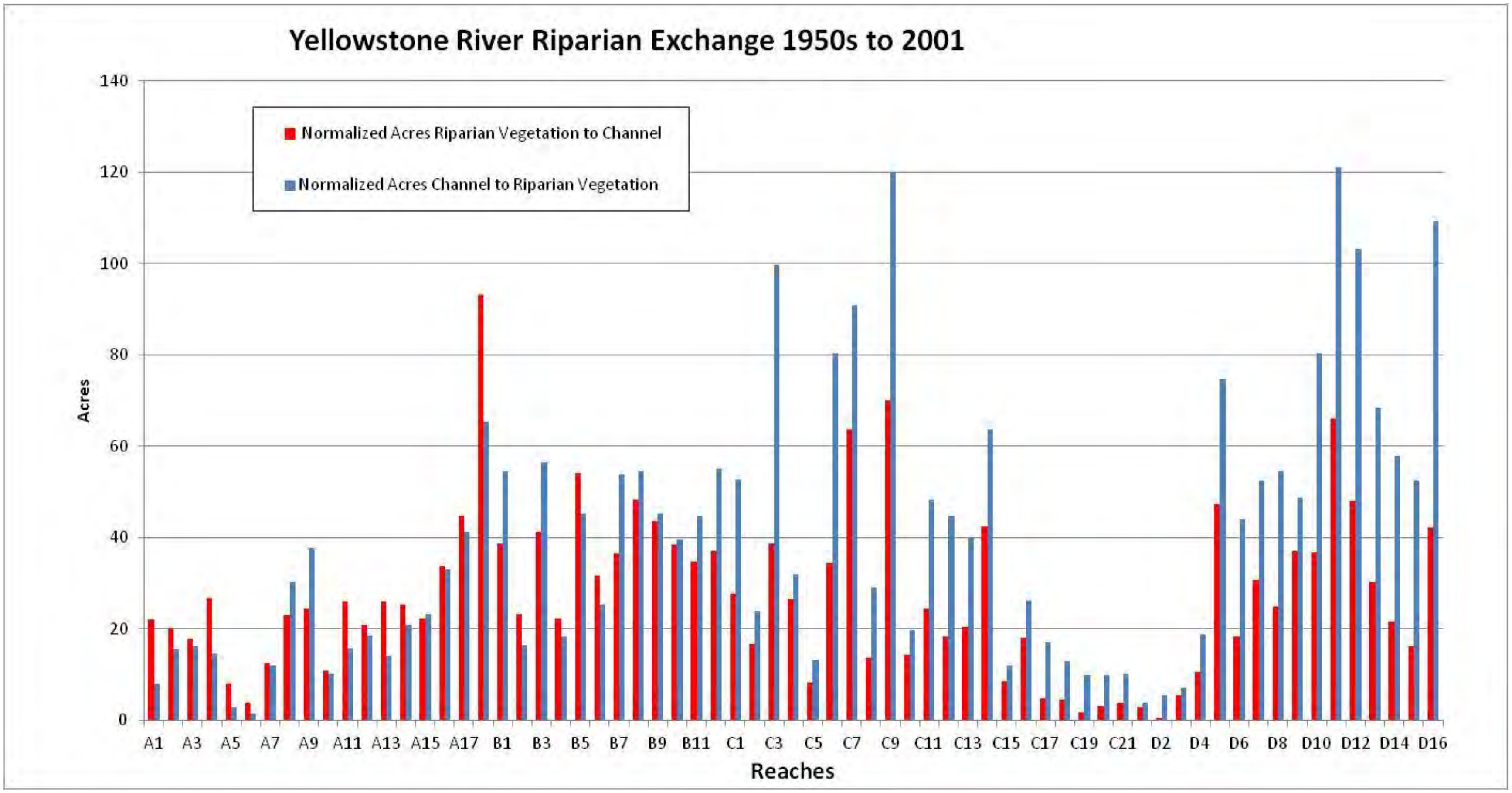

Figure 1-15 **Analysis of exchange rates between channel and riparian habitat indicates that the conversion of channel to riparian vegetation (blue bars), regularly and by a greater margin, exceeds conversion of riparian habitat to channel (red bars) in the river below the mouth of the Bighorn River (Regions C and D).**

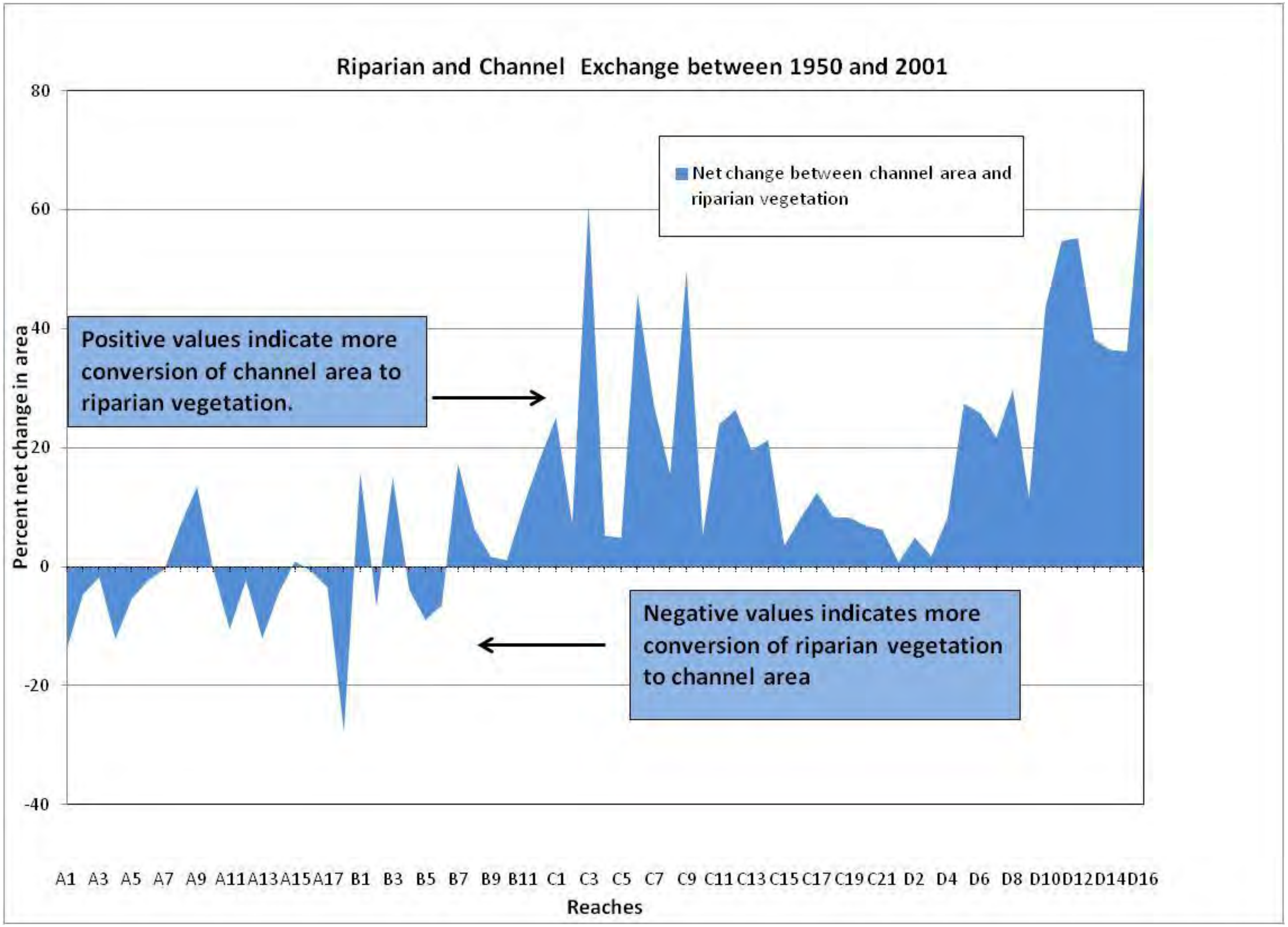

Figure 1-16 **Net change in riparian and channel area between 1950 and 2001 and shows that channel areas have been converted to riparian habitat in Region C and D to a greater extent and magnitude than in Regions A and B.**

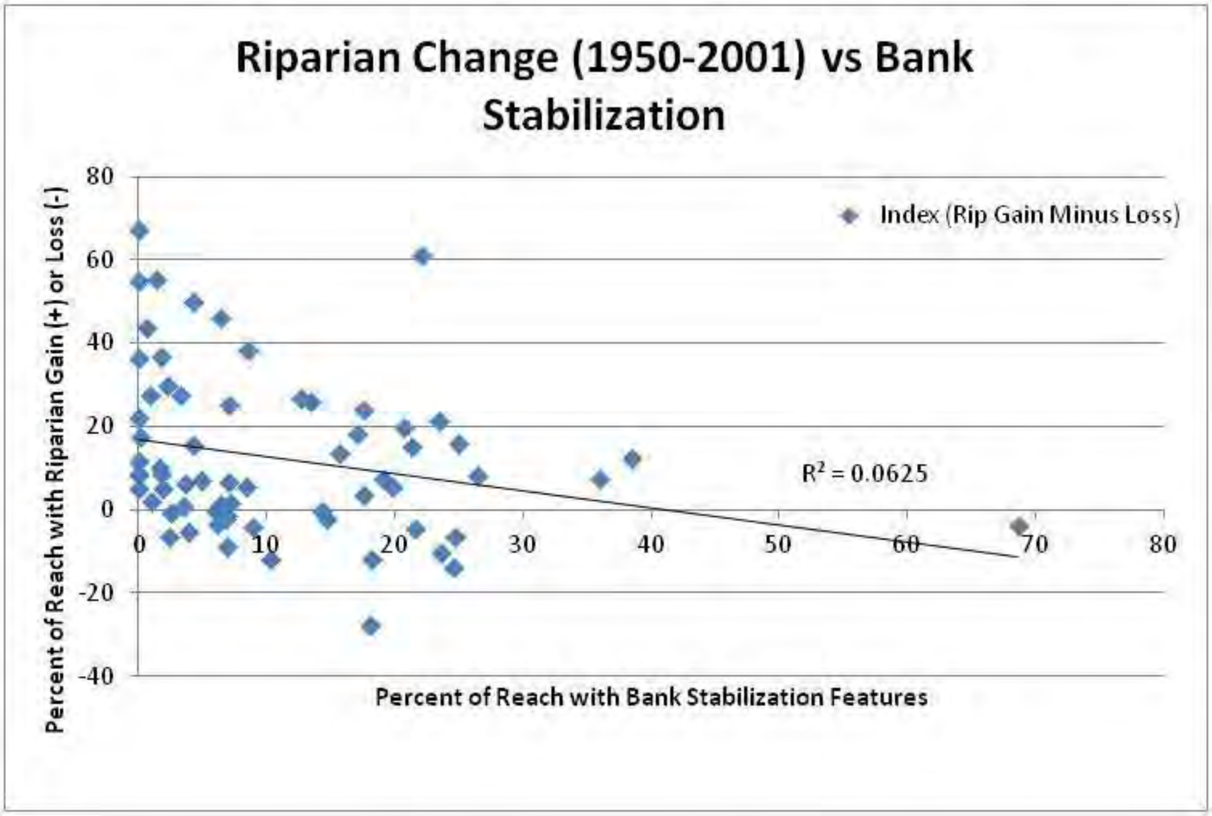

Figure 1-17 The relationship between riparian change and the density of bank stabilization features shows a general trend but with a relatively poor correlation.

Urban/Ex-urban Development - Over 1,100 riparian acres or about 1.5 percent of the total 1950s woody riparian conversions shifted to urban/ex-urban development near cities and towns along the river corridor (Reaches A13, B1, B2, B3, C17, D6, and D14). The B Reaches near Billings account for 54 percent of the total urban-caused conversion. Reach B2 alone experienced a loss of nearly 50 percent of its woody riparian acres. The majority of the loss took place between 2001 and 2011.

1.4 Sources and Causes - Indirect

In addition to direct conversion of riparian habitat discussed later in this appendix, there are a number of mechanisms that serve to indirectly impair the function and values associated with riparian areas. Following is a discussion of findings within the CES studies or pertinent literature.

Transportation Corridors - The connectivity of riparian areas may also be indirectly affected by transportation corridors that pass through or across the linearly-oriented riparian habitat within the corridor. Fragmentation of habitat results and effectively hinders or cuts off access by terrestrial and avian wildlife due to noise, frequency of chronic and acute disturbance, and mortality caused by vehicles using the transportation routes (Forman and Alexander, 1998). No specific studies or research is available to help quantify or qualify this impact for the Yellowstone River corridor but based on studies elsewhere, the impact may be as significant as the other direct and indirect impacts identified, given the extent and orientation of transportation land uses in the corridor (Appendix 1).

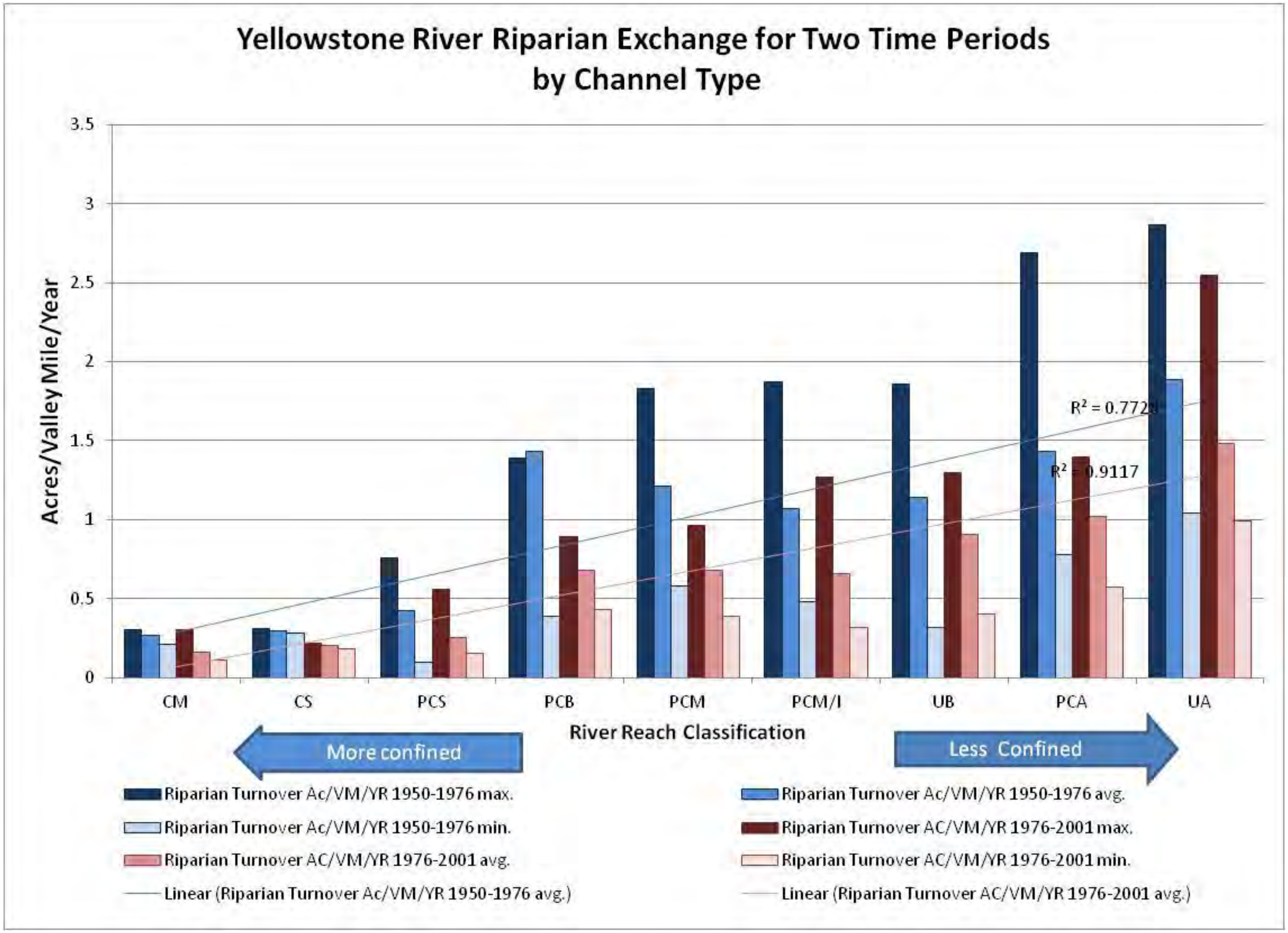

Figure 1-18 **Riparian exchange or turnover stratified by channel classification for both the 1950-1976 and the 1976- 2001 time periods. The data correlates well as evidenced by the strong R^2 values for the average rates. Note the reduced rate for the latter time period for all channel types, but particularly for the more dynamic, less confined channel classifications.**

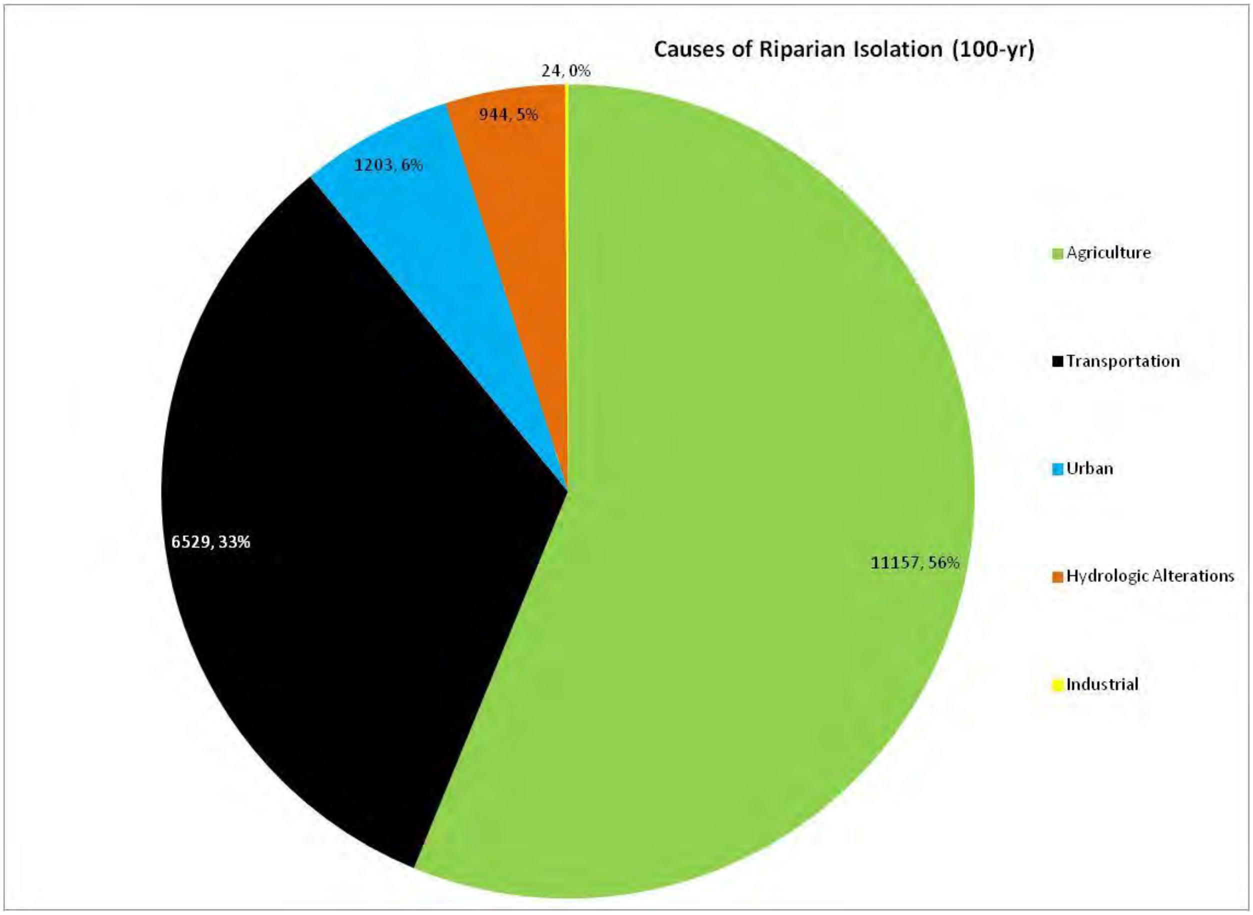

Figure 1-19 Agriculture is the leading cause of riparian isolation on the Yellowstone River followed by transportation features.

Floodplain dikes and levees – Floodplain restrictions due to transportation facilities affect riparian habitat indirectly. Effects occur when road and rail prisms block out of bank flows from accessing the floodplain. Many road and rail prisms intercept flood flows up to and above the 100-year flood elevation (Appendix 2). The impact serves to diminish the complete function of the affected riparian area by reducing the moisture and energy flow regime. Without period flushes of water, sediment, and nutrients, riparian areas dry out and become decadent (Braatne et al., 1996; Johnson, 1992; Brinson, 1981) and in many cases are then converted to another land use. Cutoff from the channel and flood flows, these riparian areas can no longer provide critical environmental services.

The 100-year inundation boundary was used to determine the scope and spatial extent of floodplain restrictions affecting riparian areas; however, it should be noted that greater impacts to the extent of riparian habitats affected will likely occur if lower stage events are evaluated. The analysis determined that nearly 20,000 acres of riparian mapped acres have been isolated by floodplain (100-year) restrictions along the corridor. For additional details, see the Floodplain Connectivity (Hydraulics Assessment) Technical Reference. Figure 19 shows the relative contribution of the various causes of floodplain isolation. Agricultural-related floodplain restrictions are identified as causing nearly 60 percent of riparian isolation.

The 20,000 isolated acres represents about 7 percent of the total area of the 100-year inundation boundary along the study corridor. Of the isolated riparian lands, about 80 percent are in herbaceous cover. Woody riparian cover classes make up about 7 percent of the total. Figure 1-20 depicts the relative extents of riparian isolation by floodplain features and the nature of those features by Reach. Reaches in Region C and the lower end of Region D exhibit the most acres affected.

Figure 1-21 provides the relative contributions of the various floodplain restrictions and riparian classifications affected. The herbaceous class is the most affected category with nearly 16,000 acres impacted. The land use of this riparian class is primarily irrigated and non-irrigated crop, pasture, and non-woody bottomland. Figure 1-22 illustrates the various types and extent of agricultural-related causes of floodplain isolation. General agricultural floodplain features are the largest source of impact on riparian land cover. The Hydrologic Alterations cause represents floodplain and riparian isolation due to

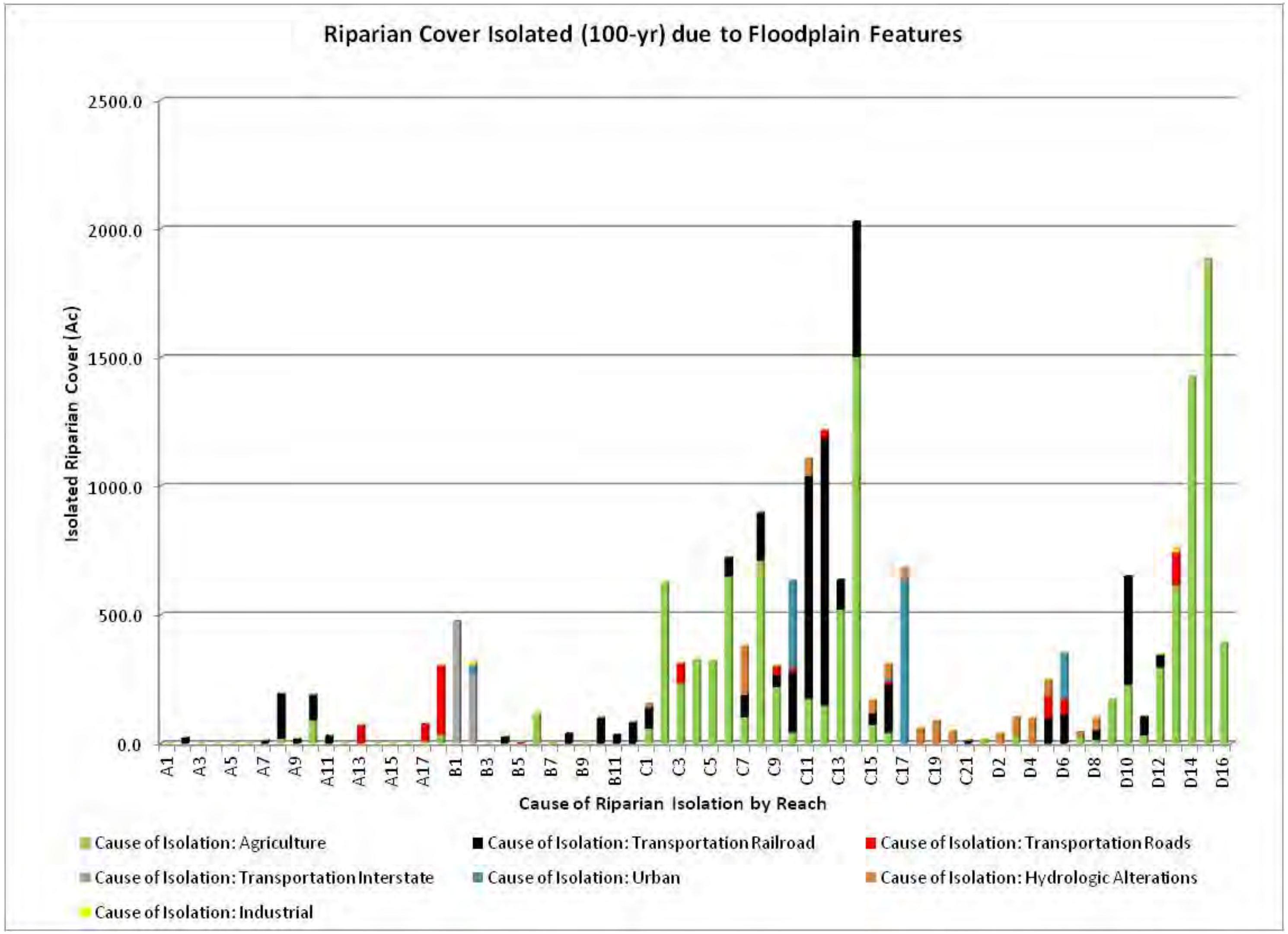

Figure 1-20 The extent of riparian cover isolated by floodplain features on the Yellowstone River is relatively greater in Region C and the lower reaches of Region D with agricultural floodplain features being the leading cause of isolation.

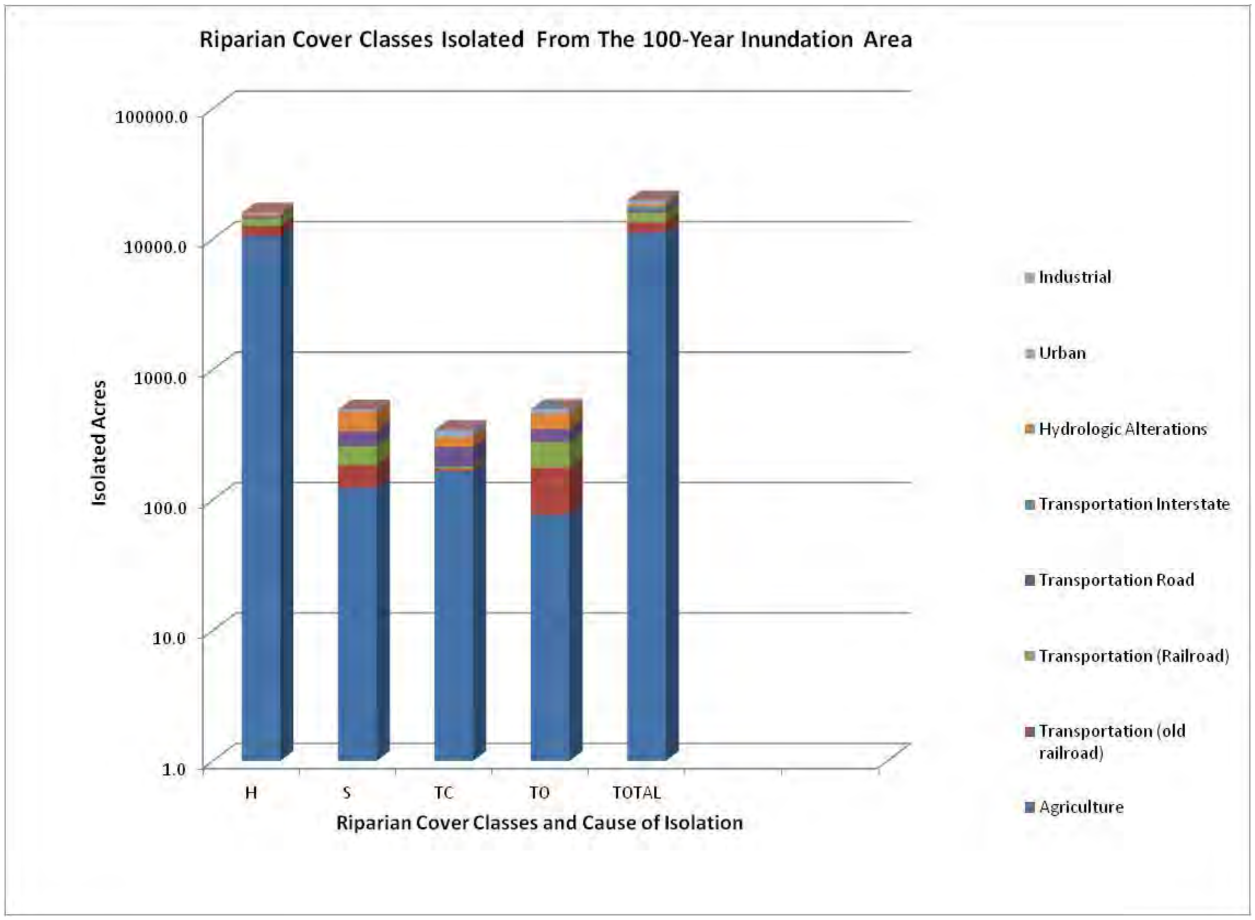

Figure 1-21 Riparian Classes Affected by Floodplain Isolation (100-yr Inundation) and Causes Identified. Please note that the scale of the vertical axis is logarithmic.

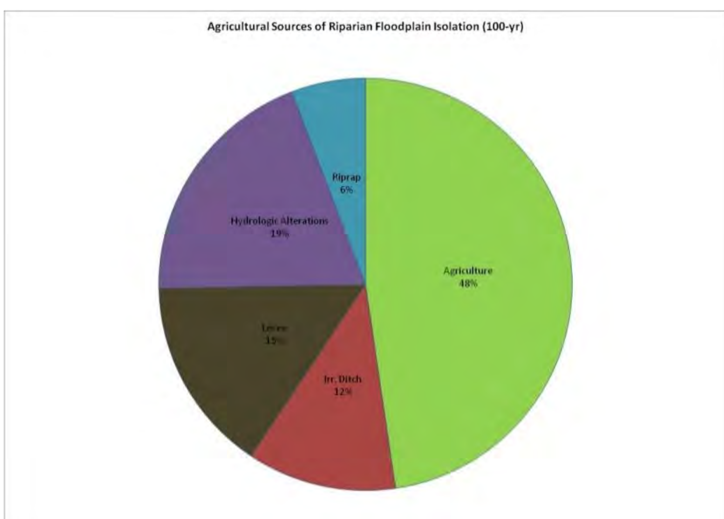

Figure 1-22 Breakdown of Agricultural-Related Causes of Riparian Floodplain Isolation.

Figure 1-23 shows the cumulative impacts of isolation features on riparian habitat moving downstream. As noted in the preceding charts, hydrologic alterations causing reductions in discharge have also created riparian floodplain isolation (Appendix 3). Flow alterations and floodplain features have resulted in a 5- to 20-percent reduction in 100-year floodplain extent compared to historic (undeveloped) conditions. Above the Bighorn River confluence, less than 20 percent of the 5-year (20-percent chance of occurrence) historic floodplain has been isolated; but below the confluence the isolation of the historic 5-year floodplain has more than doubled to a 50-percent reduction. The majority of the 5-year isolated floodplain area is now irrigated land however, some 2,400 acres of riparian habitat in the isolated 5-year floodplain was converted since 1950 and likely a great deal prior to 1950. The isolation likely facilitated conversion of riparian habitat by reducing flood risk and the influence of seasonal water tables.

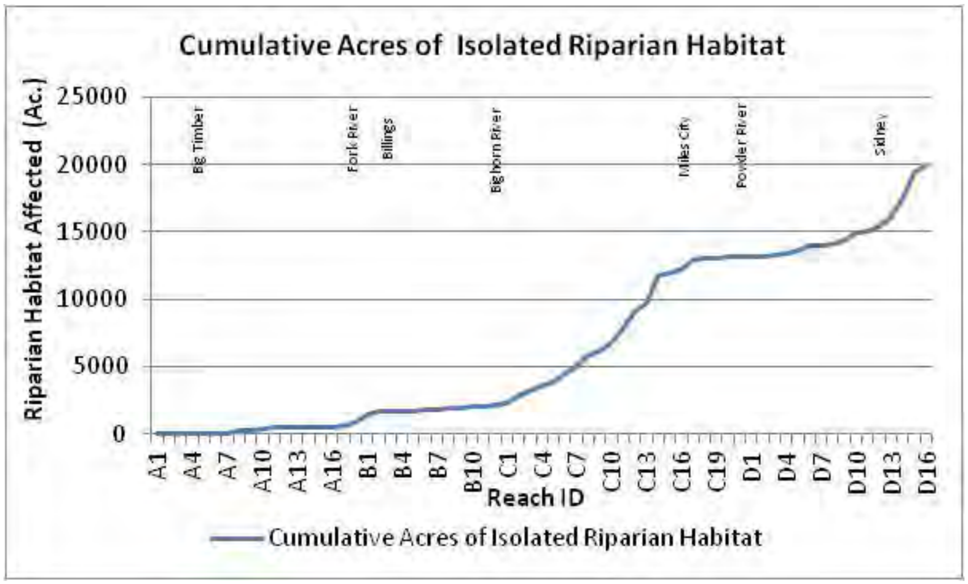

Figure 1-23 The slope of the line in the chart represents the rate of riparian habitat isolation going downstream. Note the slight increase in B1 near Billings and again throughout most of Region C, and then a spike again at D13 to near the mouth.

Much of the analysis of the 2-year flood event (50-percent chance of occurrence) shows that the reduction in floodplain inundation is greatest between the Tongue and Bighorn Rivers. The difference in floodplain inundation (developed versus undeveloped condition) is on the order of a 40- percent reduction in area (Chase, 2013 and 2014). As noted earlier, early historical accounts describe the area above the mouth of the Tongue River as having extensive cottonwood forests which are much diminished as of 2001 (DTM and AGI, 2008; Confluence, 2003; Brownell, 2006).

Literature citations for the many impacts of hydraulic alteration on riparian species' establishment, health, and growth is provided in several edited research reviews (Braatne et al., 1996) (Rood and Mahoney 1992 and research published later: Braatne et al. (2007) discuss the impacts of flow regulation on cottonwood recruitment and invasive weed species; Boggs (1984) noted that age classes on the lower Yellowstone would become skewed since regeneration would be eliminated by diminished flows; Rood and Mahoney. (1995) describes the absence of seedlings on the Marias River in Montana as a result of river damming; Rood et al. (1996) related the decline of cottonwoods on the St. Marys River in Alberta, CA to instream flows; Rood et al. (2008) discussed the effect of declining summer flows on floodplain forest in the Rocky Mountains; Scott et al. (1996) (1997) addresses drought stress, slow growth, and mortality observed as a result of water deficit on the Missouri River in Montana; Auble et al. (1994) noted substantial sensitivity of riparian vegetation to changes in minimum and maximum flow; Johnson (1992) found fewer saplings on the Missouri River because of reduced flooding; Akashi (1988) described reduced abundance of cottonwoods on the Bighorn River as a result of river damming; and Reilly and Johnson (1982) also related reduced tree growth on the Missouri River to the effects of river damming.

Channel Migration Restriction - No data is available for when the first bank stabilization structure was installed on the Yellowstone River to attempt to prevent or control bank erosion but it was likely not long after settlers began farming and sought to protect their early agricultural and transportation infrastructure investments. Bank armor on the River has taken many forms over the years from loose rock pilings to concrete slabs, cabled trees and tires, to linear blanket rock riprap and highly engineered, upstream-oriented rock structures called bendway weirs, groins, or vanes. When successfully applied, bank stabilization structures, by design prevent or at the least, drastically restrain lateral channel movement.

Areas so protected have been designated as Restricted Migration Areas (RMAs) in Channel Migration Zone (CMZ) mapping efforts (DTM and AGI 2009). The extent of bank armor and floodplain restriction within each of the designated geomorphic reaches on the Yellowstone ranges from 0 percent to over 60 percent of the bank length (DTM and AGI, 2013).

As discussed previously, channel migration is an inherent component of fluvial processes and is integral to riparian renewal or turnover. To help evaluate the potential impact of bank stabilization structures on channel migration and how that affects riparian habitat, we can look to the CMZ studies and evaluate areas mapped as having RMAs to determine their impact on lands mapped through the riparian mapping project (DTM and AGI, 2008). Riparian mapping affected by designated RMAs totals about 11,200 acres or about 7 percent of the riparian area mapped within the 100-year inundation boundary. Figure 1-24 depicts riparian cover classes affected by RMAs for each Reach. This illustrates again that herbaceous cover is affected to the greatest extent by channel migration restrictions. Reach B1 has the greatest extent of mapped riparian area affected, primarily herbaceous cover, but with about 475 acres of woody riparian cover impacted (S, TC, and TO cover classes).

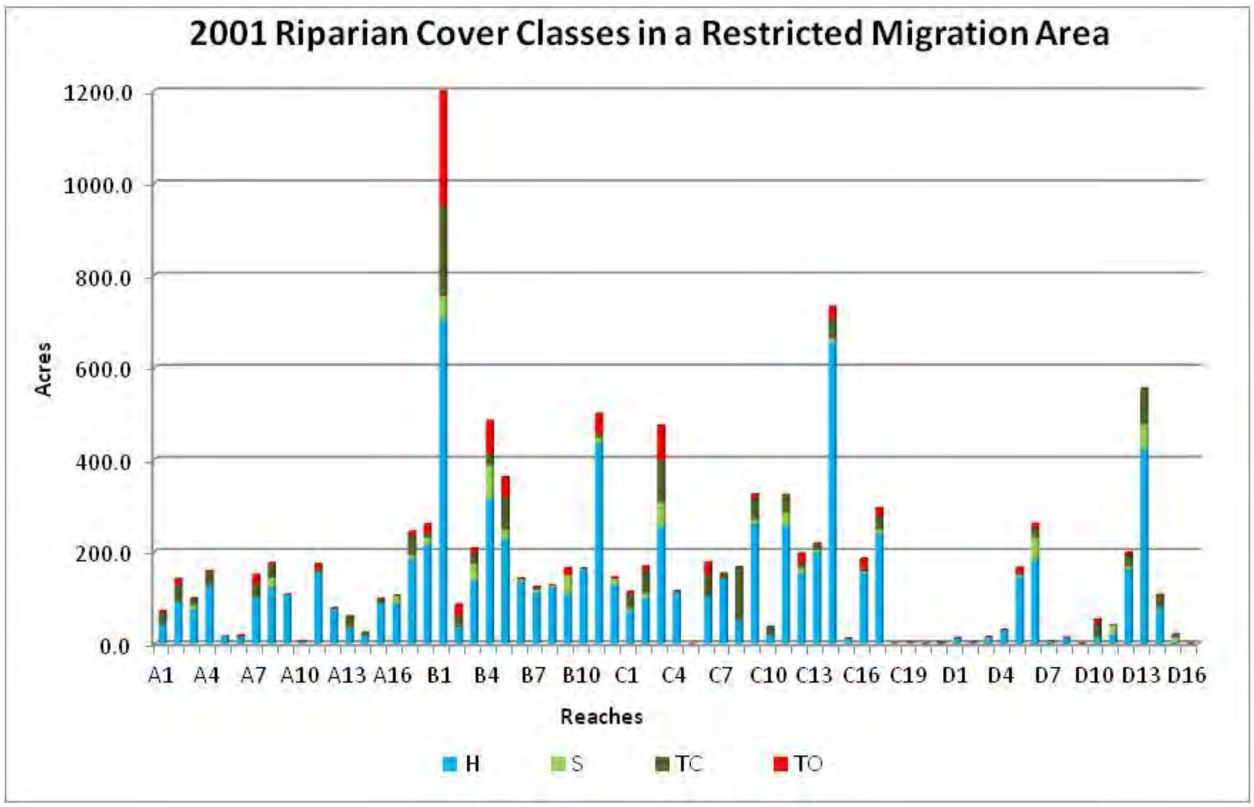

Figure 1-24 Riparian Cover Classes Affected by Restricted Migration Areas.

There are many causes of channel migration restriction throughout the corridor. Looking at the entire corridor represented in Figure 1-25, Riprap alone and in conjunction with flow deflector installations is responsible for over 70 percent of the migration restrictions causing the RMAs. Road and railroad prisms also often have rock riprap associated with the fills so it appears that placement of rock bank protection is responsible for the majority of RMAs that create migration restrictions affecting riparian cover.

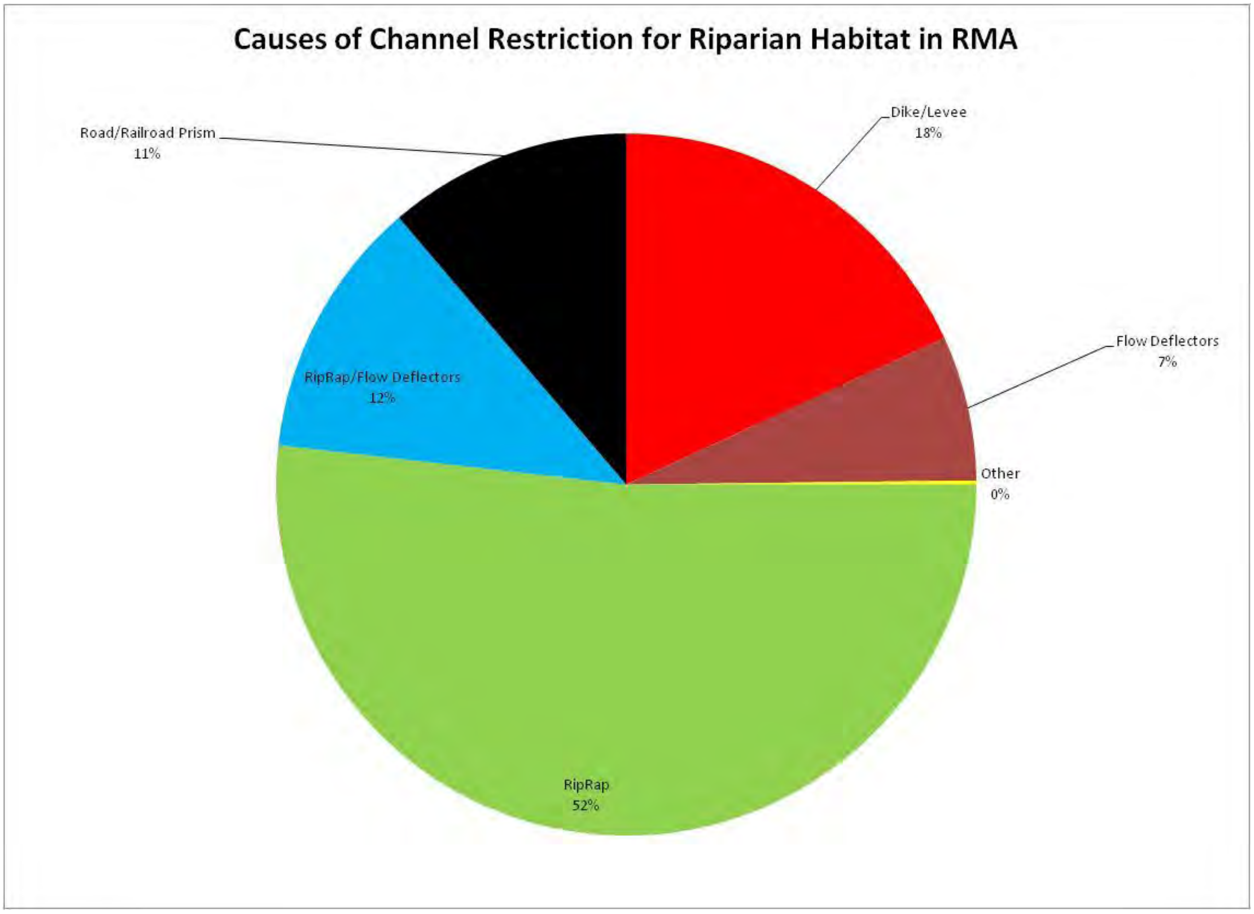

Figure 1-25 Riprap and flow deflectors are the major cause of restricting channel migration in riparian areas within designated RMAs on the Yellowstone River.

Figure 1-26 shows the riparian mapping classes for each geomorphic reach along with the cause of the RMA. Riprap and flow deflectors are the greatest cause of the restrictions in Reach B1. Road/railroad restrictions to migration in riparian mapping occur sporadically throughout the corridor.

Channel migration restrictions likely were placed more frequently in reaches having higher channel migration rates. Therefore, it is likely that RMAs more frequently impact riparian cover within such areas. Figure 1-27 depicts the extent of riparian classes affected for each channel classification. Data for channel and outside CMZ categories was omitted because of their relatively small contribution. The figure illustrates that the less confined Reach types, characterized by braided and multiple channels with proportionally more riparian habitat have the greatest extent of migration area that is restricted by bank protection. Figure 1-28 depicts cumulative riparian habitat within RMAs in a downstream direction that illustrates the trend in restriction. Areas of steeper slope show increases in restricted Riparian greater than the general increase.

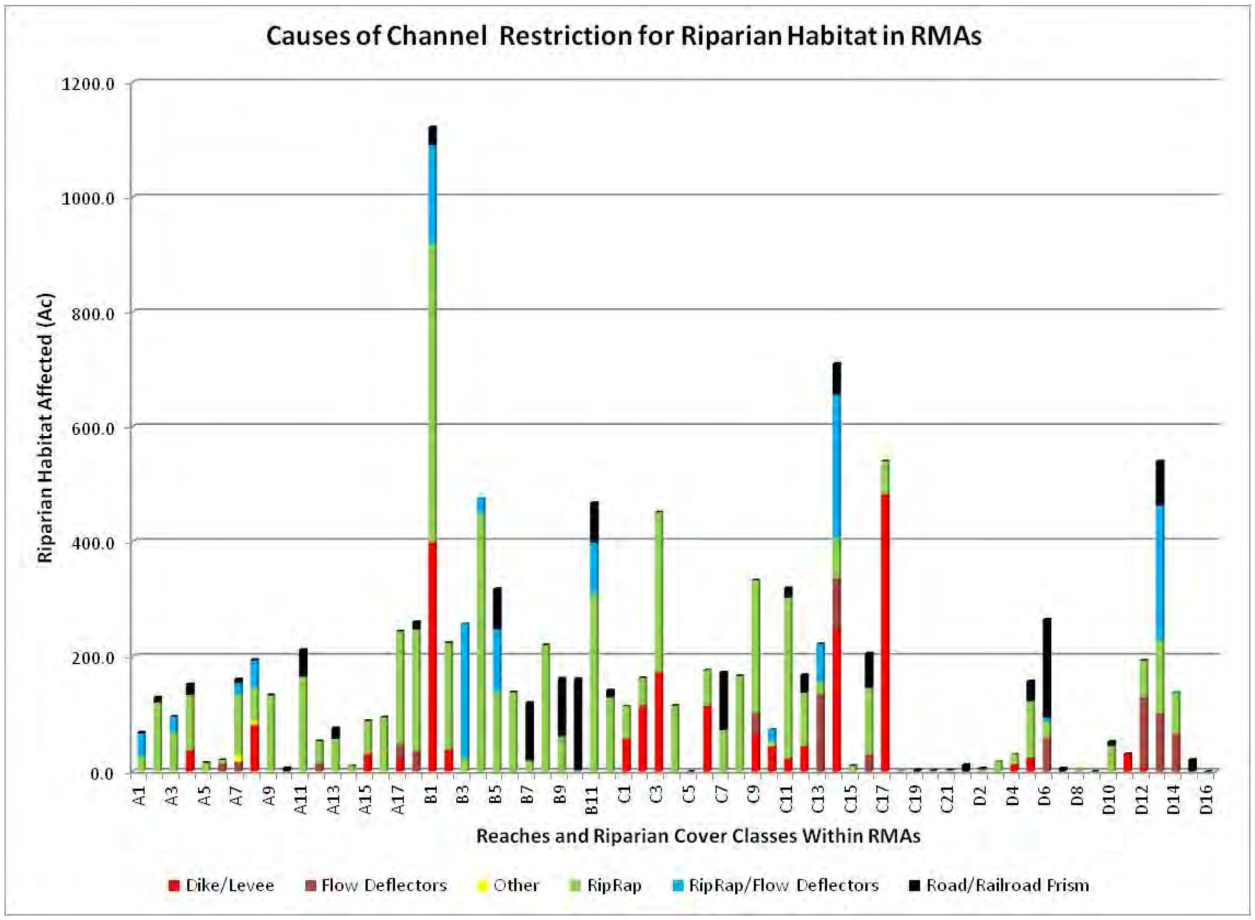

Figure 1-26 **Illustration of riparian habitat within RMAs and the respective causes of the channel restriction designation for each geomorphic reach of the Yellowstone River.**

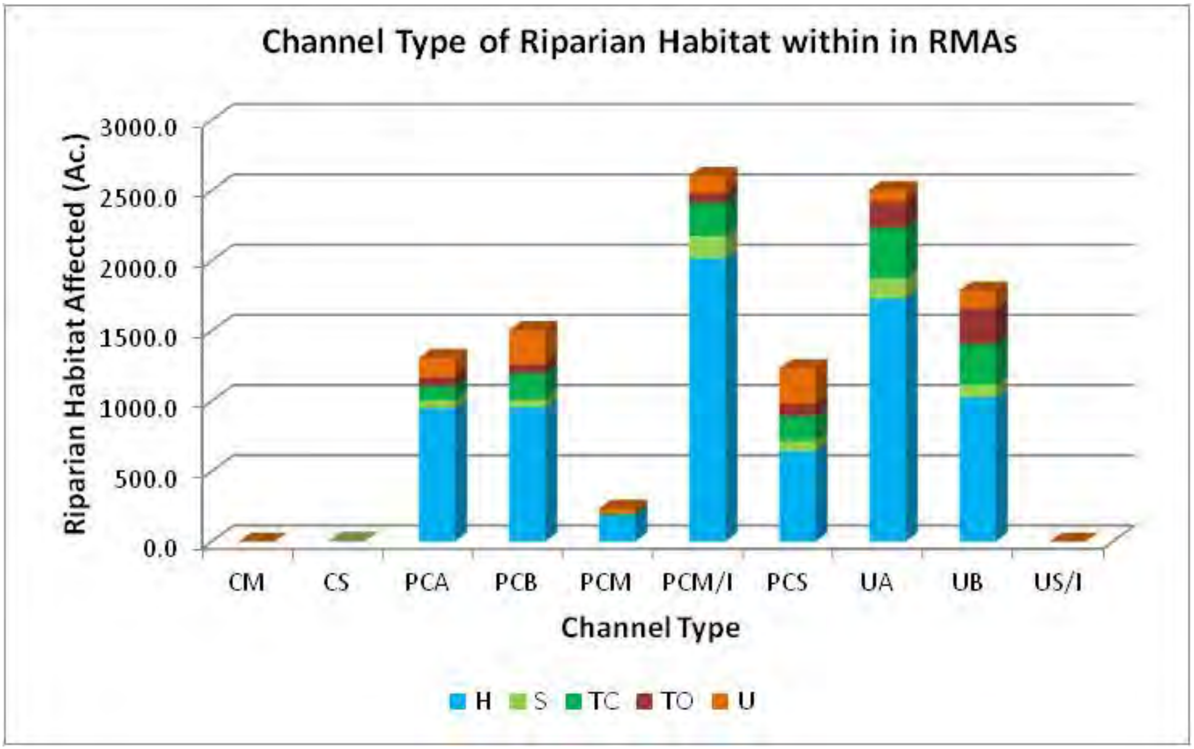

Figure 1-27 **Proportionally more restricted riparian mapping classes are located within less confined reach types (PCM/I, UA, and UB).**

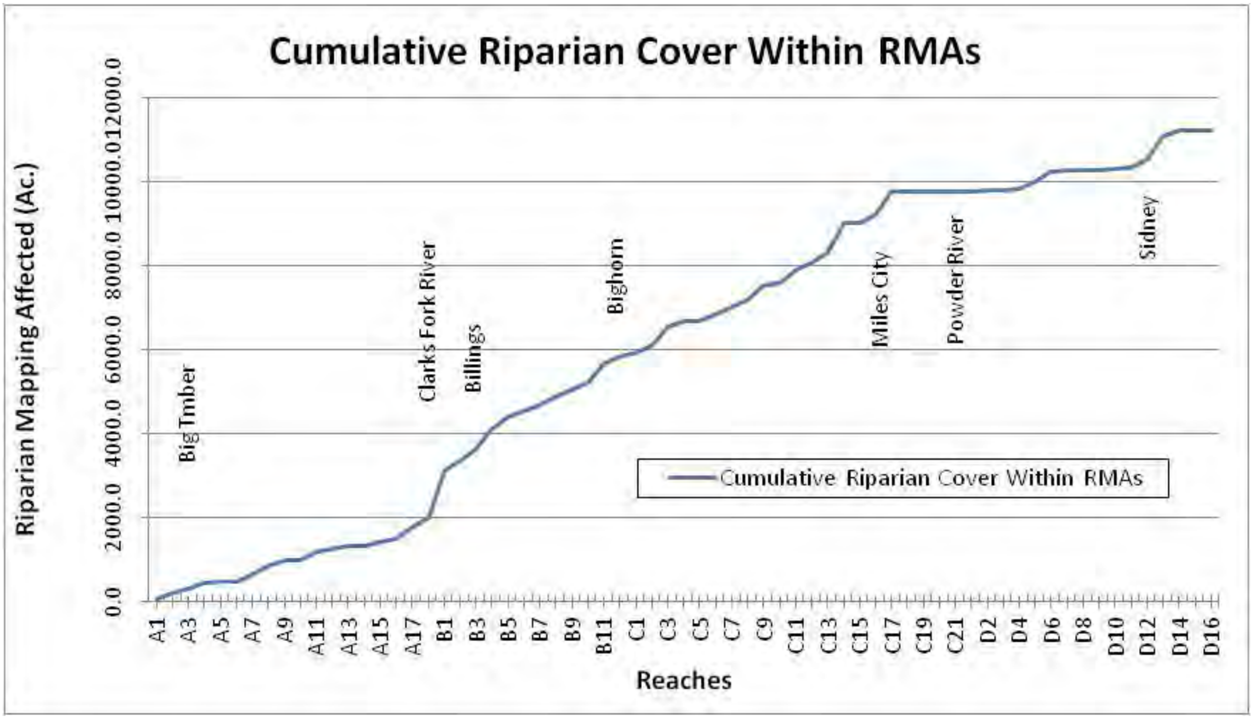

Figure 1-28 Graph depicts the downstream trend in cumulative acres of riparian floodplain habitat that is located within a Restricted Migration Area (RMA). Sharp increases in affected riparian habitat are noted at the beginning of Region B, throughout Region C to about C17, and again beginning at about Reach D 12 through D14. The primary cause of restriction, as noted in preceding figures and the discussion, is agriculture and transportation features, except in C17 where the main cause of isolation is a levee protecting urban development near Miles City.

These results are consistent with the overall trends reported by others. Boggs (1984) predicted that diminished flood flows would lead to abandonment and colonization of seasonal side channels. He also found that channelization would lead to altered age classes by reducing channel migration rates. Merigliano and Polzin (2003) working in the Park County study area (Upper Yellowstone River found that reaches with braided channel classifications showed an increase in older cottonwood stands, in addition to an increase in the presence of gravel bars. In reaches with moderate confinement, they also noted an aging of cottonwood stands and a reduced abundance of gravel bars. They also concluded that the river is less dynamic in more recent times with less regeneration of cottonwoods and mature stands becoming decadent without replacement by younger age classes. Their work did not provide a clear reason for the reduced river dynamics but suggested that human activities, including agriculture and bank stabilization, may have contributed, as well as phenomenon such as climate change and changes in sediment loading.

Other Agriculture - Degradation of riparian habitat by uncontrolled livestock grazing has negative impacts on a variety of environmental services provided by riparian areas, including, but not limited to water quality, bank stability, flood water attenuation and storage, and aquatic and terrestrial wildlife habitat (Fleischner, 1994; NAS, 2002; Poff, 2012). Belsky et al. (1999) estimates that livestock grazing has damaged approximately 80 percent of the remaining stream and riparian habitat in the western United States leading to large-scale changes in local and downstream ecosystems.

Other authors hypothesize that riparian systems in the Great Plains Region have a co-evolutionary history of grazing by large herbivores such as bison, elk, deer, big-horn sheep, and antelope and thus have less inherent sensitivity to livestock grazing (Kay, 1994; Lauenroth et al., 1994). Accounts of early-day explorers of the Yellowstone indicate that large, migrating herds of all the fore-mentioned herbivores were still present in the mid to late 1800s (Forsyth and Grant, 1875; Raynolds, 1867; Russell, 1921). Indeed, some explorers noted a lack of trees in some locations, or poor forage availability and a lack of understory shrubs in response to fire, drought, and use by large herds of wildlife having moved through the area (Raynolds, 1867; Russell, 1921; Taylor, 1990; numerous citations). A contrasting view is that this hypothesis may hold more pertinence in prairie grassland landscapes than in riparian areas (Taylor, 1990).

In general though, season-long livestock grazing utilizing high stocking rates has been shown to result in degraded riparian function (Platts, 1991; Chaney et al., 1990; Trimble and Mendel, 1995). In most cases, the decline of shrubs and trees are related to livestock browsing on young plants (Clary, 1989; Belsky, 1999) and to a lesser degree in some locations, rubbing or mechanical damage (Skovin review, 1984).

Although many authors question the suitability of any grazing in riparian areas, (Mehan and Platts, 1978; Ohmart, 1996) there have been some reports published more recently that indicate grazing systems utilizing scientific-based prescriptions for livestock grazing frequency, duration, and intensity may mediate negative impacts. Specifically, their studies have shown that seasonal grazing, rest-rotation, deferred grazing, and high intensity-low frequency grazing systems can result in riparian zones regaining cover and function over time when livestock are managed to avoid overuse (Erhart and Hansen, 1998; Armour et al., 1994; Elmore and Kauffman, 1994; Savory, 1998). Extremely damaged riparian systems may require very long periods of rest in order to fully recover function (Skovlin, 1984; Elmore, 1996; Clary et al., 1996) or in some cases to guarantee full recovery, permanent protection from all grazing may be required (Chaney et al., 1990; Bock et al., 1993; Case and Kauffman, 1997).

No extensive data set, gathered in a systematic way that measures and evaluates riparian health or condition or the impact of stressors such as grazing, is available for the entire Yellowstone River corridor. Jones (2014) noted observations that the main drivers of fragmentation and loss of riparian forest habitat quality were (1) bank armor, (2) riparian conversion (agriculture), and (3) poor riparian management (unregulated livestock grazing). In a more focused study, Eggers (2005) looked at the impact of cattle grazing at 27 paired, grazed-ungrazed locations along the river corridor between Emigrant, Montana and Sidney, Montana. Her comparison found that the grazed sites exhibited a general decline in plant litter, native woody, forb, and graminoid species diversity and production with a commensurate increase in bare ground and non-native species cover. Invasive species were present in both grazed and ungrazed riparian communities.

Boggs (1984) studied riparian succession in riparian communities along the Lower Yellowstone between Glendive and Sidney. He found that riparian succession regularly proceeded over a fairly predictable sequence depending on elevation above and distance from the river surface. Willow (*Salix* spp.) and plains cottonwood (*Populus deltoides*) colonized freshly deposited sand and gravel bars. Subsequent sediment deposition and channel migration gradually elevated the land surface (up to about 10 feet) above and away from the stream surface and created a more arid environment not conducive to further colonization by these species. Willows began to die out after about 20 years. As cottonwood stands matured and became less dense, shrubs invaded. Cottonwoods were eventually replaced some 100+ years later by a shrub and grassland community as the climax stage. Where moisture remained adequate, green ash (Fraxinus pennsylvanica) replaced cottonwood and became the climax stage. In an alternate pathway when cottonwood did not adequately establish, peachleaf willow (Salix amygdaloides) dominated and were then eventually replaced by green ash. Fire, grazing, channel migration, ice damage, or flooding can alter the sequence of this pattern but in general it describes the sequence that creates the mosaic of riparian cover seen today on streams throughout the Great Plains. Figure 1-29 depicts the riparian woody plant community succession sequence described by Boggs (1984) and later Hansen (1995).

Merigliano and Polzin (2003) found that the narrow-leaf cottonwood (*Populus angustifolia*) that is the ominate riparian woody cover in the upper 100 miles or so of river, is a species that can regenerate from root sprouts similar to many willows. Similar pathways exist otherwise except that green ash is not common in the upper river. Coarser, more rocky bank materials found in the upper river may somewhat minimize hoof damage that has been associated with livestock grazing in finer soil material, however, damage to woody riparian vegetation and ground cover is expected to remain high under intensive, season-long grazing use, particularly when the sole water source in a riparian pasture is the river. Repeated livestock trampling and repetitive grazing is detrimental to vegetation similar to that found in popular river recreation sites. As an example, heavy foot traffic found at fishing access sites in the upper Yellowstone region has been shown to restrict narrow-leaf cottonwood reproduction (Eggers, 2005).

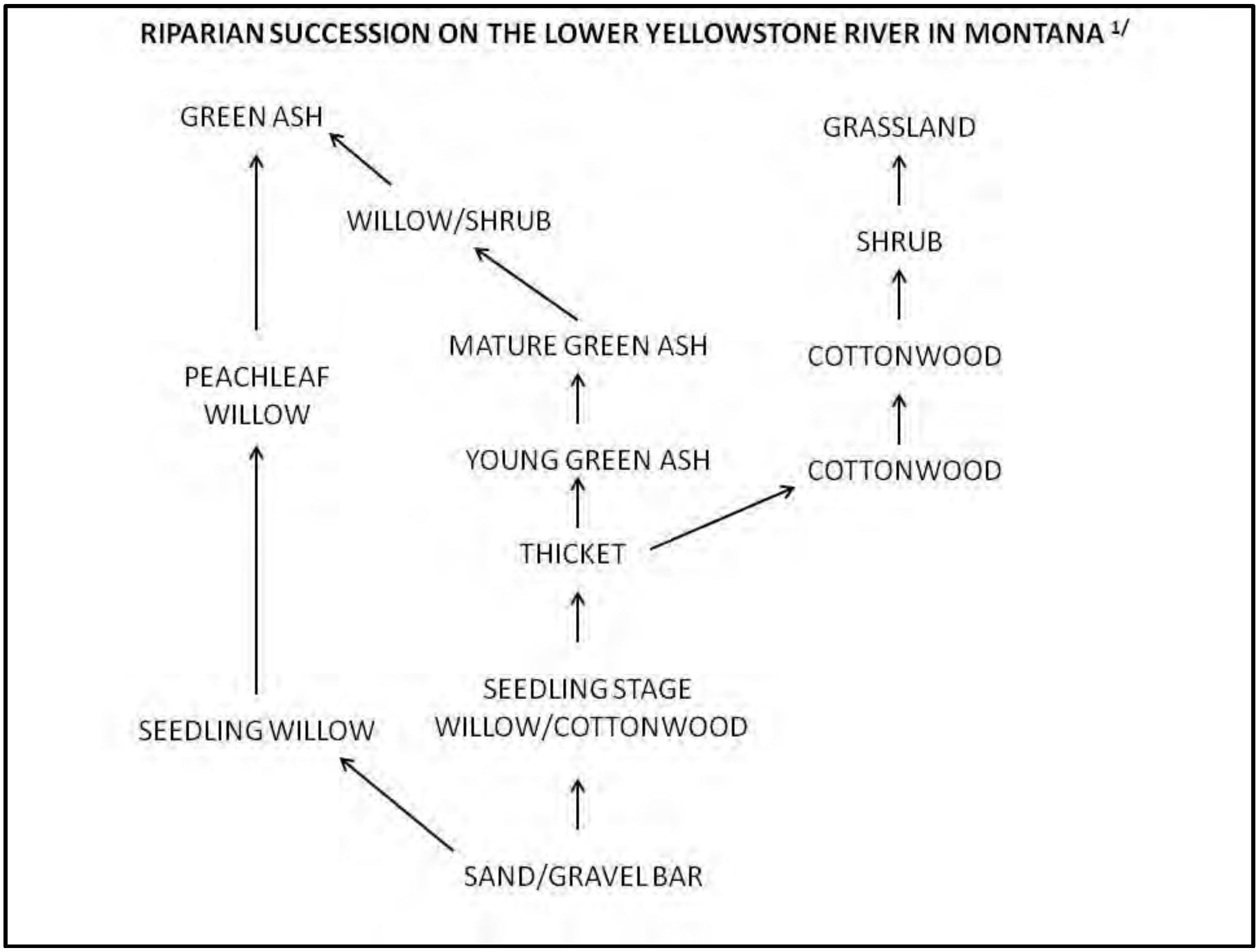

Figure 1-29 Flow chart shows the general changes in dominant woody species communities in the lower Yellowstone River. [1/] **Adapted from Boggs (1988).**

2.0 INVASIVE SPECIES IMPACTS ON RIPARIAN COMMUNITIES

2.1 Russian olive (Elaeagnus angustifolia)

Russian olive was introduced to Montana in the early 1900s for use in conservation and ornamental plantings. Russian olive was widely promoted for use in windbreaks in the post Dust Bowl era as it could tolerate the cold winters, was very drought tolerant, and grew quickly. Over time, it has become naturalized or invasive on sites in eastern Montana with moist, slightly to moderately saline soil. These are sites that typify many riparian and wetland habitat, however, extended ponding or submersion is needed to kill Russian olive (Pick, personal observation). Russian olive is reportedly the fifth most dominant woody riparian plant in the western United States (Nagler et al., 2009). As a result of concern over its growing extent and potential to alter riparian plant communities, Russian olive was put on the state noxious weed list as a Priority 3 ‘regulated’ plant, meaning it is not to be planted and control is encouraged.

Russian olive has demonstrated a number of key competitive advantages over native vegetation: its large seed is viable for a long period of time (28 years in some studies), tolerance to moist, moderately saline or sodic sites, relatively early maturity, strong drought tolerance, means of spread (water and animals), low browse palatability, few disease and insect problems, strong sprouting habit, and extreme cold tolerance (Pick, 2013). Several USDA sponsored initiatives have provided cost-share assistance for Russian olive control efforts along the Yellowstone River corridor. Invasive species can alter the composition and structure of riparian habitat which negatively impacts resident and migrating aquatic and terrestrial native wildlife (Fischer et. al., 2012; Hansen et al., 1995).

The distribution of Russian olive using the NRCS 2008 mapping product (Figure 2-1) was evaluated for the purpose of this study to determine key relationships with the study area setting, 100-year inundation boundary, the CMZ 1950s banklines, 2001 fisheries habitat, 2001 riparian vegetation classes, and 2001 physical features (DTM 2013). Following are the significant results of the analyses. All figures are from DTM (2013) unless noted otherwise.

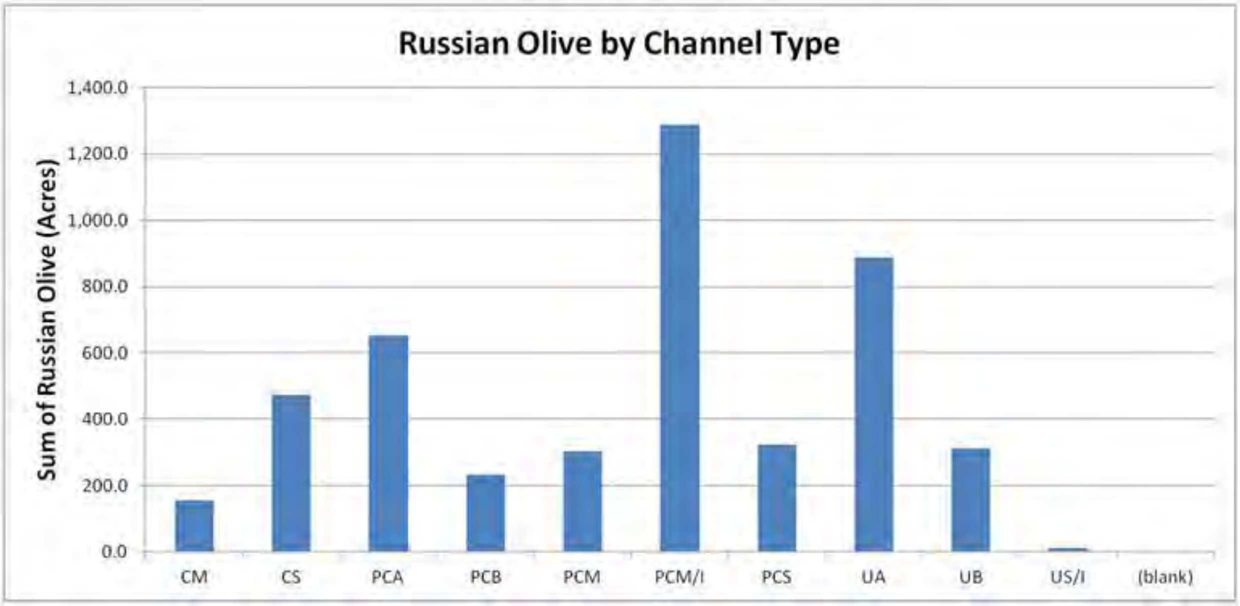

Figure 2-1 The greatest extent of Russian olive occurs within the PCM/I channel type reflecting its adaptation to moderate disturbance and especially islands and abandoned channels.

Study area reaches and regions – Figure 2-2 provides the relative extent and composition of Russian olive in each Reach. The greatest extent of Russian olive is in Region C with 2,475 acres which represents about 54 percent of the total infested area in all Regions. This status is related to the relatively wide floodplain and footprint of Region C. When normalized on a percentage of area basis, Region B has the greatest concentration of Russian olive with about 0.3 percent of its area occupied by Russian olive. Russian olive is dramatically reduced in reaches above A15 near Park City. This location is near where the Yellowstone River valley floor and floodplain widen as the River leaves the Valley and Foothills Ecoregion and enters the eastern plains of Montana (Woods et al., 1999). Overall, the analysis of Russian olive extent and frequency is somewhat skewed by the presence of linear features such as irrigation ditches and canals, surface drains, and fences, as well as by the presence of tributary floodplains.

Channel Type – Russian olive extent is related to channel type in the same manner that the potential for riparian vegetation and floodplain extent are greater where the channel is moderately confined by geologic control (Figure 2-3). Nearly 30 percent of Russian olive acreage occurs in the PCM/I channel type where 1950s islands are well occupied. On a percent of reach basis, the PCM, PCM/I and UA all have nearly 0.25 percent occupied by Russian olive. Confined reaches have substantially less extent and concentration of Russian olive, generally less than 0.15 percent.

100-year inundation boundary - A slight majority (66 percent) of all mapped Russian olive occurs within the 100-year inundation boundary showing its adaptation to the moist, slightly saline soil within the River's floodplain, particularly within Region B and C (Figure 1-25). An unusual deviation is noted in Reaches C14 and 15 where there is also a very low percentage of riparian habitat mapped. These are also reaches with a slightly less wide valley floor due to the uplands north and south impinging on the channel and, importantly, a large amount of developed irrigated cropland in the corridor.

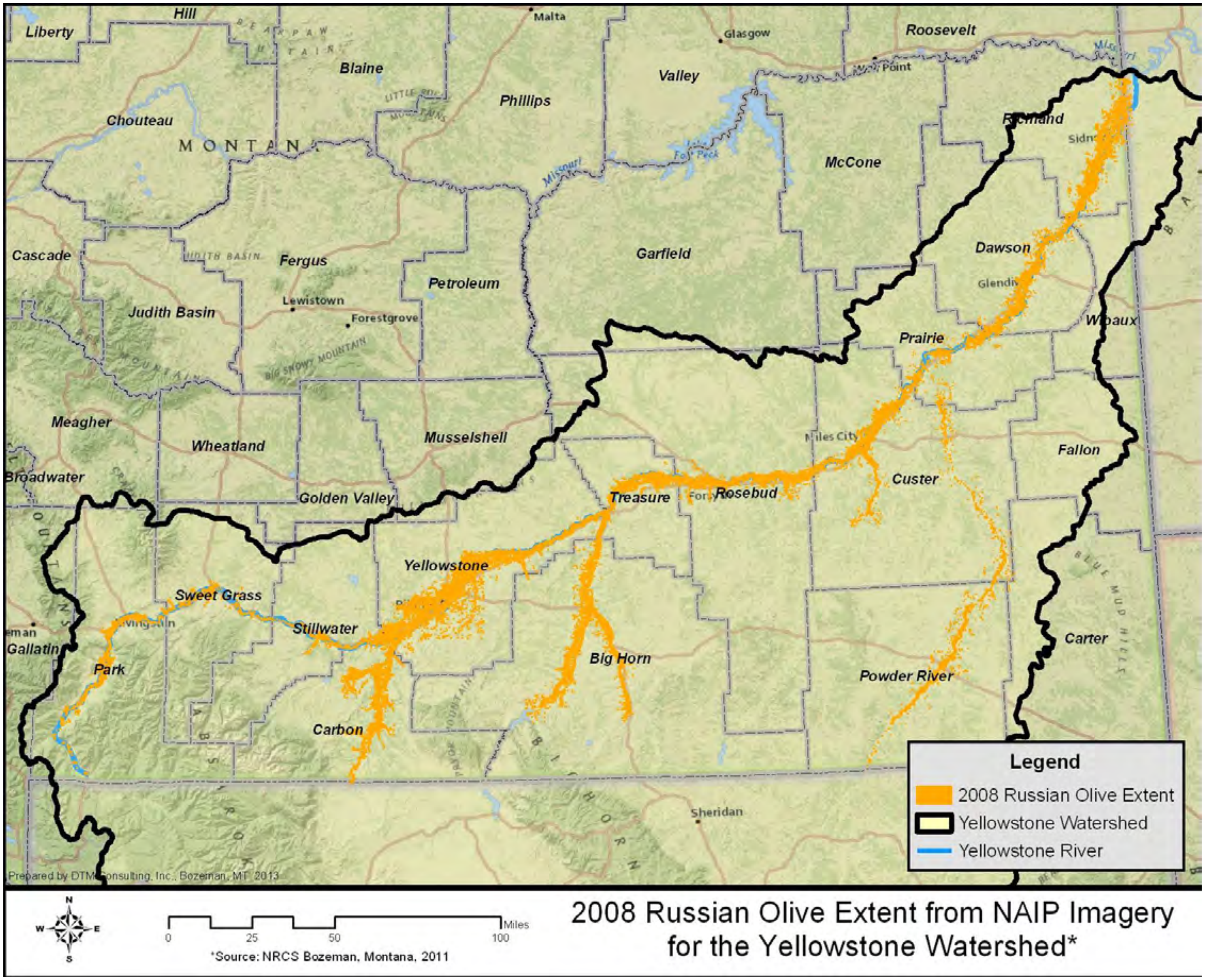

Figure 2-2 NRCS Russian Olive Mapping in the Corridor of the Yellowstone River and Its Major Tributaries.

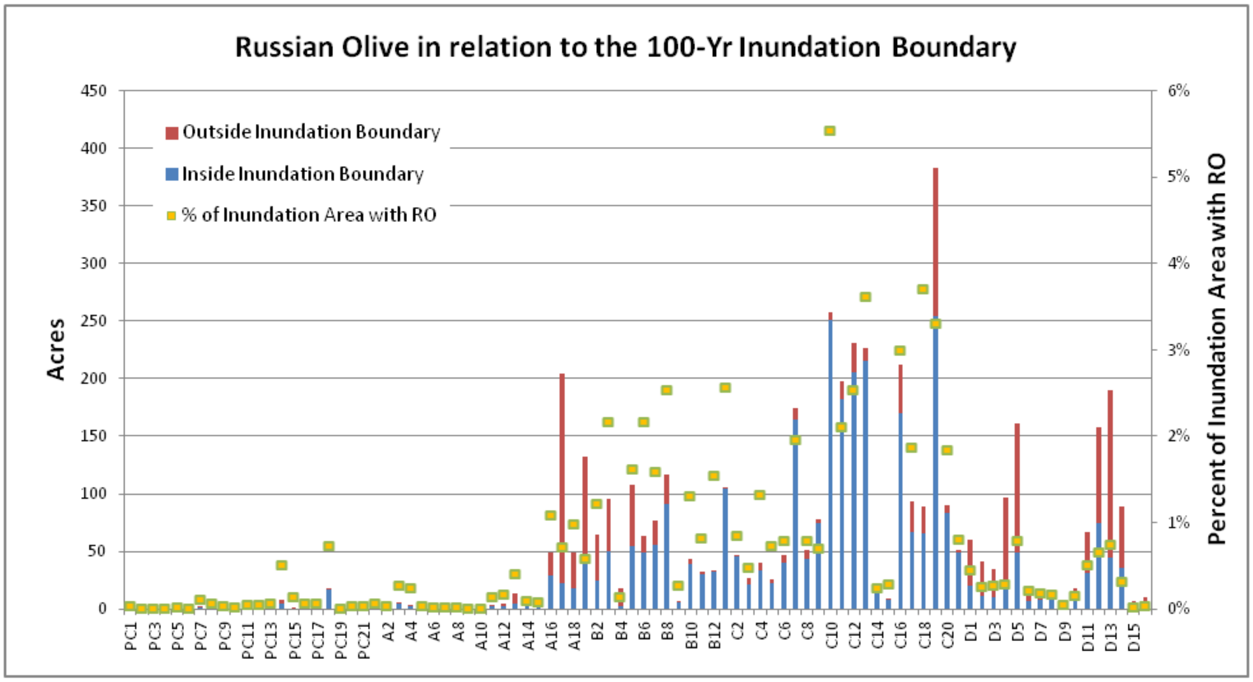

Figure 2-3 Russian olive in relation to the 100-year inundation boundary by reach. The percent of the inundation boundary occupied by Russian olive is also shown (right side axis).

Analysis shows that Reaches C14 and 15 lost over 50 percent of their riparian cover between 1950 and 2001. Historical accounts indicate that extensive cottonwood stands were located upstream of the Tongue River in the 1800s so it is fair to assume that the riparian stands in this area were converted prior to 1950 during the early days of agricultural development. Intensive agriculture in these two reaches may preclude extensive Russian olive invasion. Relatively low densities of Russian olive occur in Region D with more outside of the CMZ.

Channel Migration Zone (CMZ) - Russian olive occurs in greater extent and frequency in areas outside of the historic CMZ (Figure 2-4). Less Russian olive occurs in 'Restricted' areas that have been cutoff or isolated from river flooding by dikes and levees. While somewhat misleading, this finding concurs with previous studies showing that Russian olive poses a greater invasive threat in controlled river systems that don't experience regular flooding (Lesica and Miles, 2001). Perhaps these restricted areas are also intensively farmed or managed so as to limit the occupation of Russian olive or the lack of regular disturbance or another unknown factor appears to limit the invasion of Russian olive in these isolated areas. In a similar analysis, modern day Russian olive is well correlated with the 1950s channel location which has changed significantly over time (Figure 2-5). 1950s islands are even more favored with occupation percentages above 5 percent for many reaches in Region B and especially Region C. Again, the disturbance and associated open bars and abandoned channel area appears to have provided good establishment sites for Russian olive, particularly in light of the diminished spring high water flows in Regions C and D below the Bighorn River confluence that has resulted in side channels now occupied by riparian vegetation and reduced potential for the creation of new side channels. Significant portion of the 1950s channel is occupied by Russian olive in Region C.

Work in the southwest United States has shown that Russian olive and saltcedar roots add sufficient reinforcement strength to channel banks and increased floodplain roughness such that channel migration has been dramatically restricted. Removal of the two invasive species has resulted in bank retreat rates doubling leading to hopes that the historic multiple, shallow and wide channel pattern can be restored from the current single, deep, meandering channel (Bankhead et al., 2008; Everitt, 1998; Graf, 1978).

Riparian Cover Type – Russian olive is well distributed throughout all riparian cover categories (Figure 2-6, Figure 2-7, and Figure 2-8). As expected, Russian olive correlates highly with riparian areas since it is likely that the plant was mapped as part of the riparian Shrub category and occurs within cottonwood stands where it may or may not have been identified under the cottonwood canopy. This finding fits the widespread premise that Russian olive serves to expand riparian habitat where suitable conditions exists.

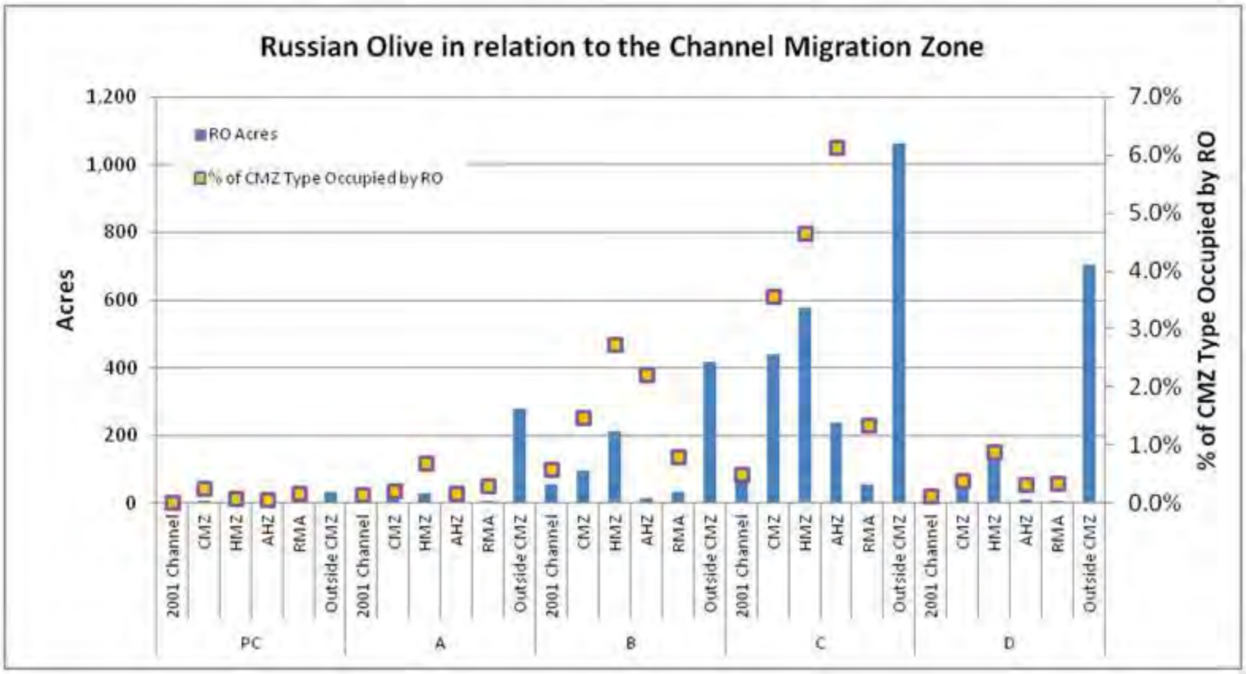

Figure 2-4 **Russian olive acreage within the CMZ mapping by type indicating the percent of each CMZ type's area occupied by Region.**

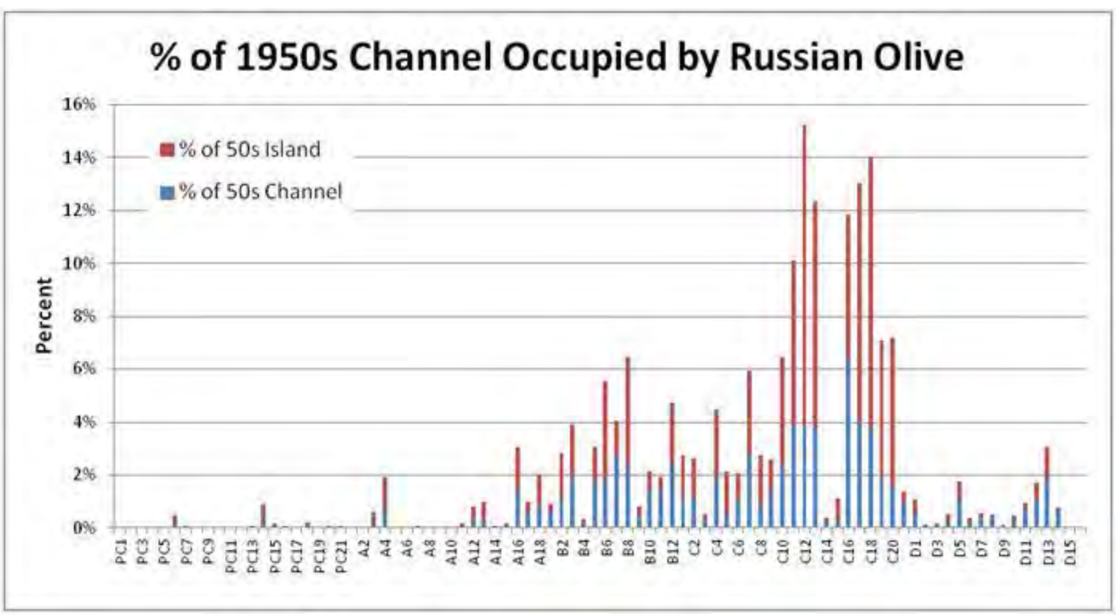

Figure 2-5 **Percentage of 1950s bankfull channel occupied by Russian olive.**

Figure 2-6 Russian olive cover type distribution in mapped 2001 riparian cover by Reach (extent).

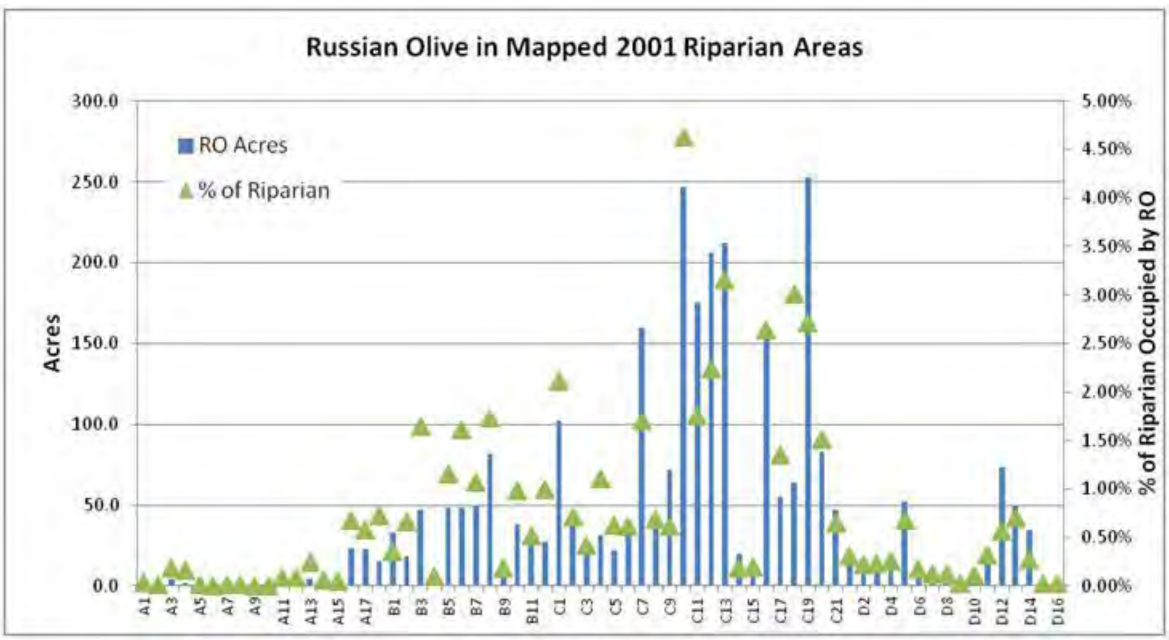

Figure 2-7 Russian olive percent composition and acreage in 2001 mapped riparian cover.

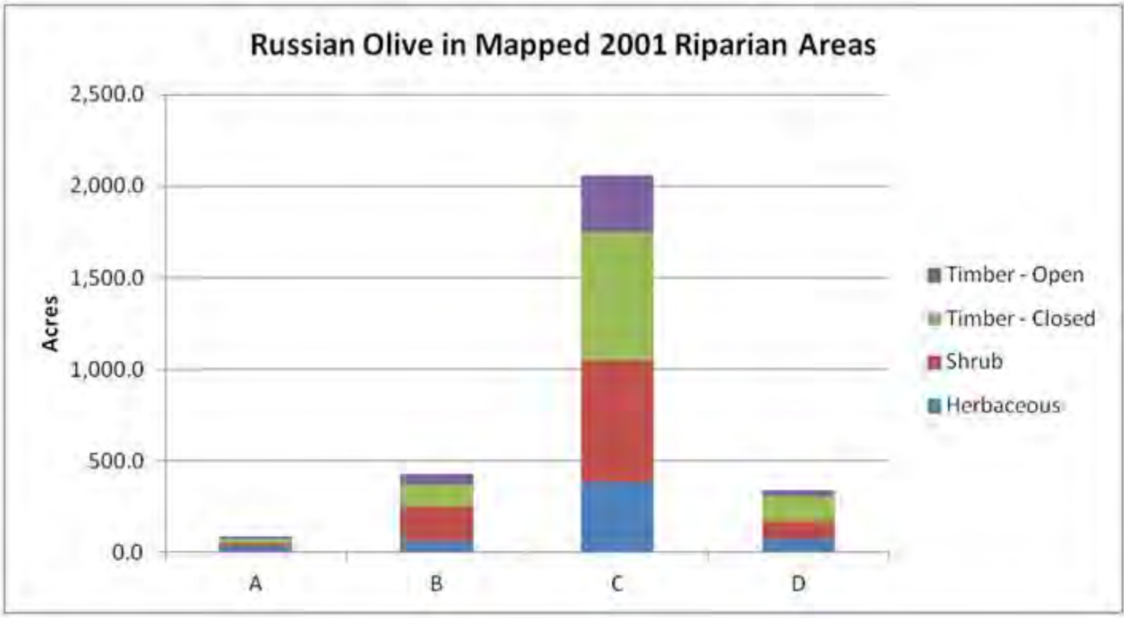

Figure 2-8 **Russian olive distribution within 2001 riparian cover in Regions A-D. The extent of Russian olive mapped within the Closed Timber category may have been underestimated in some places due to the mapping procedure used and difficulty in identifying the species under dense overstory foliage.**

A majority of Russian olive occurs in the Shrub class and secondarily in the Timber closed category. Russian olive occurs relatively less so in the Herbaceous and Open Timber classes, as might be expected. As noted earlier, a majority of the Russian olive extent occurs in Region C where it makes up as much as 30 percent of the Shrub category in Reaches C10 and C19. This is likely correlated to the previously discussed succession of channel to riparian cover below the Bighorn River (Figure 1-8) but the same relationship does not hold true for Region D. Russian olive makes up nearly 4percent of the total riparian in the C Reaches with some large individual stands. The relatively low proportion of Russian olive in Region D’s riparian cover breaks a downriver trend in increasing extent and density demonstrated from Park County through Region A to C.

Most of the more than 2,000 acres of Russian olive infestations in Region C occur within Shrub and Open Timber class (Figure 2-8). It is not yet clear why Region C has an extent of Russian olive within the 1950s bankfull channel and island boundaries unless it is also related to reduced flows and the observed propensity for this plant to grow on the bankline. Region D’s lower composition values reflect the generally reduced extent of Russian olive there although one would expect Russian olive to have occupied the relict side channels now colonized by riparian cover there.

Fisheries Habitat – Only a relatively small acreage and percentage of fisheries habitat is occupied by Russian olive although a few of the categories are shown preference by Russian olive (Figure 2-9). Secondary seasonal, dry channels, and side bars have significantly more Russian olive than other fisheries habitat types affirming the preference of Russian olive for disturbed sites adjacent to the channel. As indicated earlier, most area of Russian olive infestation is found outside of the channel migration zone as it is not as well adapted to the disturbance associated with flooding and channel migration as are native species.

The increased presence of Russian olive in the near-channel area could affect the quality and quantity of LWD in the down river system. With fewer large cottonwood and willow trees, root balls and leaf litter entering the system, a cascade of undesirable impacts to aquatic species and habitat is likely to occur (multiple sources in Ellis, 2008).

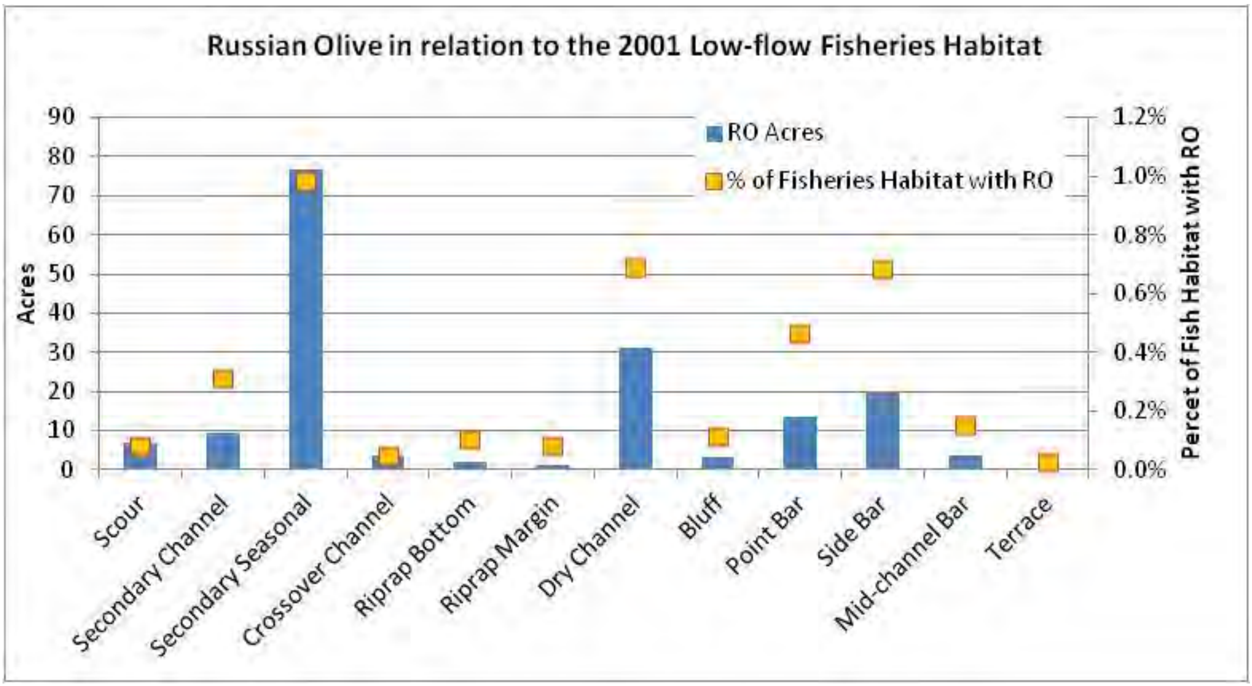

Figure 2-9 Russian olive occurs in relatively low abundance and density within low-flow fisheries habitat.

Physical features – Russian olive does not appear to be correlated with 2001 bank stabilization or other physical features. There is a link between proximity and Russian olive but not a strong one. Where Russian olive does occur within 100 feet of bank armor, it is somewhat more likely to be within about 80 feet than further away. This relationship does not seem to be a remarkable finding (DTM 2013) from a spatial analysis standpoint. A band of Russian olive is often seen to colonize the very edge of the river bank, possibly to take advantage of less completion and more sunlight or possibly this is where the seed is deposited more frequently by normal stage flows (Pick, 2014) as depicted in Figure 2-10. Beavers in eastern Montana streams have been shown to alter riparian species composition through the preferential felling of *Populus* and *Salix* species adjacent to the channel, resulting in increased growth for the unfavored species like Russian olive and saltcedar (Lesica and Miles, 2004). More sobering implications are that Russian olive (along with saltcedar) can cause channel narrowing, island building, and simplification of complex channel patterns due to restricting channel movement and trapping sediment as has been observed at other locations in the western United States (Bankhead et al., 2008; Everitt, 1998; Graf, 1978). Additional study of this potential impact is recommended.

2.1.1 Saltcedar (*Tamarix* spp.)

Saltcedar or tamarisk is a long-living, deciduous, exotic shrub imported from Eurasia to control streambank erosion in the 1900s. It is classified as a Priority 2B noxious weed in MT and ND. The plant is adapted to colonizing fresh alluvium after disturbance. Saltcedar is able to reproduce by seed, root sprouts, and cuttings. The plant flowers at three to five years old or earlier and produces up to 600,000 seeds annually with seed production occurring throughout the growing season. Damage to the trunk produces dense sprouting (Nagler et al., 2009). These adaptations give saltcedar a decided advantage over native species which is why it is classified as a noxious weed. Extremely dense stands of saltcedar exclude other vegetation and the shed leaves contain concentrations of salt which makes seed germination difficult for competing species. Saltcedar is reportedly the second most dominant woody riparian plant in the western United States (Nagler et al., 2009). The plant's genetic diversity may allow saltcedar to rapidly acclimate to colder climates and facilitate its spread to higher elevation, colder climates (Hellman et al., 2008; Sexton et al., 2002). While saltcedar has been noted to utilize a significant volume of water in the southwestern US, Montana studies have not shown the plant's water use to be excessive here (Meredith and Wheaton, 2011). Flow regulation and hydrologic alteration following establishment tends to promote the dominance of saltcedar. Several USDA sponsored initiatives have provided cost-share for saltcedar control along the Yellowstone River corridor.

Figure 2-10 Russian olive and saltcedar shows preference for the open bankline adjacent to an immature plains cottonwood stand where there is not active channel migration or competition present. Preferential removal of cottonwood and willow by beaver favor these species in the near channel area. The dense mass of stems, especially with saltcedar may increase floodplain building due to greater sediment deposition while the added root mass may reduce channel migration rates.

Saltcedar, like most invasive species, has been noted to drastically alter the composition and structure of the riparian areas that it tends to dominate but little is known about its impacts on streams, riparian habitat, and wildlife functions in the northern Great Plains (Jacobs and Sing, 2007; Sher et al., 2001). As mentioned earlier, saltcedar in the southwestern United State has been noted to increase channel stability leading to changes in the pattern and profile of affected channels. Reports of channel narrowing between 13 to 55 percent and other geomorphic modifications in addition to more frequent overbank flooding due to saltcedar infestations have been noted (Graf, 1978; Everitt,1998).

There are no Yellowstone River-wide, comprehensive studies evaluating the scope and density of saltcedar. Individual counties have completed inventories along with control work, however, there is a need to complete assessments using consistent criteria and methods. Efforts to map saltcedar using multi-spectral imagery and GIS analysis tools have been unsuccessful to date (Pick, 2013).

Implications are that saltcedar (along with Russian olive) has been noted to create geomorphic alterations on small streams in the southwestern United States, causing channel narrowing and simplification due restricting channel movement and trapping sediment (Bankhead et al., 2008). Work in the southwest United States has shown that Russian olive and saltcedar roots add sufficient reinforcement strength to channel banks and increased floodplain roughness such that channel migration has been dramatically restricted. Removal of the two invasive species has resulted in bank retreat rates doubling leading to hopes that the historic multiple, shallow and wide channel pattern can be restored from the current single, deep, meandering channel (Bankhead et al., 2008; Everitt, 1998' Graf, 1978). It is not known whether these channel modifications are presently occurring or are likely to occur on a large river system like the Yellowstone River, but in practice, Russian olive and saltcedar are more invasive on hydrologically controlled, less dynamic river systems (Lesica and Miles, 2001).

2.1.2 Other Invasive Species

Because riparian habitats are created and destroyed through the processes of erosion and sedimentation (Knight et al., 2014; Merigliano and Polzin, 2003; National Research Council, 2002), these fluvial processes also render the freshly disturbed sites very susceptible to invasion by exotic species. Initially barren gravel bars and sediment deposits are fertile ground for invasive species, as well as native plants. A number of other invasive species also have the potential to adversely impact the extent or structure of riparian habitat by competing with native species establishment or by providing habitat for other exotic species. Jones (2001) noted that hounds tongue Canada thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea maculosa*) are serious pests that threaten riparian habitats along the Yellowstone River. Impaired riparian functions and values result if invasive weeds are allowed to spread uncontrolled. See http://mtweed.org for more information on identification and control of noxious weeds in Montana.

There are additional exotic species which pose threats to the sustainability of riparian corridors. One such species is common buckthorn (*Rhamnus cathartica),* a tall shrub or low tree which typically shades out other species (Figure 2-11). It commonly grows in the understory of cottonwoods and appears to be expanding its range in Montana. It is classified as a noxious weed in a number of northern tier states.

Figure 2-11 Common buckthorn. Photo credit: Paul Wray. Iowa State University. Bugwood.org.

3.0 RELATED IMPACTS

As described in the preceding sections of this chapter, there are a number of notable, indirect human influences on riparian areas within the Yellowstone River corridor. Based on the available studies and related literature, those described previously are thought to be the most significant sources of riparian alteration or change. Given the scarcity of Yellowstone specific studies with quantitative and qualitative data to provide context, there could be other potential impacts that have or will contribute to riparian impacts in the future. Some of these are described below.

3.1 Climate Change or More Variability in Climate Extremes

As discussed in Appendix 2, potential impacts of historic and projected trends in climate on the Yellowstone River have not been analyzed in detail but projected climate changes could affect the river's hydrology in several ways. Due to their topographic position and reliance on water resources, riparian and wetland systems may be impacted as much as any other river-related resources by changes in water availability, duration, or timing that are driven by variability in climate. At the minimum, warmer air temperatures would likely lead to earlier runoff and elevated water temperatures, particularly affecting summer low flows (Braatne et al., 2007; Miller et al., 1995). Predicted reductions in streamflow in the Yellowstone region during runoff events or low-flow periods would be expected to further stress riparian areas and lead to impaired function due to exposure to longer, warmer dry periods (Leppi et al., 2012). Susceptibility to invasive species may be enhanced, as well (Boggs, 1984; Eggers, 2005). Alteration of inundation duration, runoff timing, and even low-flow regimes has been shown to be a very common modifier of riparian community composition and extent (Merigliano, 2007; Miller et al., 1995; Auble et al., 1994) so any further reductions in this aspect of minimum flows necessary to sustain the riparian resource may have significant impacts.

Fire and beaver are other recognized historic modifiers of riparian mosaics (Akashi, 1998) that no longer have a significant impact under present policies and practice along the Yellowstone River. Future trends in longer, warmer summer temperatures could affect the fire trend (Knight et al., 2014). A shift in how beavers are viewed by landowners would very likely be needed to return significant numbers of these animals to the ecology of riparian areas in the Yellowstone River corridor (Pick, personal observation).

In summary, climate-related impacts on the Yellowstone River may take the form of short- and/or long-term impacts to riparian areas and the plant and animal communities that are dependent on them. As a result of constraints in time and financial resources, specific climate projections and analyses have not been made under the auspices of the Yellowstone CES, but are encouraged to be undertaken as resources are available by those who follow this work. That the current riparian communities will adapt to fit changing climatic drivers is not questioned. Rather, the question is "What will the physical and biological outcome for the resulting riparian communities - terrestrial and aquatic plants and animals - look like?" Will it be similar to or far different than what we see along the river today?

3.2 Municipal and Industrial Water Use

As sectors of overall water withdrawals on the Yellowstone River, municipal and industrial water users are relatively minor users and even smaller consumers of water. Compared to agricultural withdrawals, municipal water use in counties along the river is relatively minor, making up less than 1 percent of the daily water use. Industrial water use, is somewhat greater, but only comprises around 8 percent of agriculture's use. However, it was also noted that off channel industrial uses (oil extraction, mining, and energy production) consume water in the lower river which could have impacts on flow stage during low-flow periods.

With projected increases in population and industry within the Yellowstone River watershed (mining, oil, and gas development), increased water demand will occur in the future which would heighten the impact of total water withdrawals during low-flow periods, particularly when coupled with possible climate change or variability as discussed in the preceding section. Data or metrics for this analysis and potential impacts on riparian areas have not been made but would be expected to parallel the subjective reasoning in the preceding sections.

3.3 Expansion of Urban/Ex-urban Development

The majority of past conversion and alteration of riparian habitats has been related to agriculture, primarily because of the dominant spatial extent of agricultural land uses in the basin and corridor. While agricultural land uses will likely not expand in the future, it is expected that urban and ex-urban land uses will continue to grow as population expands within the corridor. Current laws and regulations (Federal Clean Water Act, Montana Stream Protection Act of 1963, the1975 Natural Streambed and Land Preservation Act, and the 1973 Montana Floodplain and Floodway Management Act) may serve to protect riparian environments to some degree, however continued growth will bring pressure to convert land for housing and urban/ex-urban infrastructure so future impacts of urban/ex-urban development could be significant near urban centers like Billings, Miles City, and Glendive unless additional programs are instituted to conserve and protect riparian habitat within the river corridor.

3.4 Changes in Water Quality

The documented reductions in low-flow discharge (Appendix 2) on the Yellowstone below the Clarks Fork River confluence, coupled with other potential increases in water demand, could further reduce low flows, especially in the lower river below the Bighorn River confluence. Further reductions in flow have the potential to increase concentrations of water quality contaminants as described in Appendix 6 to a point that beneficial uses could be threatened.

Potential changes in riparian community composition and age structure due to grazing or hydrologic alterations, as noted earlier, that favor exotic species such as Russian olive and saltcedar can alter the retention or sequestration of potential pollutants in riparian areas. Boggs (1994) measured a net loss of nitrogen and carbon in the riparian system when woody riparian vegetation was replaced with a shrub-grassland community.

Increases in salinity, dissolved solids, nutrients, water temperature, and other water quality metrics could adversely impact native riparian species establishment and growth (Dillaha et al., 1999). As a result, alteration of species composition, stand structure, and increased susceptibility to invasion by exotic species tolerant of elevated levels of salt and nutrients are potential impacts of water quality changes on riparian and wetland habitats.

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 7

Biology: Aquatic Plants (Wetland Systems)

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1.0 INTRODUCTION

The following Appendix summarizes the Biology: Aquatic Plants (Wetland Systems) data and analysis used in support of the Yellowstone River Cumulative Effects Assessment (CEA). The analysis is based on the following series of existing primary data sources as well as information extracted from supporting documents. The objective of this document is to provide an overview and summary of the wetland resource that can be used to help evaluate results that have been reached in other components of the CEA. The information presented herein represents only a small portion of the most pertinent information collected. All supporting documents referenced are available for public review and evaluation. The primary data sources used include the following documents:

1. **Upper Yellowstone River Mapping Project, (Bon 2001).** This study was conducted between 1998 and 2000 as part of the National Wetlands Inventory (NWI) program. Approximately 85 miles of river were assessed between the northern boundary of Yellowstone National Park near Gardiner, Montana to the bridge that crosses the river at Springdale, Montana. Portions of 14 topographic quads are covered within the study area including: Gardiner, Electric Peak, Dome Mountain, Miner, Dailey Lake, Emigrant, Pray, Dexter Point, Chimney Rock, Brisbin, Livingston, Mission, Elton and Springdale. GIS data is organized based on these quads and is available at: http://www.nwi.fws.gov/shapedata/wet_riparian/yellowstone_river/.

2. **National Wetlands Inventory for Sweetgrass, Stillwater, Yellowstone, Treasure, Rosebud, Custer, Prairie, Dawson, and Richland Counties in Montana, and McKenzie County, North Dakota, (US Fish & Wildlife Service 2014).** The NWI was established by the US Fish and Wildlife Service (Service) in 1974 to conduct a nationwide inventory of U.S. wetlands to provide its biologists and others with information on the distribution of wetlands to aid in wetland conservation efforts (USFWS, 2014). The focus is on developing and maintaining a map and digital database of wetlands to the public and providing periodic reports on the status and trends of wetlands in the United States using a probability-based sampling design. Digital wetland and riparian maps and data are available through the Wetlands Mapper at http://www.fws.gov/wetlands/Data/Mapper.html.

   Yellowstone NWI wetland and riparian mapping was completed using 2005 and 2006 imagery as part of the Yellowstone River Priority Area. The project used the Cowardin classification system (Cowardin et al., 1979) to map wetlands and the USF&WS riparian mapping system (1979) for the latter areas. Most Yellowstone wetlands are in the Palustrine System which includes any wetlands not within a stream or river channel (Riverine System) or within bodies of water > 20 acres (Lacustrine System).

   There are ten Cowardin classes possible in the Palustrine System. Also, one Riverine System was described. Following are the descriptions for NWI classifications used in mapping wetlands in the Yellowstone River corridor.

   PAB: Palustrine aquatic bed wetlands can occur as isolated ponds adjacent to or within streams and rivers. These wetlands typically have water throughout the year and vegetation that grows on or below the water surface. Common plants found in these wetlands include pondweeds (*Potamogeton* spp.), lily pads (*Nymphaea* spp.), and water-milfoil (*Myriophyllum* spp.).

   PEM: Palustrine emergent wetlands are the most common type of wetlands in the project area and typically contain persistent erect, rooted herbaceous vegetation. Dominant graminoids found in these types of wetlands include foxtail barley (*Hordeum jubatum*) and western wheatgrass

(*Pascopyrum smithii*) on drier sites; and bulrush (*Scirpus* spp.), sedges (*Carex* spp.), cattails (*Typha* spp.), and bluejoint reedgrass (*Calamagrostis canadensis*) on wetter sites. These communities are representative of the Great Plains Closed Depression Wetland ecological systems. Halophytic species such as saltgrass (*Distichlis spicata*) and Nuttall's alkaligrass (*Puccinellia nuttalliana*) occur on sites with saline soils. These communities represent the Western Great Plains Saline Depression Wetland ecological system. Emergent wetlands are also found in floodplains of the Yellowstone River and other large streams in the region.

PSS: Palustrine scrub-shrub wetlands are associated with streams and rivers within the project area. These types of wetlands are dominated by woody vegetation less than 20 feet tall. This community represents the Northwestern Great Plains Riparian ecological system. Native species in scrub/shrub wetlands are red-osier dogwood (*Cornus sericea*), chokecherry (*Prunus virginiana*), western snowberry (*Symphoricarpos occidentalis*), silver buffaloberry (*Shephardia argentea*), silverberry (*Elaeagnus commutata*), sandbar willow (*Salix exigua*), peach-leaf willow (*Salix amygdaloides*), several cottonwood species (*Populus* spp.), and Rocky Mountain juniper (*Juniperus scopulorum*). In many cases, this wetland type represents transitional plant communities of younger age classes of forest communities.

PF: Palustrine Forest wetlands are composed of mature trees taller than 20 feet and are typically classified as seasonally flooded. Cottonwood species are the tallest and most visible native woody species. In the upper reaches, narrow-leaf cottonwood (*Populus angustifolia*) and black cottonwood (*Populus trichocarpa*) are present. In the middle and lower reaches of the Yellowstone River (beginning in the vicinity of Columbus) Great Plains cottonwood (*Populus deltoides)* becomes the dominant species. Other native woody species such as peach-leaf willow and sandbar willow are present throughout. Yellow willow (*Salix lutea*) and green ash (*Fraxinus pennsylvanica)* occurs throughout the lower reaches.

PUS: Palustrine unconsolidated shore is the fringe around a wetland that is irregularly exposed due to seasonal flooding and subsequent drying. The dominant substrate is silt or mud with less than 30- percent vegetative cover.

R2UB: Riverine lower perennial unconsolidated bottom occurs within rivers in the project area that are low gradient and have a slow water velocity. Substrates in this system are predominantly sand and mud and floodplains are usually well developed.

R2US: Riverine lower perennial unconsolidated shore areas are the shorelines to low gradient rivers that have less than 75-percent areal cover of stones, cobbles, boulders or bedrock and less than 30 percent vegetative cover. The shoreline is also irregularly exposed due to flooding and drying.

R3UB: Riverine upper perennial unconsolidated bottom wetlands are found in rivers that have a substrate of at least 25-percent mud, silt, or other fine particles and that typically have steep gradients and fast water velocity. Floodplains are typically absent or poorly developed.

R3US: Riverine upper perennial unconsolidated shores occur in rivers that have steep gradients and high velocity water and shorelines with less than 75-percent areal cover of stones, boulders, or bedrock and less than 30-percent vegetative cover. Shores are irregularly exposed due to seasonal or irregular flooding and subsequent drying.

R4SB: Riverine intermittent streambeds are stream channels that have surface flow only during a portion of the year. In the project area, isolated pools may form in the channel when there is no water flow.

The CEA wetland analysis conducted by DTM (2014) consolidates the NWI classifications described above into four main wetland categories: Riverine, Emergent, Shrub/Scrub, and Forested habitats.

3. **Ecologically Significant Wetlands in the Upper Yellowstone Watershed, Including the Boulder, Clarks Fork Yellowstone, Shields and Stillwater River Drainages, (Jones 2001).** This report graded wetlands of the upper Yellowstone River according to ecological significance based on (1) condition, to include hydromorphic and geomorphic characteristics and absence/presence of invasive species, (2) landscape context, such as hydrologic connectivity between uplands and wetlands, (3) biodiversity, (4) rarity of plants, animals or communities, and (5) size. Inventory wetlands were ranked "A" (highest quality), "B", "C" or "D". A total of 46 wetlands were inventoried, where 8 sites received an "A" ranking, 16 received a "B" ranking, 20 received a "C" ranking and two sites were not ranked due to inaccessibility.

4. **Yellowstone River Land Use Mapping and Analysis, (DTM, 2013).** This report provides results of land use mapping of digitized polygons using 1948-1950s, 1976-1977, 1999-2001, and 2012 aerial imagery. Four tiers of nested land use attributes were delineated within the GIS-modeled 100-year inundation boundary plus a buffer of 500 meters.

5. **Yellowstone River Wetland/Riparian Change Detection Pilot Study, (Kudray and Schemm, 2006).** This report provides the results of a pilot study to determine if wetland and riparian vegetation in two representative reaches could be accurately mapped using digitized historical aerial photography (30s, 50s, 70s, 90s, and 2001). General Land Office surveyors' notes were also evaluated for their potential to detect historic vegetative conditions.

6. **Russian olive (Elaeagnus angustifolia L.) Distribution Mapping for the Yellowstone River and Tributaries Using Feature Analysis Software, an Extension for ArcMap, (Combs and Potter, 2011).** This Technical Guide document describes a Natural Resources Conservation Service (NRCS) project to delineate the distribution and extent of Russian olive (*Elaeagnus angustifolia*) along the Yellowstone River and its major tributaries in Montana. A variable width project area was delineated that encompassed the floodplain and valley floor. Feature Analyst, an ArcMap extension, was used to identify and delineate individual plants and polygons using National Agriculture Imagery Program (NAIP) imagery. Manual editing was used to further refine the mapping product for which county level metrics were calculated.

7. **Yellowstone River Historical Retrospective Completion Report, (Confluence Consulting Inc., 2003).** This report summarizes a review of historical information for the Yellowstone River mainstem regarding fish, water quality, fluvial geomorphology, vegetation, and wildlife activity prior to 1900. Academic studies, historical records, archival documents, photographs, and maps, interviews, and other sources were used to create the summary and accompanying database of annotated comments. The information is useful in gaining a large scale view of conditions pre- and post-settlement.

8. **Upper Yellowstone River hydrogeomorphic functional assessment for temporal and synoptic cumulative impact analyses, (Hauer et al., 2001).** The hydrogeomorphic (HGM) approach was developed to evaluate wetland ecosystem function. This HGM assessment was

conducted in 2000 on three reaches of the Yellowstone River between Emigrant and Livingston. Floodplain areas were assessed where cut-and-fill alleviation has been particularly active, resulting in a number of permitting applications for bank stabilization structures. This assessment results documented an increase in barbs and jetties, and the use of rock riprap, which approximately doubled in extent within the study area between 1976 and 2000. A decline in Functional Capacity Indices (FCI) between 1976 and 2000 was due to the increased riverbank and floodplain stabilization structures. Ecological integrity of the riparian vegetation was also affected according to the study due to land use and livestock grazing.

1.1 Major Findings in Support of Cumulative Effects Analysis

The primary findings of the wetland and related land use analysis that may support multiple aspects of the CES include the following:

- Wetlands provide a multitude of ecological, economic, and social benefits. They provide habitat for fish, wildlife, and a variety of plants. Wetlands are nurseries for many freshwater fishes and shellfish of commercial and recreational importance. Wetlands are very important landscape features because they hold and slowly release flood water and snow melt, recharge groundwater, recycle nutrients, and provide recreation and wildlife viewing opportunities for millions of people (Montana Department of Environmental Quality, 2013; National Academy of Sciences, 2002). Wetlands within the 100-year inundation boundary constitute less than four percent of the project area. While wetlands within the Yellowstone River corridor comprise a relatively small portion of the landscape in spatial extent, they provide multiple environmental services in addition to key aquatic and terrestrial wildlife habitat.

- NWI Mapping and Analysis for Park County (Region PC) identified 55 categories of wetlands and deepwater habitats occupying 7,750 acres in the Upper Yellowstone River project area (Region PC valley floor). Riverine wetlands and deepwater habitats (including sand and gravel bars) make up the largest percentage of wetland habitats and cover 4,198 acres or 54 percent of all wetlands within the project area. The remaining 46 percent or 3,552 acres of wetland habitat are Palustrine wetlands, of which 1,675 acres (47 percent) are emergent or herbaceous, 1,042 acres (29 percent) are scrub/shrub and 664 acres (19 percent) are forested wetlands. Of the total wetlands in the Region PC project area, nearly 2,500 acres fall within the 100-year inundation boundary.

- DTM (2014 unpublished data) conducted an analysis of NWI mapping data on the Middle/Lower Yellowstone (Regions A, B, C, and D). Over 12,700 acres of Palustrine and Riverine wetlands mapped within the 100-year inundation boundary were evaluated by Reach. Mapped wetlands may include riparian habitats discussed in the Riparian Technical Reference 4.7. Important findings include:

    - 62 percent of the wetlands mapped were Palustrine emergent wetlands.

    - Shrub/scrub wetlands amounted to the second most extensive constituting 27 percent.

    - Forested areas meeting wetland criteria were the most rare with only two polygons mapped consisting of 0.2 percent of the total wetlands.

- Reaches A3, A18, C7, C9, and D16 have the greatest wetland density per mile of valley length. Region A has the highest average wetland density of all Regions. Region B has the most consistent range of wetland densities.

- The extent and frequency of wetlands is closely related to channel classification. Wetlands occur at a higher density in reaches that are less confined (i.e., those that are meandering, braided, or anastomosed). Confined and straight reaches have fewer wetlands per river mile which is very similar to the pattern exhibited by riparian habitat as discussed in Chapter 4.7 Biology: Terrestrial Plants. These relationships provide reason to believe that channel migration is critical to creating and maintaining riparian and wetland habitat within the river corridor. While no direct relationship between wetland frequency and bank stabilization was noted, efforts to reduce lateral channel movement will likely have a long-term, negative impact on wetland turnover, extent, and function.

- While no precise measurement of temporal change in wetland spatial extent is feasible, indications are that extensive wetland habitat in the Yellowstone River corridor has been lost or isolated due to transportation, development, and agricultural activities since settlement. Estimates of losses range from one-quarter to one-third of the historic extent. A sample wetland change estimate conducted by the Montana Natural History Program for two study Reaches indicates a 7.6-percent loss between 1950 and 2001 although the authors noted that created wetlands (Palustrine aquatic bed ponds) masked the actual loss of natural wetlands in their calculations (Kudray and Schemm, 2006).

- Wetlands are noted to be very dynamic, created and removed by high flow events. Some wetlands persist for only a few years while others are present for longer periods of time. The CEA study shows that 2-year high flows are linked to channel forming processes. Reductions in channel forming flows puts the relatively steady turnover relationship between riparian-wetland vegetation and channel migration in dynamic reaches at risk which will affect long-term viability of the riparian and wetland communities and the wildlife associated with them.

- Relatively few wetlands (500 acres) within Regions A-D have been found to be isolated from the 100-year floodplain by fills or other features. Nearly 250 acres of primarily emergent wetlands have been isolated from the active 100-year floodplain by earth fills related to railroad bed prisms. Forty percent of the wetland isolation occurs within three Reaches: A18, C14, and D13, primarily affecting emergent wetlands. Periodic high flows are necessary to drive the exchange of sediment, nutrients, and organic matter between Riverine and Palustrine wetlands and riparian areas which are necessary for sustainable function (National Academy of Sciences, 2002).

- Similarly, relatively few wetlands (<200 acres) within Regions A-D are located in areas that have channel migration restrictions. Somewhat more troubling is the finding that of the migration restricted wetlands, a majority are Riverine wetlands located within just a few Reaches (B1 thru B3 and in D13). Riverine wetlands consist of several types of shallow water habitats locally important to aquatic species. Reach B1 is noted for having extensive floodplain riprap, dikes, and levees (Technical Appendix 3 Floodplain Connectivity (Hydraulic Assessment)).

- Invasive species pose a great threat to the ecological function of wetlands. Wetlands within the 100-year inundation boundary do not have significant infestations of Russian olive with around one percent of the total wetland area having Russian olive present. Locally, some reaches have up to 8- percent wetlands with Russian olive. Reaches B5 to B8 and C10 to 20 (excepting C-14) have the greatest presence of Russian olive ranging from 3 to 7 percent. The potential exists for expansion of Russian olive at greater rates based on observations in other locations. No summary data for saltcedar (*Tamarix* spp.) infestations exists but it is likely becoming naturalized in the middle and lower reaches. Efforts to coordinate saltcedar monitoring and control efforts should be given priority.

- A number of additional invasive species have the potential to infest wetlands and aquatic sites in the Yellowstone River corridor given their proximity and habitat adaptations. Human recreational activities are known to transport many of these invaders. These species should be included in management and monitoring outreach programs in order to limit infestation in the future.

- Increases in the presence and acreage of artificial ponds (Palustrine aquatic bed) in the corridor may have increased the total extent of wetlands but the value of these artificial wetlands to the aquatic environment is much debated by wetland scientists (Dahl, 2010) as they are typically isolated from the channel and floodplain and are simplified systems with fewer functional attributes.

2.0 SPATIAL DISTRIBUTION OF WETLAND VEGETATION

2.1 Wetland Extent and Density

Wetlands are differentiated from riparian areas through their unique hydrophytic vegetation, hydric soils, and hydrology. Where riparian areas represent a transitional condition between aquatic and upland habitats, wetlands must, by definition, be representative of a hydric or aquatic state for each criterion. Therefore, some Palustrine wetlands would be considered riparian habitat; but not all riparian areas are wetlands from a practical and jurisdictional standpoint.

Only Palustrine and Riverine wetland types were evaluated under the CEA. Other wetlands mapped under the NWI program within the corridor such as Lacustrine and related types were not considered within this evaluation as their origin and maintenance are generally not related to channel processes. Palustrine and Riverine wetlands mapped under NWI procedures (USFWS, 2014) within the Yellowstone River corridor were evaluated within the 100-year inundation boundary by DTM. The 100-year inundation boundary is blind to floodplain obstructions so this analysis allows evaluation of wetlands in several ways. The analysis resulted in finding that wetlands are widespread throughout the corridor but not equally distributed in type and extent. As with riparian cover, wetlands are arrayed in a complex, non-linear pattern within the study area. The most extensive wetland type by far is Emergent (8,011 acres) wetlands and the second most extensive is Scrub/Shrub (3,458 acres). Riverine sites constitute about 10 percent of the total mapped wetland area. Forested wetlands are the most rare type occurring only twice on 22 acres in Reach D16 and at the Confluence with the Missouri River. NWI wetlands total about 12,716 acres in Regions A to D. For comparison, Park County contains about 2,500 acres of Riverine and Palustrine wetlands within the 100-year inundation zone with the majority (47 percent) in the Emergent category. Notably, Forested wetlands made up about 19 percent of total wetlands mapped in Park County while the Scrub-Shrub category comprised 29 percent.

Figure 2-1 depicts NWI wetland extent by wetland type and Reach. Reach A3 had the greatest extent of wetlands mapped within the 100-year inundation boundary followed by C7, C9, C14, and D16. Reaches A6, A10, C18, and D2 and had the least amount of wetland acres mapped. About 4 percent of the 100-year inundation area is occupied by wetland habitat. Wetland distribution is directly related to geomorphic channel type and floodplain area.

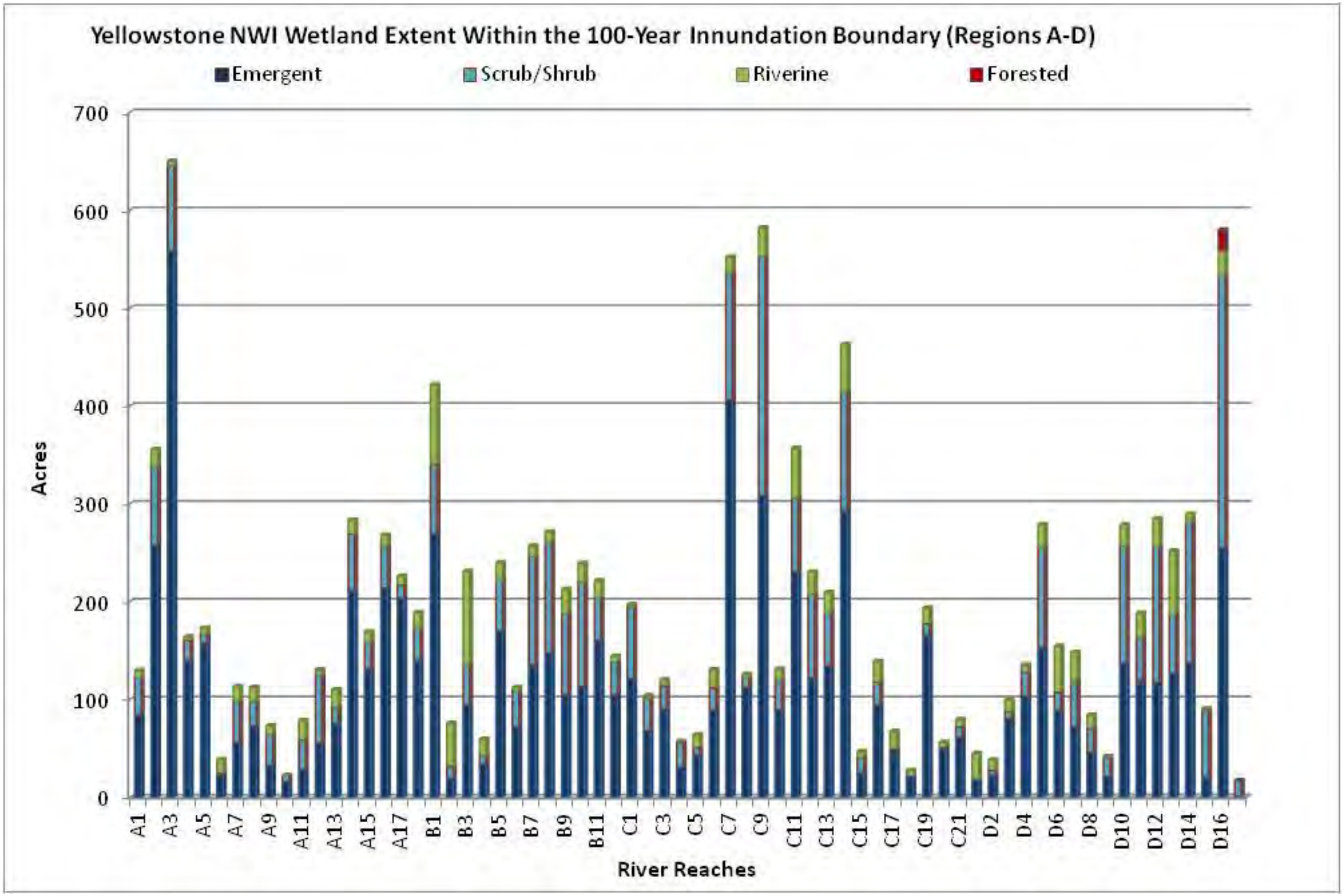

Figure 2-1 **Chart depicting the extent of NWI-mapped wetlands within the 100-year inundation boundary for all 62 Reaches. Note that Riverine Wetlands consist of the Unconsolidated Bottom (UB), Aquatic Bed (AB) and Unconsolidated Shore (US) Wetland mapping classes combined.**

Since not all reaches have the same area or spatial footprint within the river corridor, total acres of wetlands by reach are only useful for a general understanding of available wetland habitat. Larger reaches tend to have more wetlands. Wetlands can also be expressed as a relative density by normalizing to acres of wetland (by type) per mile of valley length.

Table 2-1 provides the density of wetlands normalized by valley length. Park County figures are provided for reference. Region A has the greatest density of wetlands (36.4 ac/mi) although there is not a significant difference between Regions PC, A, B, and C. Region D exhibits the lowest density of wetlands (23.3 ac/mi). Reach A3 has the greatest density of any one Reach (140.3 ac/mi) while Reach D2 has the lowest (3.9 ac/mi) outside of Reach PC1 (0.0 ac/mi). Region B has the most consistent proportion of wetlands. Wetland density, similar to riparian habitat, is dependent primarily on channel type. For purposes of comparison, riparian cover densities [Technical Appendix 6 Biology: Terrestrial Plants (Riparian Systems)] are well over 160 acres per mile in Regions A through C but increases in Region D to around 240 acres per valley mile.

Figure 2-2 depicts wetland densities by reach and wetland/channel type. This approach provides a somewhat different picture as to the relative abundance of wetlands within Reaches. Reaches A3, A18, C7, C9, and D16 have the greatest wetland density per mile of valley length.

Figure 2-3 depicts the numeric relationship of NWI wetland density to channel classification. This figure shows that wetlands occur at an increasing density in Reaches that are less confined. Confined and straight reaches have fewer wetlands per river mile which is very similar to the pattern exhibited by riparian habitat. These relationships provide reason to believe that channel migration (floodplain turnover) is very important to creating and maintaining riparian and wetland habitats along the river corridor.

Figure 2-4 provides an illustration of the relationship between wetland density and the cumulative floodplain turnover for all channel types. While the relationship is not a perfect fit from a statistical standpoint (R^2 <0.80), it does provide additional evidence of the correlation of higher floodplain turnover to greater wetland density. If the data was stratified for only less confined channel types, it would show even greater evidence for the regression correlation.

The hypothesis that wetland extent or density is correlated to shallow water fisheries habitat (identified by Reinhold et al. (2014)) was not supported by comparison of the two separate data sets. This finding may be due to differences in the way the data was gathered or perhaps not enough data points were available to allow statistical interpretation.

Table 2-1
Relative NWI wetland extent in each Region along with mean, minimum and maximum values. NWI Wetlands in the Yellowstone River corridor (100-year Inundation Boundary)

CES Reach ID	Total Wetlands (Acres)	Valley Length (Miles)	Wetland Acres/Valley Length (Miles) Mean	Wetland Acres/Valley Length (Miles) Minimum	Wetland Acres/Valley Length (Miles) Maximum
PC	2,477.7	76.6	32.4	0.0 (PC1)	121.2 (PC18)
A	3,135.1	86.0	36.4	5.6 (A10)	140.3 (A3)
B	2,486.0	74.6	33.3	13.6 (B2)	60.9 (B3)
C	3,935.0	124.6	31.6	7.7 (C20)	88.9 (C7)
D	2,989.6	128.3	23.3	3.9 (D2)	82.4 (D16)

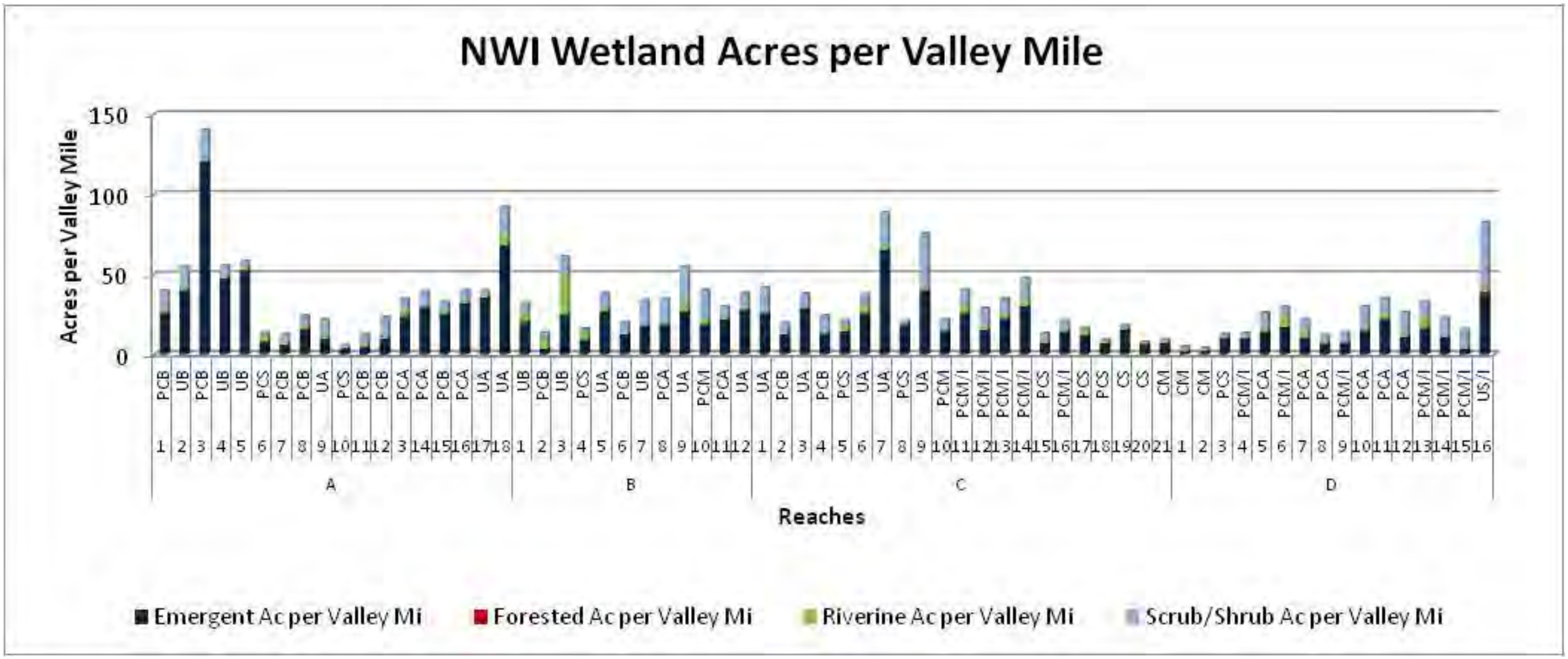

Figure 2-2 **NWI wetland types expressed as acres per valley mile to show relative abundance or density of wetlands for each reach. Less confined reaches have a relatively higher density of wetlands compared to highly confined reaches.**

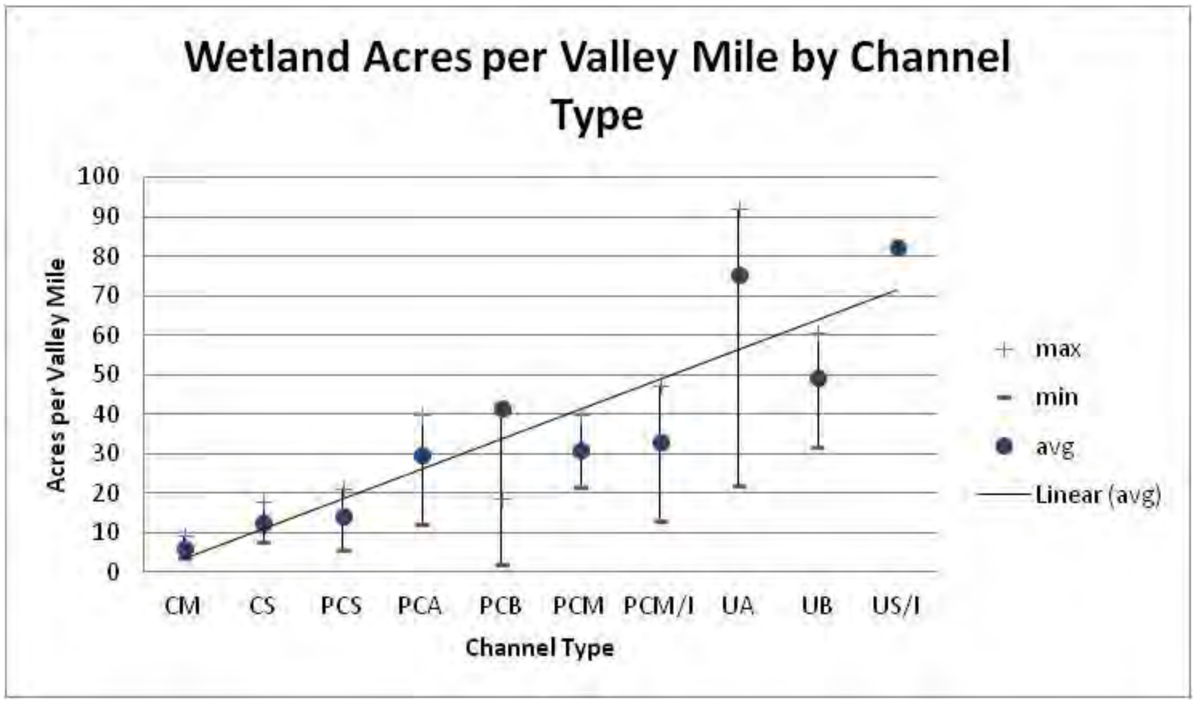

Figure 2-3 Wetlands exhibit increasing density as channel confinement decreases.

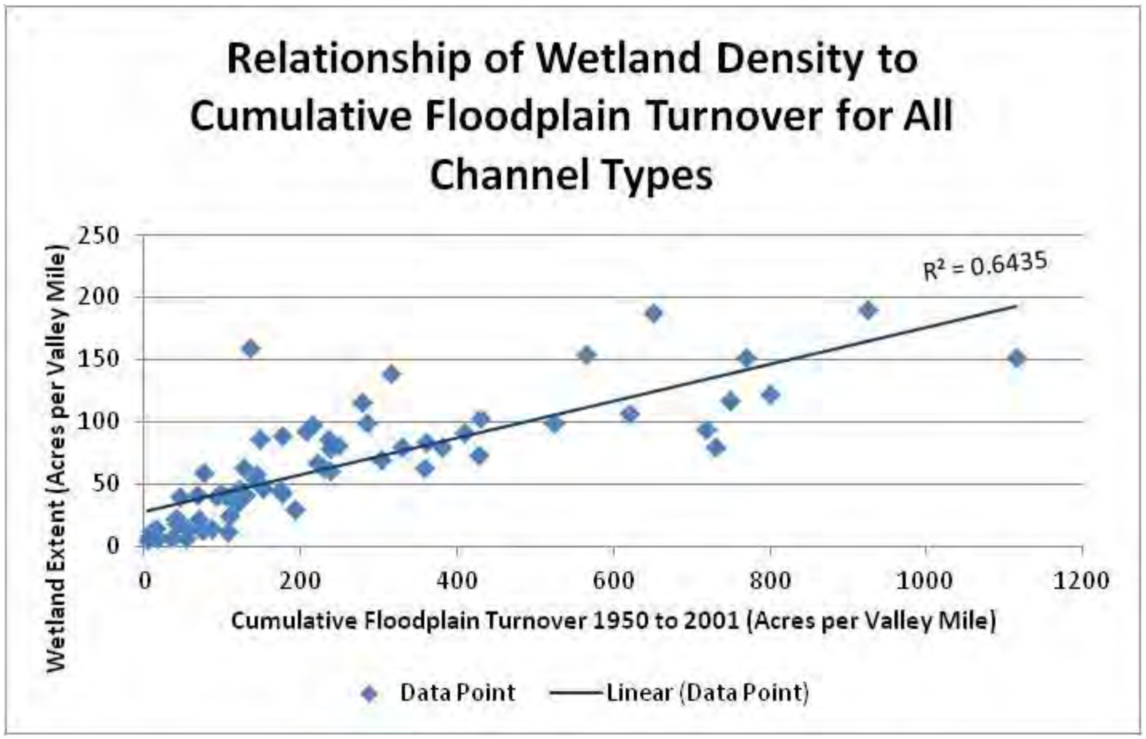

Figure 2-4 **Depicts the relationship of wetland density (acres per valley mile) to the cumulative (loss and gains) floodplain turnover (net acres per valley mile) for all channel types and reaches. While not a highly significant fit from a regression standpoint, the data shows a definite trend indicating that reaches with higher floodplain turnover values generally have relatively higher densities of wetlands. Given the few data points used, this is not a bad fit and reinforces the correlation between the two sets of data.**

3.0 TEMPORAL AND SPATIAL CHANGES IN WETLAND EXTENT AND DISTRIBUTION

3.1 Quantitative Change in Wetlands

No historic data set is available to represent the extent of wetlands prior to the NWI mapping completed in 2005 and 2006 within the Yellowstone River corridor so temporal analysis is not possible. Early records and historical documents do indicate that the pre-settlement (early 1800s) Yellowstone River corridor supported abundant stands of cottonwood and other woody species throughout the project area except where the floodplain was restricted (Confluence Consulting, 2003). Some estimates suggest that Montana has lost a quarter to more than one-third of its original wetlands to fill or drainage (Montana Department of Environmental Quality, 2013; Dahl, 2010). It is reasonable therefore to assume that at least a similar decline has occurred within the Yellowstone River Corridor.

Recent trends in wetland losses have been reduced in recent years due to various laws enacted by Congress and Executive Orders issued to protect wetlands. Primary among these protections is the Clean Water Act (CWA) (33 U.S.C. § 1251 et seq) which regulates the placement of dredged or fill material into wetlands adjacent to or on navigable waters of the United States or their tributary systems. The definition of jurisdictional wetlands under the CWA has been litigated extensively and is still pending and likely will remain so for the near future. Due to their proximity and designation as Palustrine and Riverine wetlands, the wetlands mapped under the NWI and evaluated within the Yellowstone CEA are considered jurisdictional and therefore have been regulated under the CWA since the 1970s (USACE, 2014).

A pilot study attempted to assess temporal changes in wetlands in reaches A16 and D6 using a GIS-based summary as well as through a random selection of individual wetland/riparian polygons followed over time (Kudray and Schemm 2006). While difficulties were noted, (interpretation of 1950s black and white imagery and differences in discharge levels between image dates), the study estimated that between 1950 and 2001, wetland acreage decreased in both reaches, totaling approximately (354) acres or an average eight percent loss. Wetlands were noted to be very dynamic in extent and type, some lasting only years to decades between flood events. For this reason alone, the study recommended that the best metric for wetland change is broad scale over the time period in question rather than tracking individual wetlands year to year. The study highlighted the importance of large, peak flows to maintain wetland and riparian health. The hydrologic/floodplain analysis (Technical Appendix 2 Hydrology)) documented a 20-percent decline in the two-year frequency (50-percent chance) flood flows below the Bighorn River which has resulted in the isolation of side channels and altered channel morphology. Another study of the Bighorn River below Yellowtail Dam documented loss of side channels due to sedimentation and lack of flood flows (Godaire, 2010).

The pilot study also noted that an increase in freshwater ponds within the corridor (captured within the Palustrine Aquatic Bed category) mitigated the actual extent of overall wetland losses. The value of these artificial wetland features as direct replacement for highly complex, shallow water wetlands is much debated (Dahl, 2010).

3.2 Sources and Causes - Direct Conversion

The magnitude of direct wetland conversions within the Yellowstone River corridor over time cannot be precisely measured as we cannot verify historic wetland extent. Likely, the direct conversion of wetlands, similar to riparian cover, has been significant over time in the Yellowstone River corridor. The primary conversion of wetland habitat within the corridor is assumed to be conversion to agriculture, transportation and urban/ex-urban land uses during development in the corridor. In the following section, indirect wetland impacts are described and evaluated. It is likely to assume that floodplain features that cutoff wetlands from the floodplain also resulted in direct conversion of wetlands within their footprint.

Channel Migration—Palustrine and riverine (excepting artificially created) wetlands within the river corridor, similar to riparian habitat, are created by the migration of the channel over time (Kudray and Schemm, 2008). Abandoned channels, failed avulsions, seasonal overflow channels, and other remnant channel features are often considered wetlands. As noted above, Figure 2-4 and Figure 3-1 illustrate the important link between channel dynamics and the density of wetlands.

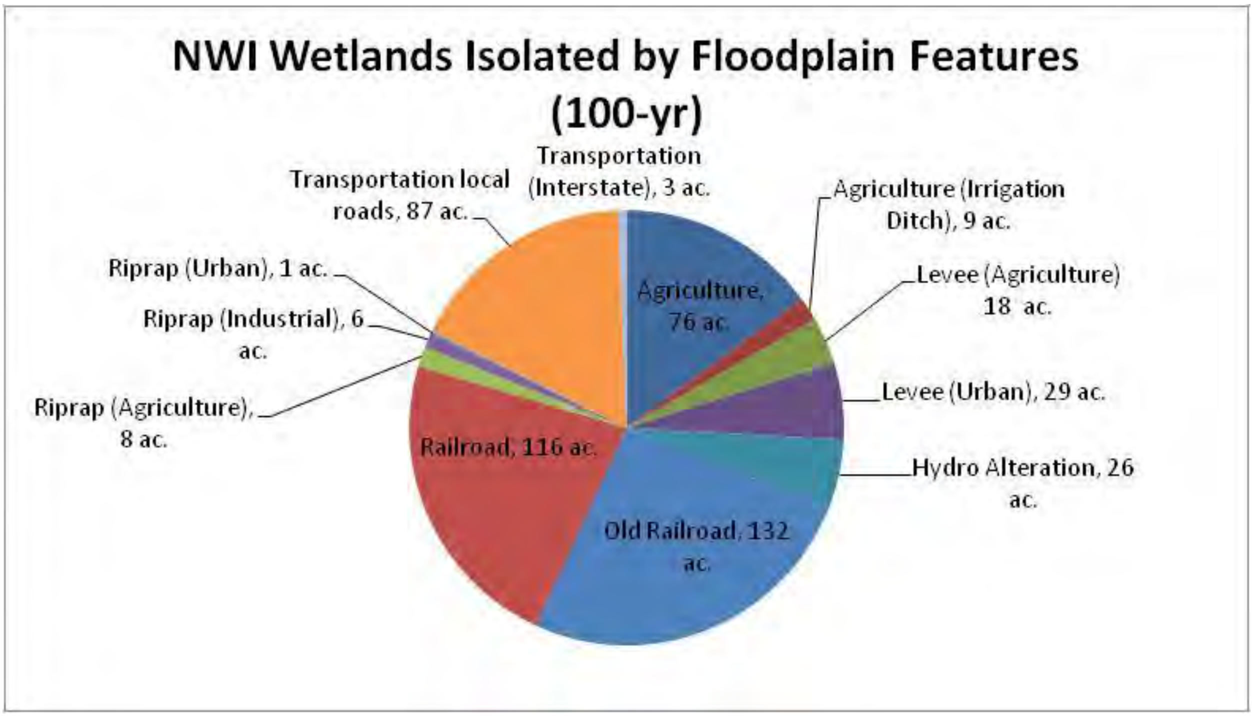

Figure 3-1 Pie chart showing the relative extent of wetlands isolated by floodplain modifying features. Nearly 50 percent of the total wetland isolation is caused by railroad related fills.

3.3 Sources and Causes - Indirect Conversion

In addition to direct conversion of wetland acres, wetlands are indirectly affected by fills that cut them off from the channel and active floodplain. Wetlands are also indirectly affected by bank protection and related features that serve to eliminate or reduce channel migration.

Floodplain dikes and levees—over 500 acres of wetlands have been isolated from the channel by floodplain features; nearly 250 acres associated with the abandoned Milwaukee Road and the Northern Pacific (now Burlington Northern-Sante Fe) railroad prism fill. The total area of wetlands isolated from the 100-year floodplain represents a relatively small four percent of the total wetlands mapped within the 100-year inundation zone.

Figure 3-1 and Figure 3-2 depict the extent of isolated wetland categories by Reach and cause. The majority (75 percent) of the isolated wetland acres are Palustrine emergent wetlands, followed by Riverine wetlands (24 percent). Scrub/Shrub and Forested wetlands incur negligible isolation by floodplain features. Over 40 percent of the wetland isolation occurs within three Reaches: A18, C14, and D13, primarily affecting Palustrine emergent wetlands.

Loss of connection to the Flood Pulse, a concept coined by Junk et al. (1989) greatly diminishes the function of affected wetlands and riparian habitat as they are permanently isolated from the seasonal flux of flood and drought that defines the wetland biota.

Channel Migration Restriction—bank stabilization features and related physical impediments to channel movement also impact wetlands through alteration of the floodplain turnover rate. The joint actions of channel migration and turnover create and eliminate wetland features similar to those described in Appendix 6 regarding riparian habitat. Without periodic channel movement, wetlands eventually fill with sediment and vegetation (Kudray and Schemm, 2006). The loss of seasonal side channel habitat below the Bighorn River (Chapter 4.4 Hydraulics - Floodplain Connectivity) also demonstrates that Riverine wetlands are lost when flood flows and channel migration is diminished as has happened since completion of the dam (Godaire, 2009 and 2010). While some attributes of wetland hydrology and vegetation may remain, restricted wetland features lose much of their diversity and complexity in depth and shape they once had thereby affecting value for wildlife and floodplain function.

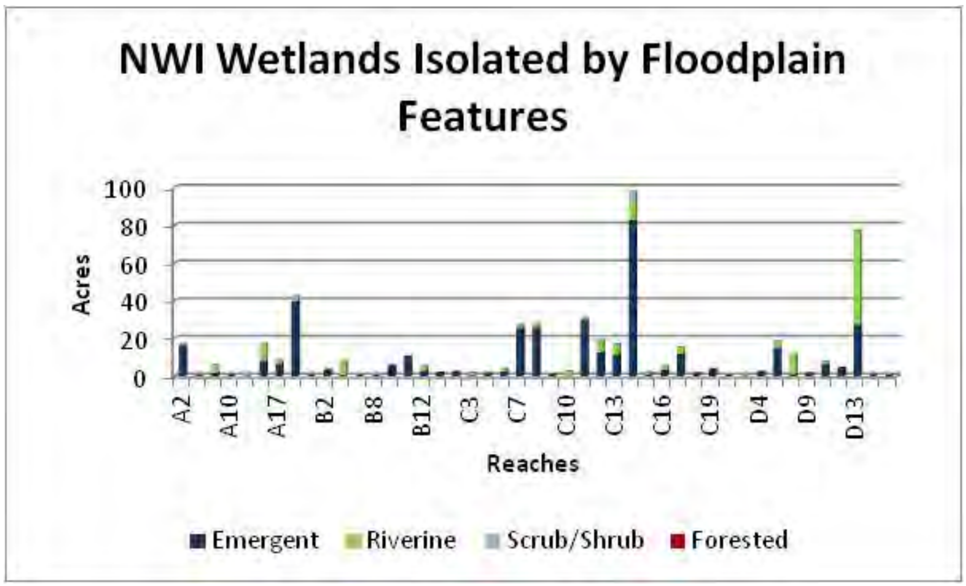

Figure 3-2 Extent of NWI wetland classifications isolated by floodplain features.

Figure 3-3 shows that about 550 acres of wetlands in Regions A-D are located within a Restricted Migration Area (RMA) mapped as part of the Channel Migration Zone (CMZ) mapping. These wetlands may be similar to those depicted in Figure 3-4, but are defined by the classification of the RMA here. This RMA-wetland extent represents a relatively small portion of the approximately 12,700 wetland acres in Region A-D within the 100-year inundation zone. About 6,400 acres of NWI-mapped wetlands are located within the CMZ, but are non-restricted; another 3,500 acres are found outside of the CMZ. Of the 550 wetland acres affected by channel migration restrictions, the majority are Palustrine emergent wetlands, however the relatively few Riverine wetlands (190 acres) affected may have been locally important as fisheries habitat since this class represents seasonal, shallow water habitat in side channels. Riverine wetlands are impacted to the greatest extent in Reaches B1, B2, B3, and D13, representing 60 percent of all Riverine wetlands falling within the RMA. As noted earlier, numerous seasonal side channels in Reach D13 have been encroached on by riparian species as channel forming flood flows have declined in stage and frequency.

Reach B1 was identified in Technical Appendix 6 Biology: Terrestrial Plants (Riparian Systems)as having a large portion of woody riparian habitat within a RMA. Approximately 1,100 acres of riparian habitat in B1 of which 475 acres are woody riparian cover types are within a RMA, the greatest amount of any Region A-D Reach. The primary cause of channel restriction in B1 is due to bank stabilization riprap and flood protection dikes and levees (DTM and AGI, 2008) so it's likely that these features are also the cause of the impacts to Riverine wetlands in Reach B1.

For purposes of comparison, Park County has over 475 acres of NWI wetlands within an RMA. This extent nearly equals the amount of wetlands within a RMA for all of Reaches in Regions A , B, C, and D indicating that the impact of channel migration restriction is much greater in this upper portion of the River, primarily due to riprap armored banks, floodplain dikes, and levees (Hauer et al., 2001).

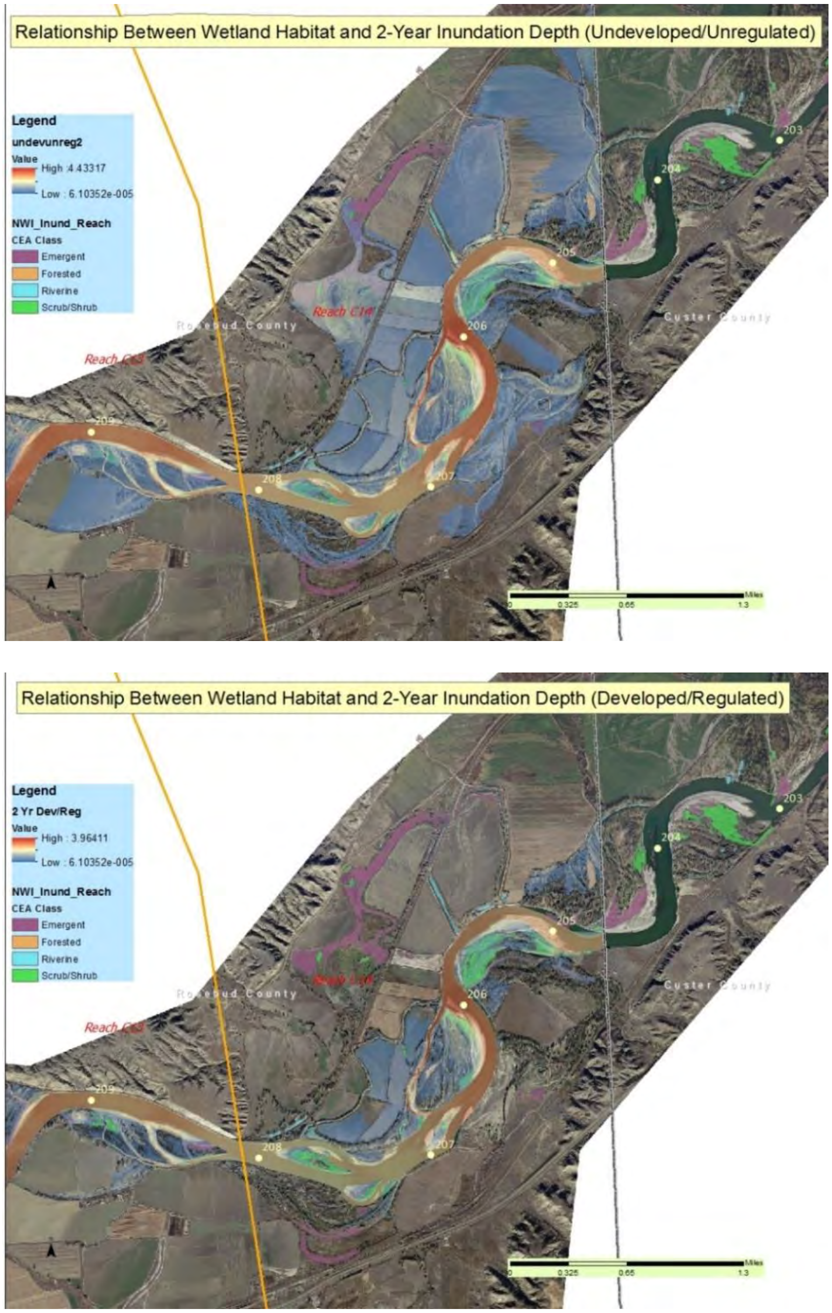

Figure 3-3 These paired images show the developed and undeveloped 2-year inundation zone (flooded area) for the same area (Reach C14 - partially confined, meandering - islands). Red/orange tint indicates deeper inundation. Also shown are the NWI wetland mapping classes. The images show how riverine and palustrine wetlands are related to the overflow provided by the 2-year event and are impacted by reductions in flood depth. Note the herbaceous wetlands to the top of the photo (purple tint) now disconnected from the channel under the developed flow condition. This area appears to be a relict channel. Also apparent are the scrolls of scrub/shrub and riparian forest habitat adjacent to the channel on meander bends through which multiple shallow water channels flow in the undeveloped setting but are significantly diminished under the developed setting.

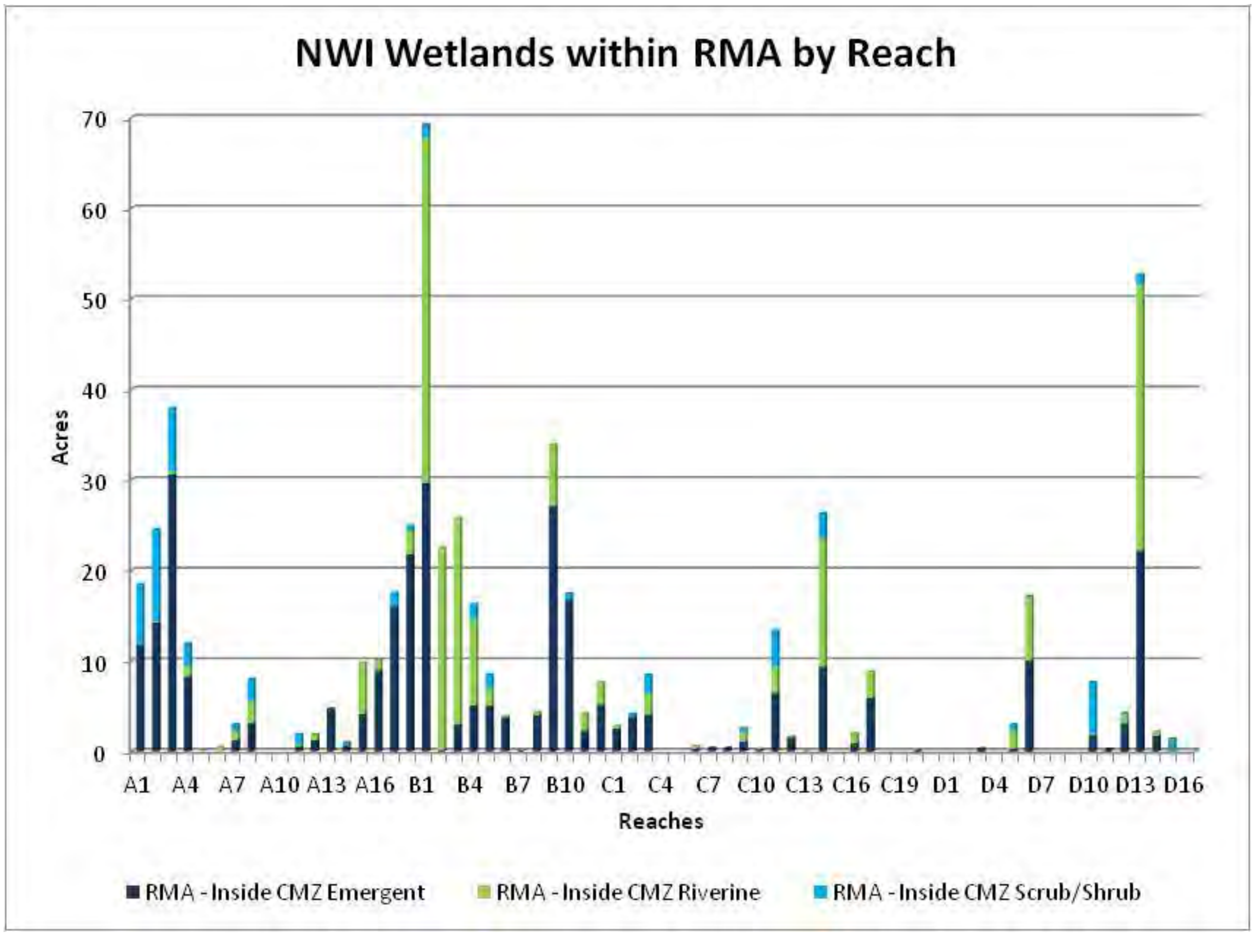

Figure 3-4 Wetlands within the Restricted Migration Area caused by the restriction of channel migration by a physical feature on the channel bank, in particular bank stabilization features.

Agricultural Activities—Wetlands may also be indirectly affected by agricultural activities such as irrigation and grazing. No quantitative or qualitative studies were conducted or readily available for use in evaluating reach or basin scale impacts of agricultural activities in wetlands under the CEA. Other studies have noted that long-term, season long grazing affects wetland vegetative structure and diversity, primarily by diminishing native shrub understories and increasing the composition of exotic grasses and weed species. Jones (2001) noted that the presence and impact on wetlands of domesticated, exotic pasture grasses such as reed canarygrass (*Phalaris arundinacea*), smooth brome (*Bromus inermis*), common timothy (*Phleum pretense),* and redtop (*Agrostis stolonifera*) that have been planted and/or spread by livestock is perhaps more problematic than the impact of noxious weeds alone.

Irrigation can alter the hydrology of wetlands by altering the amount of water received by a wetland (Jones, 2001; National Academy of Sciences, 2002). In addition to irrigation ditches and canals interrupting the flow or volume of water delivered to a wetland, return flows via drains, ditches, and overland flow may also alter the seasonal hydrology of wetlands thereby changing their characteristics and functions from their natural state.

4.0 WETLAND QUALITATIVE METRICS

4.1 Ecological Significance of Yellowstone Corridor Wetlands

No comprehensive or systematic inventories of wetland condition or health have been conducted in the Yellowstone River corridor. Little information is available to support a detailed assessment of wetland condition or functional status as part of the CEA. A 2001 inventory conducted by the Montana Natural Heritage Program (MNHP) for the Montana Department of Environmental Quality focused on the assessment of 46 wetlands in the Upper Yellowstone River Watershed. Six of the wetland sites are located on the mainstem Yellowstone; the remainder occur on tributaries. The ecological significance of the six wetlands were evaluated and ranked using five criteria: condition, landscape context, diversity, rarity, and size. Ratings placed the study wetlands into one of four categories: A (highest quality) to D (poorest quality). Of the total, eight sites were ranked A, 16 as B, and 20 sites as C. Two sites were not ranked due to accessibility issues. Results for the Yellowstone mainstem sites are shown in Table 4-1.

Table 4-1
Rankings for Yellowstone River mainstem wetlands inventoried by the Montana Natural Heritage Program in 2001. Source: Jones, 2001.

Weight factor		0.25	0.25	0.20	0.20	0.10	1.0
Site Name	**Ownership**	**Condition**	**Landscape**	**Diversity**	**Rarity**	**Size**	**Overall Rank**
Work Creek/Yellowstone	Private	B	C	D	D	C	C
Stillwater/Yellowstone	Private	B	A	D	B	C	B
Two Moon	DRNC/Private	B/C	B	C	C	A	B
Riverfront	County	C	B	B	D	A	C
Buffalo Mirage	DNRC/Private	B/C	B	C	C	A	B
Young's Point	Private	C	B	B	-	A	C

The MNHP inventory results indicated that none of the six mainstem Yellowstone River wetland sites were in pristine to undisturbed condition (A-ranked) and that about half of the sites (higher functioning B-ranked) had been affected by on- and off-site human disturbances but still possessed valuable attributes. The other half (C-ranked) of the six mainstem study sites have been functionally impaired through hydrologic or geomorphic alterations or by land use changes in the wetlands or adjacent uplands. Exotic species were widespread and abundant at many of the C-ranked sites. Composition-wise, many were also composed of a few common, structurally simple plant communities providing low diversity and rarity scores. Given that no sites were ranked D (poor) one might either assume that this indicates that Yellowstone wetlands have fared well, that no poorer quality wetlands were selected for this inventory, or many poorer quality wetlands have been converted to other uses and are no longer present.

Because the MNHP sites were strategically selected for the inventory, no statistical or rational extrapolation of the condition rankings is possible, however, the scores provided for the mainstem sites in Table 4-1 generally indicate that a range of disturbance is found in Yellowstone corridor wetlands, as might be expected. Very few pristine wetlands are likely to occur within the Yellowstone River corridor today, with most wetlands in a slight to moderately altered state due to human- and natural- related disturbances. Some examples of the disturbances noted by the MNHP study authors are due to long-term livestock grazing, invasive species infestations, hydrologic modifications, and fragmentation due to development, roads, and bank stabilization (Jones, 2001).

In evaluating the functional status of three wetland sites in Park County, Hauer et al. (2001) found decreased ecological integrity due to grazing and recreational access. Eggers's (2005) riparian study, reviewed and discussed in more detail in the Riparian Chapter 4.6, included wetland sites. Her findings that long-term grazing resulted in decreased cover and native species number and diversity on sand/gravel bar, shoreline scrub-shrub, and forest environments concurs with the other studies and literature related to grazing impacts. Kudray (2005) determined that non-native species were more prevalent than native species in a study of 154 grazed plots adjacent to the Missouri River channel in eastern Montana. Over 40 percent of the plots studied had more than 95 percent non-native species in the herbaceous layer.

The relatively small sample sizes of these studies does not allow us to make direct application of this information to all NWI wetlands within the Yellowstone corridor, however, these studies in conjunction with those in the literature review provide us with some indications that at least a portion of the wetlands in the corridor are functionally impaired due in part to livestock grazing and other human caused stresses and are in need of restoration. The extent, degree, and distribution of wetlands in need of restoration is unknown. Further study is recommended to help guide future wetland restoration recommendations and integration with other study components.

5.0 INVASIVE SPECIES IMPACTS ON WETLAND COMMUNITIES

5.1 Noxious Weeds

Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix* spp.) have been recognized as noxious weeds due to their competitive advantage in riparian and wetland environments (Pick, 2013; Lesica and Miles, 2001). Russian olive seed lasts decades and flourishes in slightly wet, saline sites and can expand rapidly because livestock and wildlife do not browse on the thorny vegetation. Russian olive also is tolerant of shade as well as growing in direct sunlight. Russian olive also may alter the habitat such that other exotics organisms are attracted and flourish which degrades the environment for native wildlife species either through increased competition or parasitism. Saltcedar favors bare, moist, slightly saline soil where it quickly develops an extensive root system. Once mature, the plant produces seed continuously during the growing season. The combination of shed leaves containing high levels of salt and dense vegetative growth often results in a dense, monotypic stand of saltcedar with bare ground beneath (Pick, 2013; Nagler et al., 2009).

The 2008 NRCS Russian Olive mapping (2010) was used to evaluate the impact to NWI wetlands (USFWS, 2014) within the 100-year inundation boundary. About 180 acres of wetlands are affected. Figure 5-1 depicts the extent of Russian olive occurring within NWI wetland classes. Nearly all of the affected acres are Shrub/Scrub and Emergent wetland types. On average, a relatively small one percent of all NWI wetlands within the 100-year inundation boundary are impacted, although some reaches in Regions B and C are impacted up to seven percent (Figure 5-2). The implications are that while a majority of NWI wetlands (as of 2008) are being affected, due to the delayed spread mechanism of Russian olive, once a threshold population of sexually mature plants is reached (at 5 to 7 years of age), spread occurs at a much higher rate so the threat is likely to be increasing. Importantly, the Palustrine emergent and shrub/scrub wetlands are those where Russian olive could provide serious competition for establishing young native species such as sandbar willow, plains cottonwood, and herbaceous, native wetland species.

Russian olive control priorities should focus on reaches in the upper watershed (Regions A and B) with very little Russian olive to keep the pristine areas free of Russian olive, and secondarily on those areas with light infestations. The upper watershed provides a seed source for downstream areas so control is futile in the lower watershed without control in the upper regions. Dense or higher infestations require significantly more effort and cost to restore native riparian and wetland species. Also, the focus of control efforts should be on maintaining higher value scrub/shrub and emergent wetlands (see preceding info using Jones 2001 inventory of environmentally important wetlands).

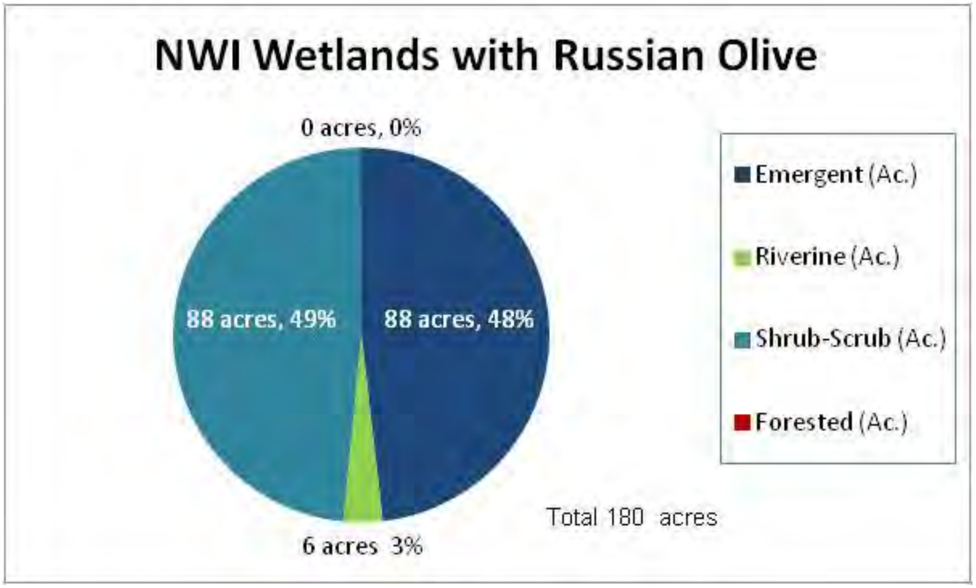

Figure 5-1 **Illustration of the relative extent of NWI wetland types within the 100-year inundation boundary with Russian olive presence. Source NWI (USFWS, 2014) and NRCS (2010).**

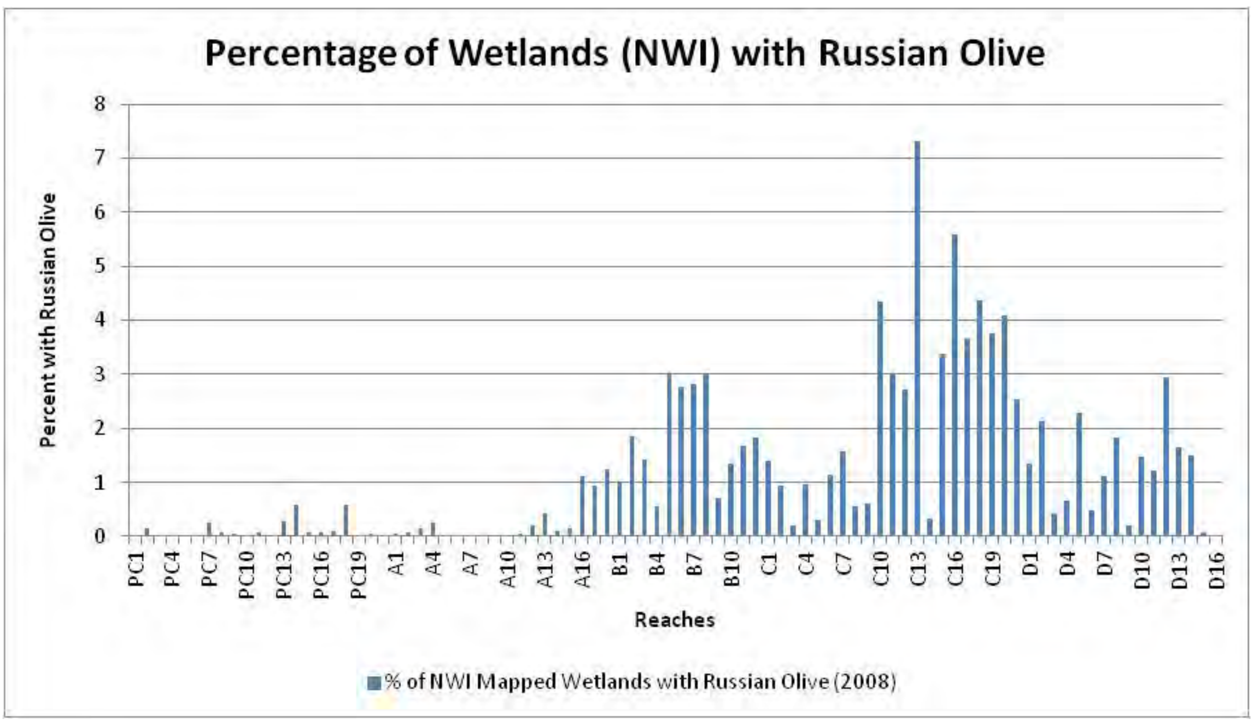

Figure 5-2 **Wetlands in the middle and lower Yellowstone River (within the 100-year inundation boundary) have higher presence of Russian olive than do wetlands in upper reaches. While relatively low at present, Russian olive densities can increase rapidly into suitable habitats. Reaches C10 to C20, excepting C14, have the greatest percentage of Russian olive in wetlands.**

There is no comprehensive database of saltcedar occurrence in the river corridor to depict density and frequency at this time. Some individual counties have undertaken mapping and control efforts, but more collaboration is needed to define present and future saltcedar control opportunities and a baseline for evaluating success. Due to its adaptation to colonize fresh sand and gravel bars, Riverine and Palustrine unconsolidated shore wetlands are likely at most risk of infestation by saltcedar.

5.2 Other Weeds

Since Palustrine and Riverine wetlands are created and destroyed through the processes of erosion and sedimentation (Merigliano and Polzin, 2003), these fluvial processes also render the freshly disturbed sites very susceptible to invasion by exotic species. Initially barren gravel bars and sediment deposits are fertile ground for invasive species, as well as native plants. Jones (2001) noted that hounds tongue (*Cynoglossum arvense*), Canada thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea maculosa*) among other weeds are serious pests in many wetlands along the Yellowstone River. Impaired wetland functions and values result if invasive weeds are allowed to spread uncontrolled (Eggers, 2005; Graf, 1978).

Several other invasive species pose threats to wetland and riparian areas along the Yellowstone River. More information can be found online at http://mtweed.org. Efforts to educate the public and land managers within the corridor should be undertaken to highlight the specific risks. Following are descriptions of some of the more notable, invasive wetland species:

- Yellow flag iris (*Iris pseudacorus*) is an aquatic, perennial plant that is listed as a noxious weed in Montana. In bloom it has a large, bright yellow, showy flower. It currently is found only in western Montana but could spread east. It prefers moist soil and full sun. It is considered poisonous to livestock and causes skin irritation in humans. The leaves resembles cattails when not flowering. Method of spread is by roots and floating seeds.

- Purple loosestrife (Lythrum salicaria and L. virgatum) is a perennial, growing up to 10 feet tall. Loosestrife prefers moist soils in seasonal wetlands, wet meadows, river and stream banks ditches and marshes. It has four-sided stems that are green to purple in appearance with clasping, lance shaped leaves turning red in the fall. Flowers are showy purple to magenta blossoms growing on a long spike known as a raceme. Each stem can produce up to three million seeds per year. The plant spreads not only by seed and roots but by plant parts which, if broken off, will grow shoots. Currently, it is found in several counties in the Yellowstone watershed.

- Perennial pepperweed (*Lepidium latifolium*) is a perennial mustard. It has multiple stems reaching up to eight feet in height. Leaves are waxy, bright to grayish-green in color, and lance-shaped. Flowers are small, white clusters borne near the end of the stems. Seeds are persistent, dropping throughout the winter period. The base of the stem is semi-woody with a very deep, dense root system. The plant grows from seed and roots. The plant is adapted to wet and dry habitats but prefers wet areas adjacent to streams and waterways. Perennial pepperweed is not currently found in the Yellowstone watershed but occurs in nearby counties. Although sometimes used in flower arrangements, the plant is toxic to livestock and has been noted to inhibit the growth of trees such as cottonwood and willow.

- Eurasian water milfoil (*Myriophyllum spicatum*) is a very invasive, submersed aquatic plant that is expanding its territory in Montana. It is adapted to diverse habitats. Currently found in western Montana and in Broadwater and Gallatin Counties east of the Continental Divide, it could easily be transported to the Yellowstone watershed. Plant parts remain viable up to seven days after drying out. Leaves 0.8 to 1.6 inches (2 to 4 cm) long, feather-like, and arranged in whorls of four around the stem. It is difficult to ID from other native milfoils without DNA testing.

- Curly leaf pondweed (*Potamogeton crispus*) is a very prolific, submerged aquatic plant that is also expanding its range in Montana and is adapted to a diverse range of habitats. Its growth form and mechanisms give it an advantage over other plants. It forms dense mats which float just below the water surface.

- Flowering rush (*Butomus umbellatus*) is an aquatic perennial reaching heights of five feet. Stems are triangular. Leaves are also sword-like and triangular and may end with spirals. When flowering the inflorescences are distinctive in that they are umbrella-shaped and pink and white in color. Without flowers the plant is difficult to identify from natives such as common bulrush. Flowering rush reproduces by seed and roots.

5.3 Other Potential Impacts to Wetland Systems

As described in the preceding sections of this chapter, there are a number of notable human influences on wetlands within the Yellowstone River corridor. Based on the available studies and related literature, those described previously are thought to be the most significant sources of wetland alteration or change. Given the scarcity of Yellowstone specific studies with quantitative and qualitative data, there could be other possible impacts that have or will contribute to wetland impacts. Some of these are described as follows:

5.4 Climate Change or Heightened Variability in Extreme Weather

Potential impacts of historic and projected trends in climate on the Yellowstone River have not been analyzed in detail but projected climate changes could affect the river's hydrology in several ways. Due to their topographic position and reliance on water resources, wetland systems in an arid environment may be impacted as much as any other river-related resources by changes in water availability, duration, or timing that are driven by variability in climate.

Less precipitation may be more the norm in the Yellowstone basin. In the northern Great Plains area, which encompasses the Yellowstone River Basin, precipitation has decreased by 10 to 20 percent since 1990 (IPCC, 1998). Graumlich et al. (2003) used tree rings to study climatic variation in the upper Yellowstone watershed. They found that climatic conditions in the 20th century are not representative of the drier climate in the preceding two centuries and likely of an even drier climate prior to the 18th century. At the minimum, warmer air temperatures would likely lead to elevated water temperatures, particularly during the late summer months. Reductions in streamflow during runoff events or low-flow periods would be expected to further stress connected and isolated seasonal wetlands and lead to impaired function due to longer and warmer dry periods (Miller, 2008) or lower late summer flows (Leppi et al., 2011).

Wetlands provide at least short-term storage of carbon in vegetation, organic debris and soils. Carbon is stored longer in wetlands than in uplands due to the anaerobic nature of the wetland environment. Lowering the water table in hydric soils will increase decomposition thereby amplifying CO_2 releases (Burkett and Kusler, 2000 cited in USACE, 2014).

Under extreme weather scenarios, infrequent, large-scale, intense precipitation events are probable USACE, 2012). Loss of wetlands within the floodplain represents less area for storing such events and leads to greater magnitude flooding.

As a result of constraints in time and financial resources, specific climate projections and analyses have not been made under the auspices of the Yellowstone CES, but are encouraged to be undertaken as resources are available by those who follow this work.

5.5 Municipal/Industrial Water Use

As sectors of overall water use on the Yellowstone River, municipal and industrial water users (including mining and resource extraction) are relatively small users. Compared to agricultural withdrawals, municipal use makes up less than 1 percent of the daily water use. Industrial water use, is somewhat greater, but only comprises around 8 percent of agriculture’s water use (Appendix 2). However, industrial uses divert water from the basin resulting in net consumption in the lower river which could have impacts on flow during low-flow periods.

With projected increases in population and industry (mining, oil, and gas development), increased water demand is likely to occur in the future which would heighten the impact of total water withdrawals during low flow periods, particularly when coupled with possible climate change or variability as discussed above. Data or metrics for this analysis and potential impacts on wetlands have not been made but would be expected to parallel the subjective reasoning in the preceding sections.

5.6 Urban/Ex-urban Development

The majority of past conversion and alteration of wetland habitats has been related to agriculture, primarily because of the dominant spatial extent of agricultural land uses in the basin and corridor (DTM, 2013; Zelt et al., 1999). While agricultural land uses will likely not expand appreciably in the future due to economics, it is expected that urban and exurban land uses will continue to grow as population expands within the corridor. Current laws and regulations (Federal Clean Water Act, Montana Stream Protection Act of 1963, the1975 Natural Streambed and Land Preservation Act, and the 1973 Montana Floodplain and Floodway Management Act) serve to protect most Palustrine and Riverine wetland environments to some degree, however continued growth will bring pressure to convert some areas for housing and infrastructure.

The importance and relative scarcity of wetlands makes a case for their protection from further conversion. Wetlands occur on as little as one-half of one percent of the landscape in Montana (Skagen et al., 2001). Healthy wetlands and riparian areas can store nearly five acre-feet of flood water per wetland acre. Fifty-five percent of 245 breeding avian species utilize riparian forests in Montana. Riparian areas support at least 56 percent of Montana’s mammals year long or seasonally while streamside buffers and wetlands provide habitat for 16 native amphibians, 3 species of turtles, and 7 snake species. Over half of Montana’s wildlife frequent riparian areas and 196 terrestrial species are considered riparian or wetland habitat obligates (Ellis, 2008). Future impacts of urban/exurban development pressure to convert wetlands could be significant near urban centers like Billings, Miles City, and Glendive unless additional programs are instituted to provide viable economic alternatives.

5.7 Water Quality

The documented reductions in low-flow discharge (Appendix 2) on the Yellowstone below the Clarks Fork River confluence, coupled with other potential increases in water demand, could further reduce low flows, especially in the lower river below the Bighorn River confluence. Further reductions in flow due to withdrawals or climate change have the potential to increase concentrations of water quality contaminants as described in Appendix 5 to a point that beneficial uses could are threatened (Miller, 2008). Increases in salinity, dissolved solids, water temperature, nutrients, and other metrics could adversely impact Riverine wetlands as well as closely connected Palustrine wetlands and riparian habitat. Changes in reduced native species recruitment, species composition, and increased susceptibility to invasion by exotic species tolerant of elevated levels of salt, nutrients, and temperature are possible impacts of water quality changes on wetlands.

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 8
Fisheries

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1.0 INTRODUCTION

The Yellowstone River remains the longest unimpounded river in the contiguous United States. However, several anthropogenic factors influence the fishery: altered hydrograph (Watson, 2014), altered geomorphology (Reinhold et al., 2014), altered riparian vegetation (Appendix 7) and wetlands (Appendix 8), altered land use (Appendix 1), altered longitudinal (Helfrich et al. 1999; Bramblett et al., in preparation) and mainstem-tributary connectivity (Duncan et al., 2012), altered water quality (Appendix 5), introduced species (White and Bramblett, 1993), and recreational fishing. Some of the written content in this report is derived from previous reports on which I was a coauthor, therefore I acknowledge my coauthors Ann Marie Reinhold, Mike Duncan, and Al Zale for their contributions

1.1 Yellowstone River Fish Community

The Yellowstone River fish community has about 59 fish species total of which 22 species (37 percent) are nonnative (Table 1; White and Bramblett, 1992). However, in terms of abundance, most nonnative fish are rare, with the exception of Rainbow Trout and Brown Trout in the uppermost about 400 km of river. The Yellowstone River has 14 fish and two reptile species of concern, including the endangered Pallid Sturgeon (Table 2; Montana Natural Heritage Program, 2015). However, the primary habitat for five species is tributaries of the Yellowstone River, rather than the Yellowstone River mainstem (Table 2).

The fish community changes along the river from its coldwater, alpine headwaters above Yellowstone Lake in Wyoming to its warmwater, prairie confluence with the Missouri River in North Dakota. Riverine ecosystems follow a longitudinal (from headwaters to mouth) continuum in which physical and biological conditions are connected and shift gradually (Vannote et al., 1980). However, the Yellowstone River fish community can be generally described as having three fish zones: an upper coldwater zone from the headwaters to the mouth of the Clarks Fork, a transition zone from the Clarks Fork to the mouth of the Bighorn River, and a warm-water zone from the Bighorn to the confluence with the Missouri River (White and Bramblett, 1993). The number of fish species found in the river increases going downstream. The coldwater zone has about 16 fish species; primarily salmonids (trout and Mountain Whitefish), sculpins, and some minnows and suckers. The transition zone has about 30 fish species; including more minnow and sucker species, four catfish species, Burbot, Sauger, Walleye, and Smallmouth Bass. The warmwater zone has about 49 total species, and adds two sturgeon species, the Shovelnose Sturgeon and the endangered Pallid Sturgeon, Paddlefish, more minnow species, including Sturgeon Chub and Sicklefin Chub, the Blue Sucker, and about six introduced sunfishes. The lower Yellowstone River has the highest fish species richness in Montana.

Table 1. Fishes of the Yellowstone River.

Family	Common name	Scientific name
Acipenseridae	Pallid Sturgeon	*Scaphirhynchus albus*
	Shovelnose Sturgeon	*Scaphirhynchus platorynchus*
Polyodontidae	Paddlefish	*Polyodon spathula*
Lepisosteidae	Shortnose Gar	*Lepisosteus platostomus*
Hiodontidae	Goldeye	*Hiodon alosoides*
Cyprinidae	Northern Redbelly Dace[b]	*Chrosomus eos*
	Lake Chubb	*Couesius plumbeus*
	Common Carp[a]	*Cyprinus carpio*
	Western Silvery Minnow	*Hybognathus argyritis*
	Brassy Minnow[b]	*Hybognathus hankinsoni*
	Plains Minnow[b]	*Hybognathus placitus*
	Sturgeon Chub	*Macrhybopsis gelida*
	Sicklefin Chub	*Macrhybopsis meeki*
	Emerald Shiner	*Notropis atherinoides*
	Sand Shiner	*Notropis stramineus*
	Spottail Shiner[a]	*Notropis hudsonius*
	Fathead Minnow	*Pimephales promelas*
	Golden Shinera	*Notemigonus crysoleucas*
	Flathead Chub	*Platygobio gracilis*
	Longnose Dace	*Rhinichthys cataractae*
	Redside Shiner[a]	*Richardsonius balteatus*
	Creek Chubb	*Semotilus atromaculatus*
Catostomidae	River Carpsucker	*Carpiodes carpio*
	Blue Sucker	*Cycleptus elongatus*
	Longnose Sucker	*Catostomus*
	White Sucker	*Catostomus commersonii*
	Mountain Sucker	*Catostomus platyrhynchus*
	Smallmouth Buffalo	*Ictiobus bubalus*
	Bigmouth Buffalo	*Ictiobus cyprinellus*
	Shorthead Redhorse	*Moxostoma macrolepidotum*
Ictaluridae	Black Bullhead [a,b]	*Ameiurus melas*
	Yellow Bullhead [a,b]	*Ameiurus natalis*
	Channel Catfish	*Ictalurus punctatus*
	Stonecat	*Noturus flavus*
Esocidae	Northern Pike[a]	*Esox lucius*
Osmeridae	Rainbow Smelt[a]	*Osmerus mordax*
Salmonidae	Yellowstone Cutthroat Trout	*Oncorhynchus clarkii bouvieri*
	Rainbow Trout[a]	*Oncorhynchus mykiss*
	Mountain Whitefish	*Prosopium williamsoni*

Family	Common name	Scientific name
	Brown Trout[a]	*Salmo trutta*
	Brook Trout[a]	*Salvelinus fontinalis*
	Lake Trout[a]	*Salvelinus namaycush*
Lotidae	Burbot	*Lota lota*
Fundulidae	Northern Plains Killifish [a,b]	*Fundulus kansae*
Cottidae	Mottled Sculpin	*Cottus bairdii*
Gasterosteidae	Brook Stickleback[b]	*Culaea inconstans*
Moronidae	White Bass[a]	*Morone chrysops*
Centrarchidae	Rock Bass[a]	*Ambloplites rupestris*
	Green Sunfish[a]	*Lepomis cyanellus*
	Pumpkinseed[a]	*Lepomis gibbosus*
	Bluegill[a]	*Lepomis macrochirus*
	Smallmouth Bass[a]	*Micropterus dolomieu*
	Largemouth Bass[a]	*Micropterus salmoides*
	White Crappie[a]	*Pomoxis annularis*
	Black Crappie[a]	*Pomoxis nigromaculatus*
Percidae	Yellow Perch[a]	*Perca flavescens*
	Sauger	*Sander canadensis*

[a]*Not native to the Yellowstone River.*

[b] *Primary habitat for this species is tributaries of the Yellowstone River, rather than the Yellowstone River main stem.*

Table 2. Fish and reptile species of concern of the Yellowstone River.

Common Name	State Rank[a]	Federal Status	Approximate Longitudinal Distribution
Pallid Sturgeon	S1	Endangered	Mouth to Powder River
Paddlefish	S2		Mouth to Powder River
Shortnose Gar	S1		Mouth to Sidney
Northern Redbelly Dace	S3		Mouth to O'Fallon Creek[b]
Brassy Minnow	S4		Mouth to Pryor Creek[b]
Plains Minnow	S4		Mouth to Clarks Fork[b]
Sturgeon Chub	S2S3		Mouth to Tongue River
Sicklefin Chub	S1		Mouth to Intake
Creek Chub	S4		Mouth to Rosebud Creek[b]
Blue Sucker	S2S3		Mouth to Bighorn River
Yellowstone Cutthroat Trout	S2		Billings to headwaters
Burbot	S4		Mouth to Boulder River
Brook Stickleback	S4		Mouth to Clarks Fork[b]
Sauger	S2		Mouth to Clarks Fork
Spiny Softshell	S3		Mouth to Clarks Fork
Snapping turtle	S3		Mouth to Bighorn River

[a]S1, At high risk because of extremely limited and/or rapidly declining population numbers, range and/or habitat, making it highly vulnerable to global extinction or extirpation in the state; S2, At risk because of very limited and/or potentially declining population numbers, range and/or habitat, making it vulnerable to global extinction or extirpation in the state; S3 Potentially at risk because of limited and/or declining numbers, range and/or habitat, even though it may be abundant in some areas; S4, Apparently secure, though it may be quite rare in parts of its range, and/or suspected to be declining (Montana Natural Heritage Program, 2014).
[b]Primary habitat for this species is tributaries of the Yellowstone River, rather than the Yellowstone River mainstem.

2.0 ANTHROPOGENIC FACTORS INFLUENCING FISH IN THE YELLOWSTONE RIVER

2.1 Altered Hydrology

The hydrology of the Yellowstone River has been altered relative to unregulated (undeveloped) conditions (Watson, 2014). These changes are presented in Appendix 2, and the major changes to the hydrology that were identified were: reduced peak flows, earlier peak flows, decreased channel forming flows, reduced summer low flows, increased fall and winter low flows, reduced hydrograph rise and fall rates, and reduced discharge from the Bighorn River and other tributaries. The magnitude and causes of hydrological change on the Yellowstone River relative to natural flows varies longitudinally (Appendix 2). In the upper river downstream to the Clarks Fork, hydrological change is minor and is mostly attributable to irrigation. In the middle river downstream to the Bighorn River, hydrological change is moderate and is mostly attributable to irrigation. In the lower river downstream to the Missouri River, hydrological change is major and is attributable to altered hydrology on the Bighorn River from Yellowtail Dam operations and irrigation (Appendix 2). Other causes of altered hydrology include damming of other Yellowstone River tributaries, non-irrigation withdrawals of surface and ground water (Appendix 2; Watson, 2014), and climate change (Leppi et al., 2012).

Changes to the hydrology of the Yellowstone River basin are likely to have ecological consequences and influence the fish community. A river's hydrograph is often considered the "master variable" that most strongly influences riverine ecosystems (Poff et al., 1997; Bunn and Arthington, 2002; Poff et al., 2010). Important mechanisms link hydrology to aquatic biodiversity, i.e., streamflow is a major determinant of physical habitat, aquatic species have evolved life history strategies primarily in direct response to the natural flow regime, flow-dependent longitudinal and lateral connectivity supports populations of riverine species, and the invasion and success of introduced species is often facilitated by altered flow regimes (Bunn and Arthington, 2002). A review of 55 peer-reviewed scientific papers indicated that fish abundance, diversity, and population dynamics consistently declined in response to both reductions and increases in magnitude of discharge (Poff and Zimmerman, 2010). Moreover, the larger the hydrological change, the greater the risk of ecological change in the riverine ecosystem (Poff and Zimmerman, 2010). Therefore, because the greatest hydrological change on the Yellowstone River has occurred below the Bighorn River (Appendix 3), the ecological risk varies longitudinally, with greatest risk occurring below the Bighorn River. This is also the reach of the river with the most fish species. Therefore, changes in the Yellowstone River's annual hydrograph are potentially of profound concern. Although ecological principles and scientific literature strongly indicate that altered hydrology affects riverine ecosystems, specific relationships between temporal trends in hydrological variables and the abundance and distribution of fish in the Yellowstone River has not been studied.

A riverine ecosystem is connected in four dimensions (Ward, 1989): longitudinal (up- to downstream), lateral (river channel-floodplain), vertical (river channel-groundwater), and temporal (time, from behavioral response time to evolutionary time). The focus of this appendix is on the longitudinal and lateral dimensions because we have little information on the Yellowstone River regarding vertical and temporal connections. The longitudinal dimension is defined by movements and connections in nutrients, energy production, organic materials, and organisms along the river as outlined by the River Continuum Concept (RCC; Vannote et al., 1980). The RCC emphasizes rivers have a continuous longitudinal gradient in physical variables, and that the organisms in the river respond and adapt to this gradient. The lateral dimension is defined by the connection of the main river channel to its floodplain, and results in a continuum of habitats in floodplains ranging from terrestrial, to lentic (non-flowing), to lotic (flowing water). The Flood Pulse Concept (Junk et al. 1989) emphasizes the importance of the lateral dimension; the connection of the river with its floodplain that occurs during floods (particularly in large rivers), and results in exchanges of water, sediment, nutrients, energy, and organisms. Floodplains contain riparian vegetation and wetlands which provide many ecological services such as recharging groundwater, and providing wildlife habitat (Appendix 7; Appendix 8), and floodplains are the source of large woody debris (LWD; i.e., trees) that recruit to the river channel where they provide important fish and macroinvertebrate habitat.

2.1.1 Reduced Peak Flows

Peak flows have been reduced on the Yellowstone River, particularly below the Bighorn River where the magnitude of the 2-year flood has been reduced about 23 percent (Appendix 2). A reduction in peak flows reduces the stage (water surface elevation) and erosive force of the river, resulting in floodplain isolation, which decreases the area and diversity of available aquatic habitats. For example, below the Bighorn River, the Yellowstone River is now smaller, with fewer and less-frequently flowing side channels, and the area of open gravel and sand bars has been reduced due to conversion to woody islands caused by riparian vegetation encroachment (Appendix 7).

Floodplain isolation reduces the area of inundation, particularly of lateral and floodplain habitats such as side channels, seasonal high flow channels, wetlands, and floodplain relative to unregulated conditions. Floodplain isolation is also caused by altered geomorphology that results from physical structures such as dikes, levees, transportation embankments, and bank armoring as well as agricultural development (Appendix 3). For example, between Springdale and the mouth of the Yellowstone River, over 21,000 acres of 100-year floodplain have been isolated from all causes (Appendix 3). Although no precise measure of temporal change in Yellowstone River wetlands is feasible, and estimated 25 to 33 percent of historic wetlands may have been lost (Appendix 8). However, regardless of the cause of floodplain isolation, the effects on the aquatic ecosystem and fish community are expected to be similar.

Side channels and other floodplain habitats are important habitats for fish (Reinhold et al., 2014), amphibians (Tockner et al. 2006), reptiles (Tornabene, 2014, Bramblett et al., in preparation), birds (Appendix 9), and other riverine animals; probably because of the habitat heterogeneity they provide. Side channels are often smaller and shallower, with slower current velocities, warmer water temperatures, and more biological productivity than main channels. Lateral habitats such as backwaters provide important habitat for larval and juvenile fishes (Sheaffer and Nickum, 1986), as well as macroinvertebrates (Sheaffer and Nickum, 1986; Benke, 2001), which contributes to fish recruitment and food sources in main channels. Therefore, connectivity between main channel and side channel habitats is also important. For example, twice as many fishes were found in connected aquatic floodplain habitats than were found in disconnected habitats in the impounded lower Missouri River (Galat et al., 1998).

During runoff, seasonally inundated lateral habitats such as backwaters and side channels provide refugia for small fish (Brown and Hartman, 1988; Pearsons et al., 1992; Aghostino and Zalewski, 1995; Górski et al,. 2011) because high-water velocities can displace small fish, especially larvae (Ottaway and Clarke, 1981; Ottaway and Forest, 1983; Hjort et al., 1984; Harvey, 1987; Sukhodolov et al., 2009). Floodplain habitats are important for fishes, particularly for spawning (Burgess et al., 2013) and for larval, juvenile, and small fishes (Scheurer et al., 2011). For example, Bigmouth buffalo spawn on inundated riparian vegetation in Yellowstone River floodplains and up to two weeks is needed for the eggs to hatch (Mike Ruggles, MFWP, personal communication). Certain fish species, such as Western Silvery Minnows have eggs and larvae that drift with the current during high flows (“pelagophils”). These species are particularly susceptible to flow regulation (Dudley and Platania, 2007), because this behavior was an adaptation to natural flow regimes. The larvae of these species often settle out and develop in lateral floodplain habitats (Cowley, 2006; Shirey et al., 2008; Scheurer et al., 2011; Magana, 2012), therefore floodplain isolation that reduces the duration of floodplain inundation will cause larval mortality.

Side channels also provide fish habitat during base flow. Fish species richness was positively associated with increased habitat diversity in the upper Mississippi River during base flow conditions (Ellis et al., 1979; Koel, 2004). Fish species richness (Koel, 2004), sizes (Copp, 1997), and abundances (Lyons, 2005; Reinhold et al. 2014) can be distinct between side-channel and main-channel communities. Moreover, the structure (i.e., composition and relative abundance) of the main-stem Yellowstone River fish community varied as a function of side channel availability during base flow (Reinhold et al. 2014).

In the Yellowstone River in Park County, side channels were likely important natural nursery areas for juvenile salmonids because other types of juvenile salmonid habitat was rare along the main-channel banks (Zale and Rider, 2003). Moreover, side channels provide shallow, slow current velocity (SSCV; quantitative definitions vary in different studies, but is generally <3.3 ft deep and <1.5 ft/s) habitat during runoff when such habitat is negligible in the main channel. Although juvenile salmonid densities in side channels were not exceptional, juvenile salmonids, especially Mountain Whitefish, rapidly occupied side channels upon inundation, suggesting that when available, side channels are important habitats for juvenile salmonids.

Bowen et al. (2003a) demonstrated that SSCV area increases with increasing discharge and peaks during peak runoff. However, anthropogenic bank modifications such as levees and bank stabilization increase lateral river confinement which decreases side channel and overbank SSCV area, thereby reducing the overall amount of SSCV habitat available. SSCV availability was lowest in the Livingston reach (i.e., from just above Siebeck-9th Street Island to the Highway 89 Bridge (river km 806.3 to 800.0; Bowen et al. 2003a) and this reach generally had less SSCV attributable to side channels and overbank areas, particularly during bankfull flows (Bowen et al 2003a). The Livingston reach also had the highest proportion of SSCV attributable to modified banks, which may be important habitats for juvenile salmonids where such habitat is otherwise rare (Zale and Rider 2003). However, Zale and Rider (2003) also stress the importance of side channels as important juvenile salmonid habitat, and side channel area has probably been lost in the Livingston reach. Habitat modifications that reduce the frequency or duration of side-channel inundation, or reduce side channel formation rates, would decrease juvenile salmonid habitat and possibly recruitment.

Side channels are also important spawning areas for Yellowstone Cutthroat Trout (DeRito et al., 2010). Although 75 percent of telemetered Yellowstone Cutthroat Trout spawned in tributaries, 23 percent spawned in side channels, compared to only 2 percent that spawned in main channels (DeRito et al., 2010). Standardized electrofishing surveys by Montana Fish Wildlife and Parks (MFWP) have revealed declines in Yellowstone Cutthroat Trout numbers near Springdale, Montana from as high as 250 fish per mile in the 1990s to 45 fish total in 2005 in the five-mile long survey reach. Although the cause of this decline is not known with certainty, limited side channel habitat could be a factor (Scott Opitz; MFWP personal communication).

Side channels provided important habitat for the Yellowstone River shoreline fish community during runoff (Reinhold et al., 2014). Overall fish catch rates, catch rates of the most common species (Western Silvery Minnow, Longnose Dace, Flathead Chub, Sand Shiner, and Emerald Shiner;

Figure **1**), and species richness of fyke net catches (Figure 2) were generally greater in side channels than main channels during early and late runoff, but not during base flow. Overall fish catch rates in side channels were up to nine times higher relative to main channel catch rates (

Figure **1**). Fish community structure also differed between side channels and main channels during runoff, but not during base flow (Reinhold et al., 2014). These results emphasize the importance of side-channel habitats during high flows. Differences in main and side channel fish communities was probably due to the availability of SSCV habitats, rather than physical habitat parameters such as depth, velocity, and substrate, which were similar at fish capture locations. This conclusion is supported by modeling results that indicate that during runoff, SSCV is limited and that it is primarily found in side channels (Bowen et al., 2003b).

The availability of side channels influenced the Yellowstone River fish community (Reinhold et al., 2014). During base flow, the catch rates of main channel fish communities varied in relation to the availability of side channels. Moreover, the relationships of fish communities to side channels were more consistent and widespread than the relationships to bank stabilization. Further, side channels and bank stabilization had differing and sometimes opposing influences on the structure of the fish communities. Side channel availability, measured at scales of up to 1.6 km upstream and downstream of sample locations, was significantly correlated with the composition and abundance of fish communities in both geologically constrained (bluff) pools and unconstrained (alluvial) and channel crossovers (Reinhold et al., 2014).

Reduced peak flows may alter the relationship between fish reproduction and hydrology; hydrologic spawning cues may be disrupted or weakened, with uncertain consequences for spawning and subsequent survival of fish early life history stages. Many fish species appear to time spawning events in relation to hydrologic cues such as the annual snowmelt peak flow. For example, Shovelnose Sturgeon spawned in the Marias River during two high-water years but not during a low-water year, despite suitable water temperatures. Therefore, it appeared that a discharge threshold was needed to provide a spawning cue for Shovelnose Sturgeon (Goodman et al., 2013). Similarly, Blue Suckers entered the Milk River from their overwintering habitat in the Missouri River when a threshold discharge of 1,000 cfs in May was reached in the Milk River (Fuller and Braaten, 2012). It was unknown, but possible that these movements were related to spawning.

Spiny Softshells in the Yellowstone River preferred secondary channels in all seasons except winter, when they preferred bluff pools (Bramblett et al., in preparation). This pattern is concordant with habitat use in the Missouri river in Montana where Spiny Softshells used shallow, slow, lateral habitats such as backwatered tributary mouths and inundated floodplains during all seasons except winter (Tornabene, 2014). These habitats were typically near shore with shallow depth, zero to slow water velocity, fine substrates, and higher water temperatures than in the main stem. Such areas seem to be important during this period because some turtles moved considerable distances, aggregated, and showed interannual fidelity to particular tributary confluences (Tornabene, 2014). Spiny Softshells hibernate on the river bottom in winter, and select deeper water with moderate current velocities between the shoreline and thalweg, likely because they are not displaced by swift velocities, have adequate oxygen, and are deep enough to be safe from ice jams (Tornabene, 2014). Bluff pools are slower and deeper than other pool types and probably provide adequate habitat for overwintering hibernacula.

Bowen et al. (2003b) modeled SSCV spatiotemporal dynamics at three reaches on the lower Yellowstone River. During the rising limb of the hydrograph, SSCV patches were located primarily in side channels and back-flooded tributaries. At peak flow, flooding of vegetated islands and side channels provided organic material (leaf litter) to the river. During hydrograph recession and baseflow periods, SSCV was found in the main channel and large side channels, and formed large patches (Figure 3). SSCV area during recession and base flow was about double that available during runoff (Bowen et al., 2003b). This modeled pattern of SSCV availability indicates that SSCV is limited during runoff, and that it is found in side channels, thereby indicating the importance of side channels in providing SSCV habitat. Biological implications of these models is provided by Reinhold et al. (2014) who found that overall fish catch rates, catch rates of the most common species, and species richness in fyke net catches were generally greater in side channels than main channels during early and late runoff.

Reduced peak flows reduces the area and the duration of floodplain inundation. This floodplain isolation will reduce the amount of terrestrial energy (nutrients and material derived from terrestrial sources) reaching the river, thereby reducing primary and secondary productivity and fish food supply as outlined in the Flood Pulse Concept (Junk et al. 1989). The ecological effects of floodplain isolation are expected to be increasingly important proceeding downstream on the Yellowstone River. Rivers typically undergo a sequence of energy sources proceeding from the headwaters to the lower reaches. As rivers become larger, the importance of energy derived from the floodplain increases (Vannote et al., 1980; Junk et al., 1989). In the headwaters, shading from riparian vegetation limits photosynthesis on the river bottom and most energy (organic materials such as leaves) is allochthonous, meaning it comes from outside the stream. In the middle reaches, water is clear, the stream is wider and relatively unshaded which allows for photosynthesis on the river bottom. Therefore in middle reaches most energy is autochthonous, meaning it comes from within the stream, although energy also derives from drift from upstream. In the lower reaches of a river, the floodplain is larger and more often inundated, and the turbid water limits in-stream photosynthesis. Therefore most energy in the lower reaches is allochthonous, coming from the floodplain as well as from drift from upstream reaches.

Reduced peak flows will reduce the frequency of creation and maintenance of lateral habitats such as side channels and seasonal secondary channels (Appendix 4). The two-year discharge is referred to as the channel-forming flow because it is the discharge most responsible for creation and maintenance of the form of the river channel and associated habitats such as side channels. The 2- to 5-year flow events are probably also the most relevant to fish reproduction, refuge habitat, and food supply because many of the fish in the Yellowstone River reproduce annually and have life spans less than five years (Brown, 1971). Therefore, inundation of the 2- to 5-year floodplain is important to fish year-class strength to the extent that fish use the floodplain for spawning, juvenile fish habitat, or food supplies.

Reduced peak flows will likely reduce the amount of bank erosion and recruitment of LWD to the river channel (Appendix 4). The erosion rate of closed timber floodplain has declined in the most reaches of the Yellowstone River since the mid- 1970s resulting in an estimated 2,500 fewer trees being recruited into the river channel every year (Appendix 4). Large woody debris influences channel geomorphology and is an important element of fish habitat because it provides cover and creates areas of deep scour. Large woody debris is also important for production of invertebrate prey items (Benke, 2001) particularly in river habitats lacking hard rocky substrates, such as the in the Yellowstone River below Sidney, Montana where sand is the primary substrate (Bramblett and White, 2001).

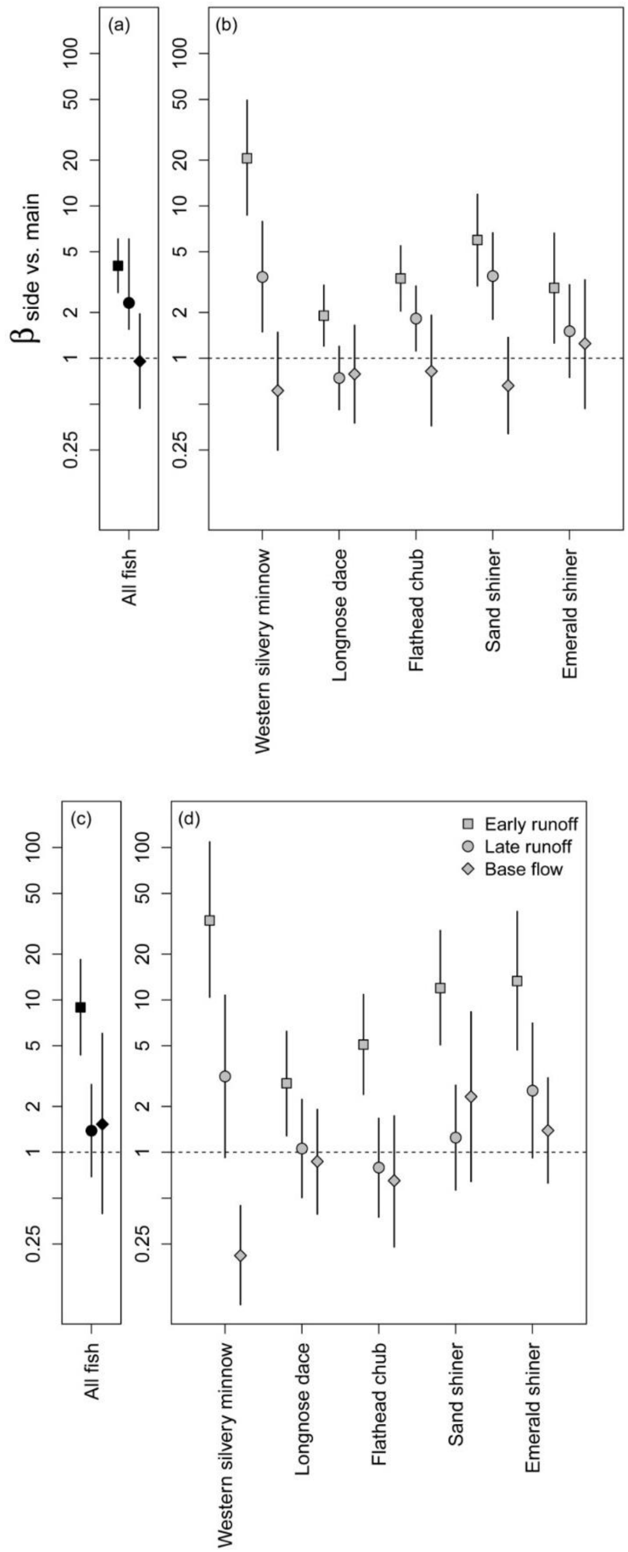
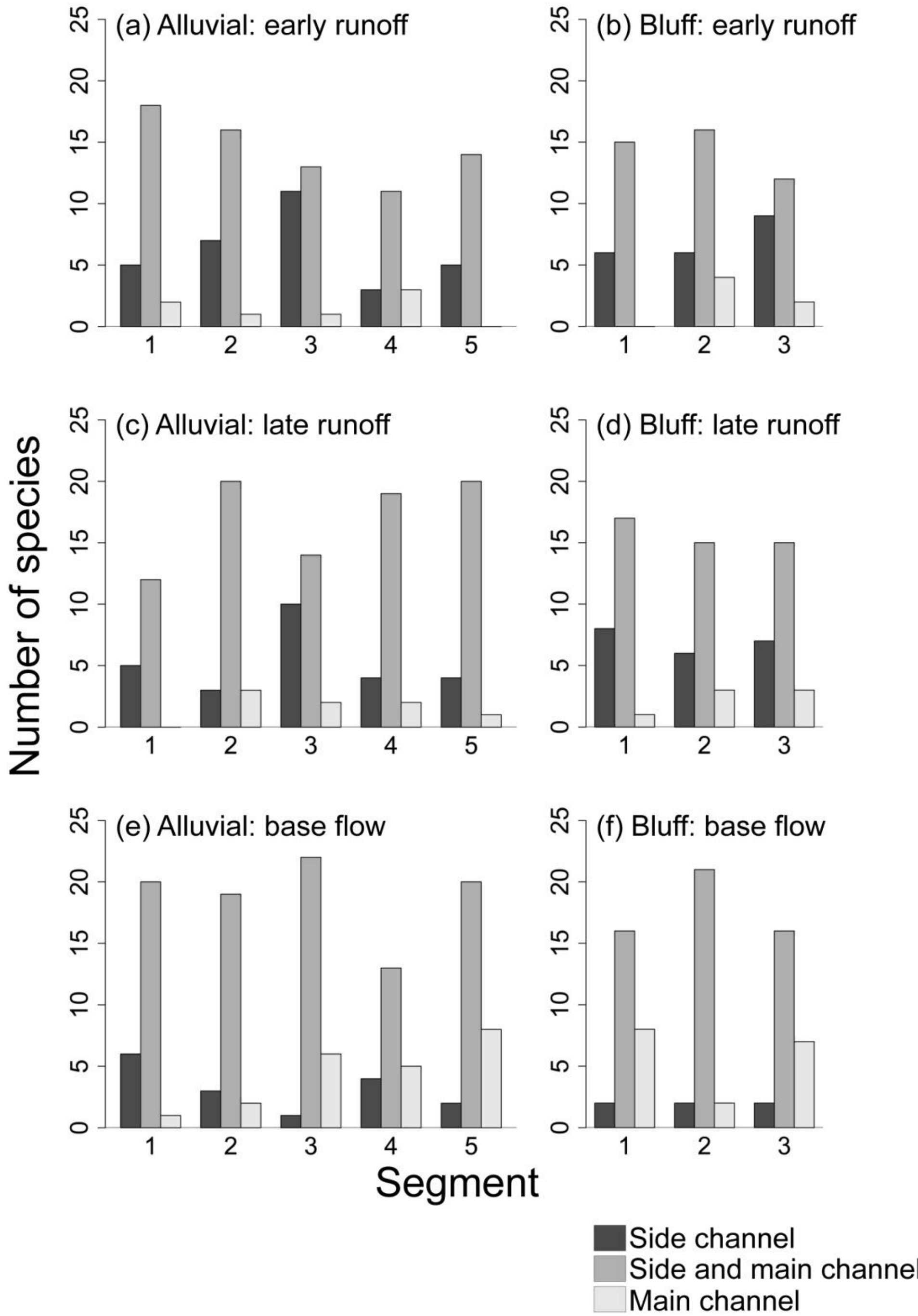


Figure 1. Estimated mean multiplicative differences (β) in side-channel versus main-channel catches of fish captured in fyke nets during runoff and base flow in alluvial (a and b) and bluff river bends (c and d). Estimates were generated from negative binomial regressions



with offsets for sampling effort. Error bars represent 95-percent confidence intervals (from Reinhold et al., 2014).

Figure 2. Habitat-specific comparisons of numbers of species for runoff and base flow conditions. Bar color indicates whether species were captured in side channels, main channels, or both (from Reinhold et al., 2014).

Figure 3. Distribution of SSCV habitat (black shading) during runoff, recession, and base flow in a portion of the Elk Island site on the Yellowstone River during the 1997 water year (from Bowen et al., 2003b).

2.1.2 Reduced Summer Low Discharge

Summer low flows have decreased on the Yellowstone River. For example, the summer low flow declined by about 48 percent from about 6,200 cfs to about 3,200 cfs at Miles City, Montana (Appendix 3). Reductions in flows reduce the amount of aquatic habitat, bringing fish into closer proximity, thereby potentially increasing the rates of ecological interactions such as predation, competition, and transmission of disease or parasites. Reduction in flows reduce river stage which affects the availability and suitability of fish habitats. For example, habitats that are at higher elevations than the main channel, such as seasonally inundated side channels and floodplain habitats could be dewatered, thereby reducing the availability of important SSCV habitats, and reducing energy transmission between terrestrial and aquatic portions of the riverine ecosystem. Moreover, lower summer discharge allows encroachment of vegetation into side channels, which probably accelerates side channel loss through subsequent sediment capture.

Reductions in summer low flows may cause warmer water temperatures, which could have a number of influences on the fish community. Sublethal effects of increased temperatures on fish include altered spawning, growth, and resistance to diseases and parasites (Armour 1991). In the laboratory, juvenile Shovelnose Sturgeon growth was decreased and mortality was increased at temperatures above 24^0 C (Kappenman et al. 2009). When temperatures exceed the upper tolerance levels of fish species, fish kills can occur. Thermally-caused fish kills of primarily shovelnose sturgeon have occurred on the Des Moines River when water temperatures were exceedingly high ($29\text{-}35^0$ C; Hupfield et al. 2014). Water temperatures in the lower Yellowstone River occasionally reach $29\text{-}30^0$ C, suggesting that thermally induced fish kills may be possible if temperatures increase. Similarly, if water temperature increases beyond the thermal tolerance of any fish species occur along the length of the Yellowstone River, fish kills could result.

Fish distributions and relative abundances may shift upstream as species seek their preferred temperatures. However, although thermal regimes may shift longitudinally, other ecosystem components such as channel slope, riverbed substrate, position of spawning tributaries, and fragmentation structures such as diversion dams will not, and may preclude simple longitudinal shifts in the distributions of Yellowstone River fish in response to temperature changes. The relative abundance of fish species may change longitudinally if water temperatures increase. For example, fish species such as Shorthead Redhorse and Goldeye that are currently present in the coldwater zone, but are more abundant downstream in warmer waters may increase their abundance in the present coldwater zone. Smallmouth Bass, which were stocked in the Tongue River below the Tongue River reservoir in the late 1960s, as well as in the lower Bighorn River between 1986 and 1992 (Ken Frazer, MFWP, personal communication) are now established in the Yellowstone River from above the mouth of the Powder River to Billings (Montana Fish, Wildlife, and Parks, 2015). However, Smallmouth Bass appear to be expanding their range in the Yellowstone River, and have recently been documented as far upstream as the mouth of the Shields River (Scott Opitz, MFWP, personal communication). This apparent upstream expansion of Smallmouth Bass may be related to warming water temperatures. Smallmouth bass are visual predators, are strongly associated with large rock substrate (Todd and Rabeni, 1989), prefer water temperatures generally less than about 70^0, and spawn primarily at temperatures of 61^0F-65^0F (Scott and Crossman). The longitudinal distribution of smallmouth bass will be influenced by gradients in turbidity, substrate, and temperature. Currently, the lower river is probably too turbid, warm, and lacking in large rock substrate for smallmouth bass, whereas the upper river has low turbidity and large substrate but is too cold. Therefore if water temperatures increase, smallmouth bass may become established farther upstream in the Yellowstone River.

The oxygen balance in a river is controlled by water temperature, atmospheric pressure, diffusion, turbulence, photosynthesis, and instream biological respiration. Warmer water contains less oxygen, however oxygen rarely limits fish survival in rivers, except in very warm, heavily polluted, or highly productive rivers. There is a paucity of information on the oxygen tolerances of the fish community in the Yellowstone River, however species such as Fathead Minnow, Longnose Dace, Sand Shiner, Emerald Shiner, White Sucker and Channel Catfish, tolerate oxygen levels as low as 2.0 mg/L (Doudoroff and Shumway, 1970; Matthews and Manness, 1979; Smale and Rabeni, 1995), which is lower than normally found in rivers. Further, it is very unlikely that the water will warm enough to approach these levels because even at 113^0 F, the oxygen saturation of water is almost 6 mg/L. Salmonids are generally less tolerant of low oxygen levels than other fish families such as cyprinids, catostomids, and ictalurids, therefore increased water temperature and reduced oxygen probably has the most potential to affect salmonids in the present coldwater zone of the river. Although it is difficult to make definitive predictions, such effects may be sublethal and involve reduced salmonid metabolism, activity, growth, or distribution. Angling mortality for salmonids generally increased with water temperatures above 20^o C (Boyd et al., 2010). MFWP has enacted fishing restrictions in the coldwater zone of the river in the past to reduce potential angling-related mortality on salmonids (Scott Opitz, MFWP, personal communication).

Altered thermal regimes may change ecosystem productivity and lead to altered food webs. Reduced flow volumes will concentrate pollutants and may thereby affect fish. Perhaps most importantly, reductions in flows may increase the anthropogenic demands for water relative to supply and thereby lead to further reductions in flow.

2.1.3 Increased Fall and Winter Low Discharge

The typical fall and winter low flow on the Yellowstone River has increased. For example, the winter low flow increased by about 60% from about 2,000 cfs to about 3,200 cfs at Miles City, Montana such that average winter flow is the similar to the summer low flow (Appendix 3). Increases in fall and winter discharges alters the natural pattern of discharge to which native fishes have adapted. It is difficult to determine thresholds of change in discharge and to predict how this may affect fish communities, however the scientific literature indicates that the greater the hydrological change, the higher the ecological risk (Poff and Zimmerman, 2010). Higher fall and winter discharges will increase volume of water in the river, and likely create greater depths and current velocities, thereby altering overwintering habitats for fish and Spiny Softshells. Such changes may increase the energy expenditures for fish and Spiny Softshells during periods of temperature-regulated low metabolism, thereby possibly reducing energy reserves of fish and turtles.

Changes in fall and winter stream discharge may alter normal patterns of ice formation, breakup, and jamming with unknown effects on overwintering fish and turtles. If ice jamming increases, Increased ice jamming could increase the risk of turtle and fish mortality caused by ice scour could also increase.In the middle and lower Yellowstone River, historically there was a small peak in the hydrograph caused by low-elevation snowmelt that occurred in March and early April, often referred to as the “prairie peak”. The overall increases in low flows during March and April have dampened the prairie peak such that it is less of a peak under current hydrological conditions (Appendix 3). Although the prairie peak was much smaller than the peak discharge that occurred in June, it may have been an important cue for fish spawning or movement in the Yellowstone River, and in tributaries such as the Bighorn, Tongue and Powder rivers. For example, Sauger spawning in the lower river occurs in this general timeframe. Jaeger et al. (2005) considered the Sauger spawning season on the Yellowstone River near Miles City to be March 15-May 15, based on collection of female Sauger that were gravid, running eggs, or spent, and spawning condition of Sauger captured in standardized sampling by MFWP indicates that Sauger spawning begins in April (Caleb Bollman, personal communication). Other Yellowstone River fishes exhibit considerable movement rates during spring when the prairie peak occurs. Burbot, Channel Catfish, Shovelnose Sturgeon, and Spiny Softshells all had movement rates during spring that were not significantly different than movement rates during runoff (Bramblett et al. in preparation). The prairie peak in the Powder River in 1938-1967 occurred in early April, but since 1968 has occurred in mid-March, which is about two weeks earlier (Karin Boyd, Applied Geomorphology, personal communication). This change may alter cues for fish movement or spawning in the Powder River and in the Yellowstone River below the confluence of the Powder River. Changes in the prairie peak may disrupt or weaken hydrologic spawning cues, with uncertain consequences for survival of fish early life history stages.

2.1.4 Reduced Hydrograph Rise and Fall Rates

The rise and fall rates on the Bighorn River have been markedly affected by Yellowtail Dam. Rise and fall rates have been reduced on the Bighorn River, resulting in a substantial dampening of the natural hydrograph that is transmitted to the Yellowstone River downstream at least as far as Miles City, although the impact is markedly lower than on the Bighorn River itself.

Altered rise and fall rates of peak runoff may alter the relationship between fish reproduction and hydrology. As discussed above, fish spawning events may be cued by hydrologic conditions such as the annual snowmelt peak flow. Reduced rise and fall rates may disrupt or weaken hydrologic spawning cues, with uncertain consequences for survival of fish early life history stages. Altered synchronicity between riverine ecosystem processes and fish life-history stages may result in changes in fish species distribution and abundance.

2.1.1 Reduced Discharge from the Bighorn River and other Tributaries

Large reservoirs, irrigation withdrawals, and small dams such as stock ponds all contribute to the reduction of discharge from Yellowstone River tributaries. Although the Yellowstone River mainstem is unimpounded, 31 percent of its drainage basin lies upstream of dams (Koch et al., 1977). Dams fragment fish populations by preventing fish movement and also alter ecological conditions in the dammed river as well as in the receiving Yellowstone River. The serial discontinuity concept (Ward and Stanford, 1983) conceptualizes the ecological effects of mainstem dams with regard to their placement along the longitudinal river continuum (Vannote et al., 1980). A dam placed on the lower reaches of a main-stem river is predicted to shift primary production, nutrient levels, turbidity, substrate size, and water temperatures to those found farther upstream on an undammed river (Ward and Stanford, 1983).

Yellowtail Dam was installed on the lower reaches of the Bighorn River in 1967; this dam transformed a sediment-laden, warm-water prairie river into a clear, cool, blue-ribbon tailwater trout fishery. This transformation in turn affected the Yellowstone River by reducing sediment load, turbidity, peak discharge and scouring flows, and causing cooler summer and warmer winter water temperatures as well as preventing long-distance fish movements between Yellowstone and Bighorn rivers. Reductions in sediment inputs can cause channel incision (Simon and Darby 1999) and consequently side-channel dewatering (Wohl, 2004). The largest reductions in braiding since the 1950s occurred between the Bighorn and Powder rivers (Thatcher and Boyd, 2007). Moreover, unvegetated bars were historically common on the Yellowstone River below the Bighorn River (Koch et al., 1977; Silverman and Tomlinsen, 1984), but many of these bars have been replaced by vegetated islands (Thatcher et al. 2008; Appendix 7). Flow regulation at Yellowtail Dam on the Bighorn River has resulted in a reduction of flood magnitudes on the Yellowstone River below the confluence, and dampened the hydrograph on the Yellowstone River by reducing daily rates of discharge rise and fall at least as far downstream as Miles City (Appendix 3).

The Tongue River Reservoir and dam modified ecological conditions in the Tongue River and the receiving Yellowstone River. However, following the tenets of the serial discontinuity concept (Ward and Stanford 1983), the ecological effects of the Tongue River dam may have been less severe than those caused by the Yellowtail Dam on the Bighorn River. Specifically, about one-third of the Tongue River drainage basin is upstream of the Tongue River Dam, whereas about four-fifths of the Bighorn River basin is upstream of Yellowtail Dam. Therefore, the transformation of the Tongue River was likely less severe because the dam is located nearer to the headwaters of the Tongue River. Nonetheless, altered hydrology on the Tongue River has affected the ecology of the Tongue and its ecological connectivity with the Yellowstone River.

Installation of dams on the Bighorn and Tongue rivers has fragmented these two rivers and also prevents long-range movements between the Yellowstone River and those tributaries. By removing the natural sediment load and turbidity, these two dams have also reduced the ecological suitability of the Bighorn and Tongue rivers as well as the Yellowstone River below the confluence of the two tributaries for native turbid water fish. This type of human influence has been documented in Wyoming where a group of fishes adapted to high turbidity including Shovelnose Sturgeon, Flathead Chub, Goldeye, Plains Minnow, Western Silvery Minnow, and Sturgeon Chub have been disappearing from Wyoming rivers that are heavily modified by reservoir construction. Of these species, only Flathead Chub appear to be secure in the Bighorn River basin (Wyoming State Wildlife Action Plan, 2010). Shovelnose Sturgeon were extirpated from the Bighorn River in Wyoming, probably because their movements were blocked by Yellowtail Dam, and a reintroduction program for them was initiated in 1996 in the Bighorn River in Wyoming (Wyoming State Wildlife Action Plan, 2010). Goldeye, Plains Minnow, Western Silvery Minnow, and Sturgeon Chub formerly occupied the Bighorn River, but are now apparently extirpated there (Quist et al., 2004; Wyoming State Wildlife Action Plan, 2010). Moreover, Sturgeon Chub populations in the Yellowstone River almost certainly extended upstream to the mouth of the Bighorn River, however no Sturgeon Chub were captured above the Tongue River during extensive sampling (Duncan et al., 2012; Reinhold et al., 2014). Sauger have also declined in the Yellowstone River in the vicinity of and below the confluence of the Bighorn River, probably due to reduced temperatures, reduced sediment yield and associated turbidity, dampened spring peak flows that cued upstream migration, diversion dams, and habitat changes (McMahon and Gardner, 2001).). Reduced turbidity may also be more suitable for Walleye than for the native turbidity-loving Sauger. The Sauger population that formerly occurred in the Bighorn River below Yellowtail Dam is now thought to be extirpated (Mike Ruggles, MFWP, Personal Communication). The population of Sauger upstream of Bighorn Reservoir in Wyoming is extant, but is genetically different than Yellowstone River Sauger (Bingham et al. 2011).

Flow regulation by Yellowtail Dam on the Bighorn River has caused increased floodplain isolation (Appendix 3). Specifically, upstream of the Bighorn River confluence, typically less than 20 percent of the historic 5-year floodplain has been isolated; downstream of the confluence over 40 percent of the historic 5-year floodplain is now inaccessible by a 5-year flood. Isolation of the 2-year floodplain has resulted in reduced seasonal high flow channel activation during that event. The extent of 2-year floodplain isolation has been most significant between the confluences of the Bighorn and Tongue Rivers, where the developed 2-year inundation footprint is on the order of 40-percent smaller than that under undeveloped conditions. The effects of floodplain isolation on fish are discussed above in Section 2.1.1.

Impoundments on the Bighorn and Tongue rivers probably influence the spatiotemporal dynamics of SSCV habitats and vegetated floodplain inundation on the Yellowstone River. Therefore, effects of Yellowstone River tributary impoundment may be similar to, but less extreme than those seen on the Missouri River (Bowen et al., 2003b). Specifically, inference from the Bowen et al. (2003b) indicates that the present-day Yellowstone River may have less variation in mean SSCV patch size, patch density, and location of patches, as well as less area of inundated woody vegetation than the pre-settlement Yellowstone River. Bank stabilization and construction of levees and floodplain dikes have probably also reduced Yellowstone River SSCV dynamics and floodplain interaction. Because the Yellowstone River biota evolved in a setting of snowmelt-driven hydrology and a river corridor absent of anthropogenic lateral constraints, it is reasonable to assume that any alterations to fluvial geomorphic processes have affected the riverine ecosystem and its native fishes.

Reduced discharge in tributaries may alter cues for fish movement between tributaries and the main stem, reduce tributary habitat volume and quality, and reduce within-tributary movement. Reductions in tributary inflows will probably reduce fish movement between tributaries and the Yellowstone River, particularly in dammed tributaries such as the Bighorn and Tongue Rivers. Movements between rivers and tributaries often coincide with hydrological cues such as high water periods. Reduced discharge from tributaries probably alter spawning cues for resident fish in the tributary as well as for fish entering tributaries from the Yellowstone River for spawning. In much of eastern Montana, prairie stream tributaries are intermittently dry and connectivity is limited during dry periods. Reduced tributary discharge would further reduce intermittent tributary connectivity. Connectivity between mainstem rivers and tributaries supports higher fish species richness in both the main-stem river and the tributary (Schaefer and Kerfoot, 2004).

The Shields, Boulder, Clarks Fork Yellowstone, and Stillwater rivers as well as other smaller tributaries are used by trout for spawning (Scott Opitz, MFWP, personal communication). Introduced Rainbow Trout threaten native Yellowstone Cutthroat Trout by hybridization. Altered hydrology or warming of these and other tributaries may alter their suitability as spawning habitats and affect survival rates of early life history phases. Cutthroat and Rainbow Trout in the Yellowstone River basin use many of the same tributaries for spawning, but a study conducted in 2001-2003 indicated that hybridization risk is reduced because Rainbow Trout and hybrids spawned in April and May whereas Yellowstone Cutthroat Trout spawned in June and July (DeRito et al., 2010). However, earlier and lower runoff, and potentially warmer temperatures may reduce temporal separation of Rainbow and Yellowstone Cutthroat Trout and lead to higher rates of hybridization. Such a compression of spawning periods has been observed by fish biologists in recent years (Scott Opitz, MFWP, personal communication). A similar loss of temporal separation in spawning periods for Walleye (April-May) and Sauger (May-June) could occur and increase hybridization between these two species(Mike Ruggles, MFWP, personal communication).

2.2 Altered Geomorphology

The geomorphology of the Yellowstone River has been altered by flow alterations, dikes and levees, land use conversions, and bank armor (Appendix 4). The floodplain of the Yellowstone River has become more isolated over time (Appendix 4). Over 21,000 acres of 100-year floodplain area have been isolated due to physical encroachments, agricultural development, and hydrologic alterations. Upstream of the Bighorn River confluence, typically less than 20 percent of the historic 5-year floodplain has been isolated; downstream of the confluence over 40 percent of the historic 5-year floodplain is now inaccessible by a 5-year flood. Isolation of the 2-year floodplain has resulted in reduced seasonal high flow channel activation during that event. The extent of 2-year floodplain isolation has been most significant between the confluences of the Bighorn and Tongue Rivers, where the developed 2-year inundation footprint is about 40 percent smaller than that under undeveloped conditions.

Altered geomorphology contributes to floodplain isolation, and has associated ecological consequences. The connection of a river with its floodplain and with other lateral habitats such as side channels is an integral part of a riverine ecosystem (Junk et al., 1989). Floodplain isolation reduces terrestrial inputs to the river's food web, reduces the area, creation, and maintenance of lateral off-channel habitats, reduces availability of shallow, slow current velocity refuges during high flows, increases current velocities in main channels, and reduces overall aquatic habitat diversity. As discussed in Section 2.1.1, altered hydrology also isolates floodplains, however, the effects on the riverine ecosystem in general and on fish communities specifically are expected to be the same regardless of the cause of floodplain isolation.

The area of isolated floodplain increases longitudinally proceeding downstream on the Yellowstone River; this pattern is similar for the 100-year, the 5-year, and the 2-year floodplains. This is not surprising because the floodplain area generally increases going downstream, so there is more floodplain to become isolated. There is an increase in floodplain isolation below the Clarks Fork and a more substantial increase below the Bighorn River. The largest single cause of floodplain isolation is hydrologic alterations, which accounts for 40% of 100-year floodplain isolation.

The longitudinal increase in floodplain isolation corresponds to the importance of the floodplain to the Yellowstone River ecosystem. According to the river continuum concept and the flood pulse concept, the amount of riverine productivity attributable to the floodplain increases in the lower reaches of a larger river. In its lower reaches, the Yellowstone River has developed a larger floodplain (except in geologically confined reaches) where under pristine conditions, the floodplain contributed heavily to riverine productivity and habitat diversity. However, these are generally the same reaches where floodplain has become most isolated. Although it is difficult to quantify the effects of this floodplain isolation in terms of fish distribution and abundance, professional judgment indicates that the impact of lost floodplain has been substantial. Moreover, because fish species richness increases downstream, more fish species are affected by floodplain isolation in the lower reaches of the Yellowstone River.

2.2.1 Bank Stabilization

The alteration of large rivers by physical anthropogenic structures such as bank stabilization results in changes in riverine habitats such as main-channel bed degradation, channel width reduction, and increased stream gradient (Stern et al., 1980; Heede, 1986; Shields et al., 1995). Moreover, bank stabilization reduces floodplain connectivity and natural riverine processes such as lateral channel migration, the formation of backwaters, braids, and side channels (Leopold, 1964; Stern et al., 1980; Shields et al., 1995; Schmetterling et al., 2001; Auble et al., 2004; Florsheim et al., 2008), and recruitment of LWD.

Bank stabilization was associated with decreases in fish abundances in some rivers (Buer et al., 1984; Li et al., 1984; Swales et al., 1986; Knudsen and Dilley, 1987; Thurow, 1988; Beamer and Henderson, 1998; Peters et al., 1998; Oscoz et al., 2005) increases in others (Knudsen and Dilley, 1987; Binns, 1994; Binns and Remmick, 1994; Avery, 1995; White et al., 2010), or had no effect (Madejczyk et al., 1998; McClure, 1991). Similarly, fish species richness was decreased (Oscoz et al., 2005), increased (White et al., 2010), or unchanged (Madejczyk et al., 1998) in stabilized reaches. Changes in fish community structure (Eros et al., 2008; Madejczyk et al., 1998) or size-class distributions (Eros et al., 2008) have occurred in bank-stabilized reaches. Thus, bank stabilization has uncertain and possibly multifaceted consequences for fish communities.

The discrepancies in the findings of previous studies may result from differences in rivers. In artificially or naturally homogenous rivers, bank stabilization may provide habitat diversity that is otherwise lacking (Schmetterling et al., 2001; Zale and Rider, 2003), and cause localized increases in fish density and species richness. Conversely, in unaltered or relatively heterogeneous rivers, moderate amounts of bank stabilization may have little or no effect on the fish communities. Moreover, with the exception of studies by Zale and Rider (2003) and White et al. (2010), all studies of the effects of bank stabilization in large rivers have been conducted in regulated rivers (Michny, 1988; Garland et al., 2002; Eros et al., 2008; Schloesser et al., 2012) where the effects of bank stabilization may be confounded by or interact with the effects of dams.

Zale and Rider (2003) compared juvenile salmonid use of altered bank habitats to use of natural, unaltered bank habitats on the upper Yellowstone River. Juvenile salmonid use of barbs and jetties was similar to that of natural outside bends, and use of riprap sections was higher than that of natural outside bends. Juvenile salmonid recruitment from main-channel habitats was probably not negatively affected by bank stabilization. However, the amount of recruitment from main-channel habitats relative to recruitment from other areas such as side channels, backwaters, and tributaries is not known. Habitat modifications that directly or indirectly reduce the frequency or duration of side-channel inundation, or reduce side channel formation rates, would probably decrease juvenile salmonid habitat and possibly recruitment.

Bowen et al. (2003a) evaluated the relationships between the level of channel modification (bank stabilization structures, i.e., riprap, jetties, barbs, levees) and SSCV habitats on three reaches (4.2 to 6.3 km in length) of the Yellowstone River in Park County, Montana. This study demonstrated that SSCV area increases with increasing discharge and reaches a maximum during peak runoff. It appears that the juvenile salmonid's biological needs and the physical habitat conditions are synchronized because the highest abundance of YOY salmonids, which are small and weak swimmers compared to adults, coincides with high SSCV habitat availability in side channels and overbank areas, when main channel habitats have the highest prevalence of fast and deep water. However, bank stabilization and levees increase lateral river confinement, decrease side channel and overbank SSCV area, thereby reducing the overall amount of SSCV habitat availability.

SSCV availability was lowest in the Livingston reach (i.e., from just above Siebeck-9th Street Island to the Highway 89 Bridge (river km 806.3 to 800.0; Bowen et al., 2003a), which was also the reach that was the most anthropogenically modified. The Livingston reach is naturally confined on the east bank by a high valley wall and confined on the west bank by levees and riprap. As a result, the Livingston reach had the lowest overall SSCV area, because this reach generally had less SSCV attributable to side channels and overbank areas, particularly during bankfull flows. The Livingston reach also had the highest proportion of SSCV attributable to stabilized banks, which may be important habitats for juvenile salmonids (Zale and Rider, 2003). However, Zale and Rider (2003) also stress the importance of side channels as important juvenile salmonid habitat, and side channel area has probably been lost in the Livingston reach. Lateral confinement probably also reduces large woody debris recruitment and retention; large woody debris provides modest amounts (8 to 22 percent of total) of SSCV during high flows.

The inference of Bowen et al. (2003b) with regard to effects on fish is based on the assumption that SSCV is an important habitat component for juvenile salmonids, and in particular YOY salmonids during runoff. Substantial basis for this assumption exists in the literature; moreover the fisheries research project (Zale and Rider, 2003) that accompanied this work supports the assumption in this setting. As noted by the authors, “Effects of reduced juvenile abundances during runoff on adult numbers later in the year will depend on (1) the extent of channel modification, (2) patterns of fish displacement and movement, (3) longitudinal connectivity between reaches that contain refugia and those that do not, and (4) the relative importance of other limiting factors.”

Reinhold et al. (2014; Chapter 2) examined the relationships among the frequency of floodplain dikes and linear bank stabilization and areal changes in side channels from the 1950s to 2001 on the mainstem Yellowstone River from its confluence with the Clarks Fork Yellowstone River near Billings, Montana, downstream to its confluence with the Missouri River. The loss in side channels exceeded the gain in side channels from the 1950s to 2001. Sixty-seven side channels were lost, 39 side channels were gained, and 91 remained stable. Floodplain dikes that blocked side channels were correlated with the net loss of 3.0 km^2 of side-channel area, which represented a 10.4-percent net loss in side channel area from the 1950s to 2001 indicating that side channels have been lost on the Yellowstone River due to dikes that block scouring flows in side channels. However, linear bank-stabilization extent did not correlate with side-channel loss. This lack of correlation may be because linear bank stabilization effects on side channels are less direct than blocking side channels with dikes, because the extent of pre-1950 bank stabilization could not be estimated, or because existing linear stabilization in the Yellowstone River is not extensive enough to cause large-scale side-channel loss.

Reinhold et al. (2014; Chapter 4) examined the relationships of main-channel fish communities to bank stabilization and side channels in five segments of the Yellowstone River from near Billings, Montana, downstream to its confluence with the Missouri River. Fish community responses to side channels were more consistent and widespread than the responses of the fish community to bank stabilization; more fish species positively correlated with side channels than with bank stabilization. Both bank stabilization and side channels influenced some subsets of the fish community, and bank stabilization and side channels were often associated with shifts in the identity and abundance of the fish communities in different or opposite directions. This suggests that bank stabilization has caused the fish communities to change from the pre-stabilization condition, and that side channels influence the fish community to remain more similar to the pre-stabilization condition. Moreover, the strengths of the relationships among fish assemblages, bank stabilization, and side channels were spatially scale-dependent; optimum spatial scales ranged from less than 200 to 3,200 m up- and downstream, suggesting that bank stabilization and side channels influenced fish across multiple spatial scales. Stabilized alluvial pools were significantly deeper than their non-stabilized counterparts, probably because bank stabilization halted lateral channel migration but increased vertical scour. Conversely, depths were similar at stabilized and reference bluff sites probably because lateral channel migration and scour are in relative equilibrium at erosion-resistant bluff pools. Therefore, a potential mechanism whereby bank stabilization influences fish communities is by creating deeper pools at stabilized alluvial river bends.

Duncan et al. (2012) detected a few differences in fish catch rates between stabilized and non-stabilized pool types in the Yellowstone River. Catch rates for Sand Shiners in bluff, terrace, and alluvial pools were significantly higher than in some stabilized pool types. Catch rates for Flathead Chub in bluff and terrace pools were significantly higher than in stabilized alluvial pools. Stabilization may therefore reduce local Sand Shiners and Flathead Chub abundance.

Bramblett et al. (in preparation) examined preference of Blue Sucker, Burbot, Channel Catfish, Shovelnose Sturgeon, and Spiny Softshell for habitat types in the Yellowstone River based on geomorphic function (i.e., pool, crossover, secondary channel) and bank material (i.e., bedrock, terrace, alluvium, riprap). Pool types were bluff (the pool contacted bedrock valley margin) terrace (the pool contacted geologic terrace valley margin), alluvial (the pool did not contact bedrock or terrace valley margin), riprap bluff, riprap alluvial, crossover, and secondary channel. Blue Suckers, Channel Catfish, and Shovelnose Sturgeon, did not prefer or avoid stabilized (riprap) habitats in any season. During spring, runoff, and summer, Burbot preferred bluff and riprap alluvial pools, and during winter, Burbot preferred riprap alluvial pools. Burbot use of stabilized and bluff pools is probably because Burbot are often associated with large substrates (Edsall et al., 1993; Dixon and Vokoun, 2009; Eick, 2012) which accumulates in bluff pools and is also present along riprapped banks. Spiny Softshells avoided riprap alluvial pools in all seasons, perhaps because preferred secondary channels in all seasons except winter when they preferred bluff pools.

2.3 Altered Riparian Vegetation and Wetlands

Riparian vegetation communities and wetlands provide important ecological services that benefit the natural function of the river including dissipation of flood energy, trapping sediments, filtering nutrients and other pollutants, providing fish and wildlife habitat, and contributing to the biological productivity of the aquatic ecosystem (Appendix 7; Appendix 8). These functions include the connection of the aquatic and terrestrial communities as described by the River Continuum Concept (Vannote et al., 1980) and the Flood Pulse Concept (Junk et al. 1989). The extent and distribution of riparian vegetation and wetlands along the Yellowstone River are strongly influenced by natural channel morphology, particularly the degree of channel confinement and floodplain turnover (Appendix 7).

Overall, riparian areas have not changed much in cumulative extent, however individual reaches have lost or gained riparian vegetation area. A noteworthy trend is that below the Bighorn River, reduced hydrologic scour caused by hydrologic changes from Yellowtail Dam has allowed encroachment of woody vegetation onto formerly open gravel and sand bars (Appendix 7). Russian olive and Saltcedar have become established in riparian forests and replacement of cottonwoods may decrease recruitment of LWD, in part because beaver preferentially remove cottonwoods and (Appendix 7). Riparian vegetation and wetlands have become isolated as described above for floodplain isolation. Alterations in distribution, extent, composition, and turnover of riparian areas and wetlands likely affect fish communities by changing the natural flow of energy and biota between floodplains and main river channels. Riverine wetlands provide important fish habitat, particularly during high river discharge.

2.4 Altered Land Use

Land use has changed temporally along the Yellowstone River and is described in Appendix 1. Although most of the land use along the Yellowstone River remains in agriculture, increases in exurban and urban land uses have occurred, particularly in Park County and in the Billings area. The effects of this land-use change on water quality and fish habitat have not been quantified. However, increased nutrients, turbidity, and pollution associated with land-use changes may affect fish in the upper river, where clean, clear, and relatively low-nutrient waters represent the natural conditions to which the coldwater fish community are adapted. Increased impervious surfaces in urban areas increases quantity of stormwater runoff, and increases pollutant loads in nearby streams (Brabec et al., 2002) and likely occurs in tributaries of the Yellowstone River in and near Billings. This may affect the quality of habitat and water for fish. Conversion of riparian forest to agricultural land alters the natural erosion rates and lateral movement of the river channels because erosion rates are higher in cleared agricultural lands than in riparian river bottoms. Land conversion away from riparian forest also reduces LWD recruitment to the river; LWD is important fish and invertebrate habitat.

2.5 Altered Connectivity

Connectivity in riverine ecosystems occurs on four dimensions: longitudinal (upstream-downstream), lateral (river channel-floodplain), vertical (river channel-groundwater), and temporal (time, from behavioral response time to evolutionary time; Ward, 1989). Longitudinal connectivity is a central factor shaping riverine biological communities (Vannote et al., 1980; Cote et al., 2008). Connectivity between the main-stem river and its tributaries is also important (Duncan et al., 2012), because many fish species use tributaries during some part of their life history.

2.5.1 Longitudinal Connectivity

Longitudinal connectivity is a fundamental feature of rivers and fish evolved in mostly unfragmented rivers. The importance of longitudinal connectivity of a river is a central tenet in river ecology (Vannote et al. 1980; Fausch et al. 2002), and loss of connectivity has been implicated in the decline of riverine fishes worldwide. The main-stem Yellowstone River has been longitudinally fragmented by six diversion dams. The diversion dams typically span the entire width of the river, and range from 1 to 3.2 m in height (Helfrich et al. 1999). Side channels are present at Intake, Ranchers Ditch, Waco-Custer, and Huntley Diversion dams and these probably allow an unknown amount of fish passage when discharge is sufficient. A limited amount of upstream fish passage (10 species) has been documented at all six dams, although it is not usually know whether a fish passed over the dam or via the side channel (at those dams with side channels), or how many fish passed.

Although some fish species can pass each of the diversion dams under certain conditions, the extent thereof, and usually the discharge conditions under which fish movement is hindered or blocked are unknown. Passage at diversion dams may be a function of the size of the fish, however no longitudinal distributions of small fish species were unequivocally associated with diversion dams (Duncan et al. 2010). Documenting passage of large fish species and individuals is most common because these species are suitable for attachment of radio transmitters. Movements of smaller fish species are more difficult to monitor, and non-game fish species movements are rarely monitored; therefore, very little is known regarding the passage of the majority of the 56 fish species found in the Yellowstone River, including ecologically-important forage fishes and species of concern such as Sturgeon Chub and Sicklefin Chub. The cumulative effects of all six diversion dams on the longitudinal distribution and abundance of all Yellowstone River fish species is not known with certainty.

The available information indicates that Blue Suckers regularly passed upstream at Intake and Cartersville diversion dams, but the annual movements of Shovelnose Sturgeon are largely blocked by these diversions (Bramblett et al., in review). Facilitating passage at these diversions would probably benefit Shovelnose Sturgeon populations by making habitat available upstream of Cartersville Diversion. However, the effect of altered riverine processes resulting from damming of the Bighorn River on the suitability of reaches upstream of Cartersville Diversion is not known. Sauger passed diversion dams, however it was thought that smaller Sauger may be blocked at Intake Diversion because Sauger were more abundant, but smaller below Intake Diversion Dam (Jaeger et al. 2005). There is less information on passage at diversion dams upstream of Cartersville and on passage by Burbot, Channel Catfish, and Spiny Softshells because these species had shorter home ranges which resulted in fewer encounters with diversion dams (Bramblett et al. in review).

Pallid sturgeon are a federally endangered species that is presumably lacking successful recruitment in the Yellowstone River for decades, because the population of wild fish is all adults which number less than 150 individuals (Braaten et al. 2009). Pallid sturgeon are blocked by Intake Diversion Dam in most instances, which eliminates access to potential upstream spawning sites. This is thought to preclude their recruitment because it limits the length of river available upstream of Lake Sakakawea available to drifting Pallid Sturgeon larvae (Braaten et al. 2015). Pallid sturgeon drifting downstream to the headwaters of Lake Sakakawea may encounter an anoxic zone caused by microbial respiration such as was demonstrated for the headwaters of Fort Peck Reservoir in Montana (Guy et al. 2015). There are plans to attempt to provide for passage by Pallid Sturgeon at Intake Diversion Dam by constructing a rock ramp or a bypass channel (USBOR and USACE 2010; USBOR and USACE 2012).

Summaries of the information regarding fish passage at the six main-stem diversion dams are presented below. Information on fish passage at diversion dams comes from radio telemetry studies and recaptures of tagged fish (Haddix and Estes 1976; Graham et al. 1979; Peterman 1979; Stewart 1990; Stewart 1992; White and Bramblett 1993; Bramblett 1996; Bramblett and White 2001; Jaeger et al. 2008; Bramblett et al., in review).

Intake Diversion Dam was completed in 1911 and is located at river kilometer 115 near Glendive, Montana. A side channel is present on the right side (facing downstream) of the river, and upstream fish passage using the side channel is reported to be possible at flows above 22,954 cfs (White and Bramblett 1993) to 30,000 cfs (Bureau of Reclamation 2014). Fish species have been documented passing upstream of the dam under certain flow conditions, but it is not usually known whether the fish passed over the dam itself or passed via the side channel. Paddlefish pass during years of above-average flow (Stewart 1992), at flows above 44,990 cfs (Peterman 1979), and Shovelnose Sturgeon (White and Bramblett 1993; Bramblett 1996), Walleye (Graham et al. 1979), and Sauger (Graham et al. 1979; Jaeger et al. 2005) have been observed passing Intake. However, Intake Diversion Dam probably restricts juvenile Sauger movement, because catch rates and juvenile abundance were higher below the dam than above (Jaeger et al. 2005).

Bramblett et al. (in review) analyzed radio telemetry data from 2005-2009 for Blue Sucker, Burbot, Channel Catfish, Shovelnose Sturgeon, and Spiny Softshells to determine whether animals were able to pass Intake Diversion Dam and if so, if they passed via the side-channel or main channel routes. There were 69 documented events of upstream passage by radio-tagged Blue Suckers (92% of encounters; 90% of these events were using the main channel route), 2 passage events by Burbot (22% of encounters; 100% of these events were using the main channel route), 3 passage events by Channel Catfish (75% of encounters; 67% of these events were using the main channel route), 3 passage events by Shovelnose Sturgeon (16% of encounters; 100% of these events were using the main channel route), and 2 passage events by Spiny Softshells (100% of encounters; 100% of these events were using the side channel route).

Helfrich et al. (1999) evaluated passage at Intake Diversion Dam and documented low numbers of marked fish (Goldeye, Sauger, Walleye, Smallmouth Buffalo) passing upstream of the dam and no consistent size differences in fish below and above dam. However, Shovelnose sturgeon were more abundant below dam, and more species were captured below dam.

No radio-tagged Pallid Sturgeon passed upstream of the dam during 1992-1994 (Bramblett and White 2001), however five adult radio-tagged Pallid Sturgeon (four males and one gravid female) passed the dam by using the side channel between 27 May and 4 June, 2014. Discharge during the passage period ranged from 46,900 to 63,800 cfs. The female Pallid Sturgeon is thought to have subsequently spawned in the Powder River (Mike Backes, MFWP, unpublished data).

Cartersville Diversion Dam was completed in 1934 and is located at river kilometer 379 at Forsyth, Montana. No side channel bypasses the diversion dam. It has long been thought to be a barrier to Shovelnose Sturgeon because they were present below, but not above Cartersville (Haddix and Estes 1976; Stewart 1990). Although Helfrich et al. (1999) captured three Shovelnose Sturgeon above the dam in 1997, Cartersville Diversion appears to be a complete barrier to the upstream distribution of Shovelnose Sturgeon because they were historically present upstream to, and in the Bighorn River (Simon 1951). As such, Cartersville Diversion Dam has a major impact on Shovelnose Sturgeon distribution, although altered ecological conditions caused by Yellowtail Dam also may reduce the suitability of the Yellowstone River below the Bighorn River. Sauger have been documented passing Cartersville Diversion Dam (Graham et al. 1979; Jaeger et al. 2005).

During 2005-2009, there were 17 documented events of passage by radio-tagged Blue Sucker (94% of encounters), 6 by Burbot (43% of encounters), 1 by Channel Catfish (25% of encounters), 0 by Shovelnose Sturgeon (100% of 15 encounters), and 1 by a Spiny Softshell (20% of encounters) during 2005-2009 (Bramblett et al., in review). Recapture of a floy-tagged Sauger and a floy-tagged Channel Catfish indicated that they had passed Cartersville Diversion Dam (Mike Ruggles, MFWP, personal communication). Helfrich et al. (1999) found no consistent size differences in fish of multiple species below and above the dam.

Yellowstone Diversion Dam (also known as Meyers Diversion Dam) was completed in 1909 and is located at river kilometer 447 near Hysham, Montana. No side channel bypasses the diversion dam. Telemetered Sauger were documented passing upstream of this diversion dam (Jaeger et al. 2005) and there were two documented events of passage by Channel Catfish (67% of encounters) during 2005-2009 (Bramblett et al., in review). Recapture of a floy-tagged Sauger and a floy-tagged Channel Catfish indicated that they had passed Yellowstone Diversion Dam (Mike Ruggles, MFWP, personal communication).

Rancher's Ditch Diversion Dam was completed in 1904 and is located at river kilometer 470, which is about 4 river kilometers below the confluence of the Bighorn River. A side channel bypasses the diversion dam, but the side channel also has a diversion dam. Telemetered Sauger were documented passing upstream of this diversion dam (Jaeger et al. 2005) and passage by one Channel Catfish was documented (100% of encounters) during 2005-2009 (Bramblett et al., in review). Recapture of a floy-tagged Sauger and a floy-tagged Channel Catfish indicated that they had passed Ranchers Ditch Diversion Dam (Mike Ruggles, MFWP, personal communication). However, Ranchers Ditch Diversion Dam has been modified to increase elevation subsequent to these documented passage events, therefore it is not known if any fish passage occurs currently (Mike Backes, MFWP, personal communication).

Waco (also known as Custer) Diversion Dam was completed in 1907 and is located at river kilometer 509. A side channel bypasses the diversion dam. Telemetered Sauger were documented passing upstream of this diversion dam (Jaeger et al. 2005), and one Burbot (33% of encounters) and one Channel Catfish (100% of encounters) passed it during 2005-2009 (Bramblett et al., in review). Recapture of a floy-tagged Sauger and a floy-tagged Channel Catfish indicated that they had passed Waco Diversion Dam (Mike Ruggles, personal communication).

Huntley Diversion Dam was completed in 1934 and is located at river kilometer 566 at Huntley, Montana. A side channel and a small artificial channel bypass the diversion dam which was recently modified to attempt to improve fish passage (Mike Ruggles, MFWP, personal communication). No Sauger have been documented passing the dam, but this dam was probably not encountered by telemetered Sauger (Jaeger et al. 2005). There was one impedance event documented for Burbot (100% of encounters) at Huntley Diversion Dam (Bramblett et al., in review). Low numbers of marked fish (White Sucker, Common Carp, Goldeye, Brown Trout, Shorthead Redhorse, Longnose Sucker, and Flathead Chub) were documented to have passed the dam, and no consistent size differences existed in fish below and above dam (Helfrich et al. 1999). Sauger historically used the lower Clarks Fork of the Yellowstone but very few Sauger are found above Huntley Diversion at present (Mike Ruggles, MFWP, personal communication).

2.5.2 Tributary Connectivity

Connectivity between mainstem rivers and tributaries is important because many fish species use both habitats at some point in their life histories. Connectivity between main-stem rivers and tributaries also supports higher fish species richness in both the main-stem river and the tributary (Schaefer and Kerfoot, 2004), and headwater streams that are distant from main-stem rivers typically have fewer fish species than similarly-sized adventitious streams that are directly connected to main-stem rivers (Osborne and Wiley, 1992; Schaefer and Kerfoot, 2004; Hitt and Angermeier, 2008; Mullen et al., 2011).

Connectivity between the lower Yellowstone River and its tributaries is crucial for Western Silvery Minnows, Flathead Chubs, and Sand Shiners (Duncan et al., 2010). Nearly three-quarters of Western Silvery Minnows, Flathead Chubs, and half of Sand Shiners used both main-stem and tributary habitats during their lifetimes (Duncan et al., 2010). These three species were three of the four most abundant small fish species in the Yellowstone River below the Tongue River (only Emerald Shiner were more abundant in this reach of the Yellowstone River). As such, they are almost certainly important food items for game fish species such as Sauger and Channel Catfish, for the endangered Pallid Sturgeon, as well as for other predators such as fish-eating birds. Forage fish such as these three minnow species make up much of the primary and secondary consumer biomass in the Yellowstone River's food web and therefore are critical components of energy flow in a functioning ecosystem. All three species are roughly equally abundant, but Flathead Chub and Western Silvery Minnow have a larger body size than Sand Shiners, so they probably provide more energy to higher trophic levels. The magnitude of dispersal between the main-stem and tributaries increased with tributary basin area (Duncan et al. 2012). Therefore, the larger the tributary, the more energy flow between the tributary and main-stem. Western Silvery Minnows and Flathead Chubs have experienced range reductions and population declines elsewhere (Pflieger and Grace, 1987; Hesse et al., 1989; Harland and Berry, 2004; Haslouer et al., 2005) therefore maintaining tributary connectivity in the Yellowstone is important to preserve these species in this area.

Of the three minnow species studied by Duncan et al. (2012), Flathead Chubs are probably most important as forage for the endangered pallid sturgeon because they are the most benthically oriented of the three species and Pallid Sturgeon are benthic predators. In the Missouri River above Fort Peck Reservoir, juvenile (age-6 and age-7) Pallid Sturgeon primarily consumed fish (90 percent by wet weight), and Sturgeon Chub and Sicklefin Chub made up 79 percent of the number of identifiable fish in juvenile Pallid Sturgeon stomachs (Gerrity et al., 2006). In the Yellowstone River, Sturgeon Chub range upstream as far as the Tongue River, and Sicklefin Chub are found primarily below Intake (Duncan et al., 2012). Therefore, Pallid Sturgeon diet probably varies longitudinally on the Yellowstone RiverReestablishing connectivity on tributary streams can result in changes to tributary fish communities (Shilz 2012; Mike Backes, Montana Fish, Wildlife & Parks, unpublished data). In 2011, a canal crossing at the mouth of Pryor Creek that blocked fish movements from the Yellowstone River was replaced with a siphon that allowed for fish passage into Pryor Creek. Fish abundance increased 45%, Flathead Chub abundance increased 58%, and Index of Biotic Integrity (Bramblett et al. 2005) scores increased 34% the reach above the former barrier the year after barrier removal (Schilz 2014). On the Tongue River, the Muggli bypass was installed in 2008 to allow fish to bypass the T&Y Diversion Dam, which was thought to have blocked passage of all fish attempting to ascend the Tongue River. Since 2008 the Muggli bypass has allowed passage of 28 fish species, including five species (Goldeye, Freshwater Drum, Sturgeon Chub, Bigmouth Buffalo and Smallmouth Buffalo) that were not documented upstream of T&Y Dam prior to bypass construction. The Muggli bypass allows multiple Yellowstone River fish species to ascend an additional 169 miles of the Tongue River that prior to 2008 were restricted to 20 river miles (Mike Backes, Montana Fish, Wildlife & Parks, unpublished data). Fish passage projects have also been completed and have showed successful fish passage at the S & H Diversion on the Tongue River and on the Clear Creek, a Powder River tributary in Wyoming.

Mainstem-tributary connectivity is important for spawning Yellowstone Cutthroat Trout. Dewatering of spawning tributaries caused by irrigation withdrawals appeared to limit the recruitment of Yellowstone Cutthroat Trout in the Yellowstone River (Clancy 1988). Tributaries are heavily used by Yellowstone Cutthroat Trout for spawning; most (75 percent) radio-tagged Yellowstone Cutthroat Trout spawned in tributaries, followed by side channels (23 percent), and the main channel (2 percent; DeRito et al., 2010).

2.6 Altered Water Quality

The water chemistry of the Yellowstone River varies longitudinally (Appendix 5). Most water quality parameters such as hydrogen ion concentration (pH), total dissolved solids, conductivity, nutrients, water temperature, sediment, and turbidity increase in a downstream direction, only dissolve oxygen decreases downstream (Appendix 5). For the most part, these longitudinal gradients are natural and native fish species have evolved adaptations to exist in the water quality setting of their preferred longitudinal location.

Anthropogenic changes to the water quality of the Yellowstone River are generally moderate, and beneficial uses are fully or partially supported, including supporting fish populations (Appendix 5). Some water quality parameters have decreased due to improved treatment of industrial and municipal waste discharges (Appendix 5). Because limited water temperature data exist, changes in water temperatures cannot be determined statistically although a slight increase in recent years is noted (Appendix 5).

Sediment and associated turbidity, which are natural and important components in the warmwater fish zone have declined due to dams and impoundments on the Bighorn and Tongue rivers, which capture sediment and virtually halt sediment delivery below the dams. Annual sediment delivery at the mouth of the Bighorn River has declined from an estimated at 7.2 to 1.5 million tons per year, which represents an 80% decline (Silverman and Tomlinson, 1984). These two dams have also reduced the ecological suitability of the Bighorn and Tongue rivers as well as the Yellowstone River below the confluence of the two tributaries for turbid water fishes. Fish species adapted to high turbidity, including Shovelnose Sturgeon, Flathead Chub, Goldeye, Plains Minnow, Western Silvery Minnow, and Sturgeon Chub have been disappearing from Wyoming rivers that are heavily modified by reservoir construction. Goldeye, Plains Minnow, Western Silvery Minnow, and Sturgeon Chub formerly occupied the Bighorn River, but are now apparently extirpated there, presumably due to dam-related altered ecological conditions (Quist et al., 2004; Wyoming State Wildlife Action Plan, 2010). Moreover, Sturgeon Chub populations in the Yellowstone River almost certainly, formerly extended upstream to the mouth of and into the Bighorn River, however no Sturgeon Chub were captured above the Tongue River during extensive sampling (Duncan et al., 2012; Reinhold et al., 2014). Sauger have also declined in the Yellowstone River in the vicinity of and below the confluence of the Bighorn River, probably due to reduced temperatures, reduced sediment yield and associated turbidity, dampened spring peak flows that cued upstream migration, diversion dams, and habitat changes (McMahon and Gardner, 2001). Although the confluence of the Bighorn River remains as the approximate boundary between the transition fish zone and the warmwater fish zone (White and Bramblett, 1993), this demarcation is probably less definite now because the suitability of reaches below the Bighorn River for turbid water fish species has declined since installation of Yellowtail Dam. The Clarks Fork lacks large dams but no longer has runs of Sauger and there is also a suspected decline in Burbot. Water quality, quantity, and diversions are thought to be responsible (Mike Ruggles, MFWP, pers comm).

Anthropogenic increases in nutrients can cause eutrophication and increase algal biomass or change the composition of algal communities. In the Yellowstone River, algal biomass and algal eutrophic indicator species were highest in the middle reaches of the river from Billings to Forsyth and was associated with inflows from the Clarks Fork and Bighorn Rivers (Appendix 5). Tolerant invertebrate taxa were more abundant in the middle reaches of the river (indicating slight impairment), and particularly below the confluences of the Clarks Fork and Bighorn Rivers (Appendix 5). Although the effects of these observed algal and invertebrate community metrics on the Yellowstone River fish community are not known, excessive changes in algal and invertebrate communities could affect fish food (invertebrate) production and ultimately fish populations.

Mercury has been detected in fish tissues and MFWP has issued mercury-related fish consumption advisories for multiple species in Tongue River Reservoir, Bighorn Lake, and Cooney Reservoir, and for Channel Catfish in the Yellowstone River near the Powder River (Appendix 5). Pesticides were detected in 54 percent of water samples at Billings and 95% of samples at Sidney although these samples were in the lowest 25 percent of concentrations measured across the United States (Appendix 5). There have been no studies to determine if these contaminants have had lethal or sub lethal effects on Yellowstone River fish.

A total of 39 pipelines transporting raw crude oil, petroleum products, liquefied natural gas, and natural gas intersect the Yellowstone River between Gardiner and the confluence with the Missouri River (Appendix 5). On 1 July, 2011, the ExxonMobil Silvertip pipeline ruptured and a reported sixty-three thousand gallons of crude oil were spilled into the Yellowstone River near Laurel, Montana at near peak discharge. The 2014 Montana 303(d) lists CEA reaches A18 to B4 (downstream from the pipeline) as not supporting aquatic life and contact recreation uses due to the spill. A report on the effects of the spill on the fish community is not yet publicly available due to an ongoing lawsuit between the State of Montana and ExxonMobil.

On 17 January, 2015, the Poplar Pipeline carrying Bakken crude oil across the Yellowstone River near Glendive, Montana was breached and an estimated 12,000 to 50,000 gallons was released. Water samples from the Glendive water supply were found to contain benzene, and residents were put on alert to not use the water for culinary purposes. Oil sheen was been observed on the river almost to Sidney. Although effects of this spill on the fish community are not known, this lower reach of the river provides habitat for the endangered pallid sturgeon, and the following species of concern: Paddlefish, Shortnose Gar, Sturgeon Chub, Sicklefin Chub, Blue Sucker, Burbot, Sauger, Spiny Softshell Turtle, and Snapping Turtle. Montana Fish, Wildlife, and Parks has issued a fish consumption advisory for the Yellowstone River from the spill site downstream to the North Dakota border.

2.7 Fish Entrainment in Water Withdrawal Structures

A physical inventory of pumps, irrigation canals and diversion structures on the Yellowstone River and 7 major tributaries indicated that 340 structures were on the Yellowstone River and only 16 percent of the total of 687 irrigation withdrawal structures were screened. However, most screening of pumps and headgates is to prevent clogging with debris, and the efficacy of screens at preventing entrainment of fish at most withdrawal sites is not known. Therefore, fish entrainment is probably a considerable source of mortality for Yellowstone River fishes. For example, prior to screening, fish entrainment at the Intake Diversion Canal included 25 native fish species and involved an estimated 382,609 to 809,820 individual fish during an annual irrigation season (Hiebert et al., 2000). Moreover, elimination of entrainment at all diversion dams would reduce adult Sauger mortality by an estimated 24 to 30 percent, and reduce juvenile Sauger mortality even more because juveniles experience higher entrainment rates than adults (Jaeger et al., 2005).

The T&Y Canal diverts irrigation water from the Tongue River 20 miles upstream of the Yellowstone River. The Intake headworks structure was screened to reduce fish entrainment into the canal in 1998-1999. In 1997, prior to screening an estimated 37,000 individual fish representing 22 species were entrained into the T&Y Canal during the irrigation season (Bollman, 2013). Screening was moderately successful, as monitoring in 2004, 2005, and 2013 indicated that about 8,000 to 30,000 fish were returned to the Tongue River via the screened bypass during the years monitored. However, and estimated 22,000-27,000 individual fish were still entrained into the T&Y Canal annually (Bollman, 2013).

2.8 Introduced Species

Although introduced species are present, overall the Yellowstone River remains a stronghold of native fish diversity. There are 59 fish species total, of which 22 species (37 percent) are nonnative. However, in terms of abundance, most nonnative fish are rare. The abundances of native species is high and the proportion of nonnative species is low relative to other large rivers such as the Missouri River (Duncan et al., 2013; Reinhold et al., 2014; R. Wilson, USFWS, unpublished data; T. Haddix, MFWP, unpublished data), indicating that the lower Yellowstone River maintains productive and diverse native fish communities. Exceptions are in the coldwater or salmonid zone of the river (White and Bramblett, 1992), where Rainbow Trout and Brown Trout are more numerous than the native Yellowstone Cutthroat Trout. Rainbow Trout and Brown Trout compose larger percentages of the trout population proceeding downstream in the coldwater zone and compose about 71 percent of the trout population at Corwin Springs, Montana, 89 percent at Mill Creek, and 88 to 100 percent of the trout population at Springdale, Montana. Moreover, Yellowstone Cutthroat Trout are apparently declining in abundance in the Springdale section of the Yellowstone River where they have declined from about 6 to 12 percent of the electrofishing catch in 2003 and 2004 to <1 percent in 2005, 2008, and 2009 (Scott Opitz, MFWP, unpublished data).

Rainbow Trout hybridize with native Yellowstone Cutthroat Trout, but hybridization is reduced because Rainbow Trout and Rainbow x Yellowstone Cutthroat Trout hybrids spawn earlier than Yellowstone Cutthroat Trout (DeRito et al., 2010). Brown trout are predaceous, and consume native fishes, but the effect of the presence of Brown Trout on the native fish populations has not been quantified. Lake Trout were illegally introduced into Yellowstone Lake in Yellowstone National Park in the 1980s (Munro et al., 2005) where they preyed on Yellowstone Cutthroat Trout, causing severe declines in their abundance in the lake and in spawning tributaries. Suppression efforts using primarily gill nets have removed nearly 450,000 Lake Trout from Yellowstone Lake from 1995 through 2009 (Syslo et al., 2011).

In the lower Yellowstone River basin, stocking of introduced game fish species into or below reservoirs such as the Tongue River Reservoir, Bighorn Lake, and Lake Sakakawea, has provided a source of introduced species to the Yellowstone River. Smallmouth Bass are rare to abundant in the lower two fish zones (White and Bramblett, 1992). Smallmouth Bass are potentially competing with Sauger, because their diet overlaps almost completely as indicated by stable isotopic tissue analysis (Rhoten, 2011). Walleye isotopic signatures did not overlap those of Sauger (Rhoten, 2011), however both Sauger and Walleye are upper trophic level piscivores, so competition for food is possible. Walleye can hybridize with native Sauger but hybridization does not appear to be an immediate threat because hybridization rates in spawning aggregations in the Yellowstone River were less than 3 percent (Bingham et al., 2011). Other nonnative fish species with potential to influence native fish communities include Common Carp, Northern Pike, Yellow Bullhead, White Bass, Rock Bass, Bluegill, Pumpkinseed, and Green Sunfish. These nonnative fishes prey on and may compete with native fishes, but their effect on the ecosystem has not been quantified. Because the introduced species did not evolve in mountain snowmelt hydrological settings, anthropogenic changes to the natural Yellowstone River hydrograph may favor these introduced species.

American Bullfrogs *Lithobates catesbeianus* have been introduced into the floodplain of the Yellowstone River (Sepulveda et al., 2014). Bullfrogs were first reported from a pond near Billings in 1999, and as of 2013 are rapidly spreading and are known to occupy about 66 miles of Yellowstone River floodplain (Sepulveda et al. 2014). Bullfrogs are generalist predators, and have been implicated in declines of native amphibians and reptiles worldwide (Ficetola et al., 2007). Native amphibians that may be affected include Northern Leopard Frog *Lithobates pipiens*, Woodhouse's Toad *Anaxyrus woodhousii*, and Great Plains Toad *A. cognatus* (Sepulveda et al., 2014). Introduced red-ear slider turtles (Trachemys scripta elegans) have also been reported in the Yellowstone River (Mike Ruggles, MFWP, pers comm)

2.9 Recreational Fishing

Recreational fishing in the Yellowstone River is a major source of recreation and income for Montana, Wyoming, and Yellowstone National Park. The upper river is a world-famous trout fishery with anglers targeting Rainbow, Brown and Yellowstone Cutthroat Trout as well as Mountain Whitefish. In Montana, Yellowstone River fishing pressure is highest in the reaches below Yellowstone National Park downstream to the confluence of the Boulder River, where an estimated 80,751 angler days occurred from March 2011 to February 2012 (MFWP, 2011). Fishing pressure was moderate during this period in the reach from the Boulder River downstream to the mouth of the Bighorn River and was estimated at 47,678 angler days. As the fish community changes from upstream to downstream, so do the fish species targeted by anglers. Near Billings, and proceeding downstream to the mouth of the Bighorn River, angler fish for coolwater and warmwater species such as Burbot, Channel Catfish, Smallmouth Bass, Sauger, and Walleye.

Fishing pressure in the lower Yellowstone River from the Bighorn River confluence downstream to the state line was estimated at 35,469 angler days in the 2011 Statewide Angler Pressure Estimates (Caleb Bollman, MFWP, personal communication). The reach of the Yellowstone River in Prairie, Dawson, and Richland counties had most angler days in FWP Region 7, and angling on the Treasure, Rosebud, and Custer counties reach of the Yellowstone River was third-highest. Angling from the Bighorn River confluence to Miles City is generally focused toward Sauger, Walleye, Smallmouth Bass, and Channel Catfish. Smallmouth Bass and Channel Catfish are the most abundant sport fish sampled in this reach in annual FWP electrofishing surveys. The influence of Yellowtail Dam reducing turbidity from suspended sediments has made this reach more suitable for smallmouth bass than the Lower Yellowstone below the Powder River confluence. The same geology that confines the Yellowstone Rivers geomorphology through part of Custer County and Prairie County makes this reach popular with channel catfish anglers targeting these fish in and around large boulders and bedrock features. Annual FWP surveys and tag returns demonstrate the availability of Sauger in this reach as well. Jaeger et al. (2005) estimated annual angling mortality of Sauger was relatively low at 18.6 percent. Past data collection suggests the reach below the Powder River Confluence downstream to Fallon is one of the more consistent locations used by Sauger during spawning. While there is some angling for Shovelnose Sturgeon upstream as far as Carterville Diversion Dam, angling for this species is more common and abundances are greater downstream of the Powder River confluence. Sauger, Walleye, and Channel Catfish continue to be abundant and popular sport fish in Dawson and Richland counties with the additional opportunity of a recreational snag fishery for Paddlefish during spring spawning runs, with most of the angling and harvest downstream of Intake Diversion Dam. Fishing contests on the Lower Yellowstone River are increasing in popularity with two newly proposed contests for 2015, a Walleye and Smallmouth Bass tournament at Miles City, and a Walleye, Sauger, and Northern Pike tournament at Savage. These are in addition to two long-standing catfish tournaments based out of Sidney (Caleb Bollman, MFWP, personal communication).

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 9
Avian

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1.0 INTRODUCTION

Land use along the Yellowstone River impacts avian communities indirectly by altering the condition of riparian habitat. Therefore, Cumulative Effects Assessment (CEA) of land use on riparian birds requires consideration of how land use changes riparian habitat condition. CEA will focus on describing the distribution of habitat along the river, as well as the status of habitat condition and change through time that may influence avian communities.

The following Appendix summarizes the data and analyses used in support of the Avian component of the Yellowstone River CEA. Important aspects of riparian habitat that are most relevant to Yellowstone River bird communities are discussed in the document 'Avian-Habitat Relationships: A Literature Review and Assessment' (Jones 2014); refer to that document for a thorough background discussion. The main changes to riparian habitat condition caused by land use along the Yellowstone River identified in that report include:

1. Decline in the extent of cottonwood forest habitat
2. Loss of structurally complex habitat types
3. Expansion of a detrimental species, the Brown-headed Cowbird
4. Alteration of riparian grasslands
5. Loss of landscape-level habitat heterogeneity
6. Spread of invasive plant species
7. Alteration of in-channel nesting and foraging habitat for Least Tern

Two types of analyses are presented in this Appendix. First, results are presented (when possible) from analyses that use local-scale avian and vegetation data collected along the Yellowstone River to validate relationships between avian responses and habitat condition that were identified in Jones (2014). These analyses will provide greater confidence in the relevance of the indicators used for inferring the impacts of land use and habitat change on avian communities. Second, results from analyses conducted at various spatial scales encompassing the larger river system are presented to quantify metrics of riparian habitat condition and document how these resources have changed over time. Metrics for quantifying aspects of the avian community that are expected to change in response to these changes in habitat condition (hereafter referred to as 'Avian Responses') are identified in Jones (2014), as well as metrics for quantifying habitat condition (see Table 8 in Jones 2014). The analyses presented in this Appendix focus on using available data to quantify these metrics for consideration of CEA.

The first three changes to habitat condition listed above are the focus of analyses presented in this Appendix because of the availability of data to quantify relationships between avian communities and habitat condition for the Yellowstone River. The last four changes to habitat condition are also a focus for CEA, but original analyses quantifying metrics representing these changes are not presented herein; instead, analyses conducted by other investigators will be referenced and summarized when relevant. Furthermore, analyses quantifying land use drivers of change in riparian habitat condition and potential human influences have been presented by other investigators, particularly in Appendix 7: Terrestrial Plants (Riparian), the Riparian Habitat Mapping effort (DTM and AGI 2008), and the Land Use Mapping effort (DTM 2013). These analyses will be referenced and summarized in this Appendix when relevant.

1.1 Primary Data Sources and Supporting Documentation

The following primary data sources and supporting documentation were used for analyses and discussions; all are available for public review and evaluation.

1. **Factors Influencing Riparian Breeding Bird Communities along the Middle and Lower Yellowstone River (Jones and Hansen 2009).** This report describes results from the 2006-2007 Montana State University/Yellowstone River Conservation District Council field study of Yellowstone River riparian bird communities. Results include a description of bird communities observed at more than 300 riparian study sites downstream from Springdale, Montana. Data used for analyses in this Appendix document the occurrence of 64 riparian bird species at 250 cottonwood forest study sites within braided and anabranching reach types, as well as a description of the habitat characteristics of each study site. Each sampling site was visited 6 times over 2 years, and results from all visits were averaged to get one value for each site. In the following sections of this Appendix, this will be referred to as the 'LYR study'.

2. **Montana Audubon Yellowstone River Field Study.** These data were collected in 2012 in support of an evaluation of the Yellowstone River for the Audubon Important Bird Areas Program. Data used for analyses in this Appendix document the occurrence of 56 riparian species at 330 study sites in Region B, C, and D. Each site was visited once during the summer of 2012. In the following sections of this Appendix, this will be referred to as the 'MA study'.

3. **Riparian Habitat Dynamics and Wildlife along the Upper Yellowstone River (Hansen et al. 2003).** This report describes results from the 2001-2002 Montana State University/Upper Yellowstone River Task Force field study documenting riparian bird communities of the upper reaches of the Yellowstone River. Results include a description of bird communities and riparian habitats observed at 130 study sites located between Gardiner and Springdale, Montana (i.e. Region PC). Data used for analyses in this Appendix document the occurrence of 53 riparian bird species at 50 cottonwood forest study sites in Region PC. Each sampling site was visited 6 times over 2 years, and results from all visits were averaged to get one value for each site. In the following sections of this Appendix, this will be referred to as the 'UYR study'.

4. **Avian-Habitat Relationships: A Literature Review and Assessment (Jones 2014).** This report describes results from a literature review examining important relationships between riparian bird communities and habitat condition. Six impacts of land use are identified as relevant to the Yellowstone River riparian landscape and bird communities. Three of these impacts are identified as most important for CEA, including a decline in the extent of riparian forest, the loss of structurally complex habitat types, and the expansion of the Brown-headed Cowbird, an invasive species. Metrics for quantifying aspects of avian communities and habitat condition in the context of these impacts are identified for inclusion in future CEA.

5. **Yellowstone River Riparian Vegetation Mapping (DTM and AGI 2008, updated 2012).** This report describes the extent of riparian vegetation along the Yellowstone River downstream from Springdale, Montana, and quantifies change in characteristics of vegetation over three time periods (1950, 1976, and 2001). Characteristics of vegetation are evaluated at various temporal and spatial scales, and data are provided that quantifies reach-scale metrics of riparian habitat.

6. **Yellowstone River Land Use Mapping and Analysis (DTM 2013).** This report describes results of land use mapping of the Yellowstone River corridor using aerial photography from 1950, 1976, 2001, and 2011. GIS data layers representing agricultural, urban, exurban, and transportation

landuses were created and used to describe attributes of the corridor and quantify change over time.

7. **Montana Interior Least Tern Management Plan (Atkinson and Dood 2006).** This document describes the distribution, habitat requirements, and status of Least Tern populations along the Missouri and Yellowstone River systems in Montana.

8. **Montana Field Guide (Montana Natural Heritage Program (MTNHP) and Montana Fish Wildlife and Parks (MTFWP) 2013).** This website provides information on life history, distribution, and management status of bird species in Montana.

2.0 SPATIAL DISTRIBUTION OF GENERAL AVIAN RESPONSES

More than 80 avian species were observed in riparian habitats; sixty-seven species were detected downstream from Springdale, Montana during the LYR and MA studies, and 15 additional species were detected during the UYR study. Common names will be used when referring to species in the text; see Table 2-1 for a complete list with scientific names. Cottonwood forest was the focus of most of the avian sampling efforts along the river because it is the most extensive habitat in the riparian zone, and avian abundance and diversity are highest in cottonwood forest compared with other riparian habitat types. Consequently, methods and results discussed herein emphasize this habitat type. However, limited discussion of other habitat types (e.g. riparian grasslands, aquatic habitats) will be included when relevant.

Three general avian responses represent aspects of riparian bird communities that are most strongly impacted by changes to habitat resources, and these are the focus of analyses and discussions. These include:

Bird Species Richness. Richness is the number of different species observed at a site at a given time. Richness is a good indicator of habitat condition because it often reflects the availability of resources in a given habitat; if a broad diversity of nesting and food resources exists at a site, more species would be expected to be there to use those diverse resources.

Richness of Conservation Species. The richness of conservation species quantifies the number of species observed for a subset of species that are experiencing population declines. Analyses that include this avian response may provide insight about the relevance of a change in habitat condition for species that are particularly vulnerable to change. Twenty-six riparian bird species are identified as conservation species along the Yellowstone River (Jones 2014).

Occurrence of Individual Species of Special Concern. The distribution of individual species of special concern in Montana (based on designation by the Montana Natural Heritage Program and Montana Fish Wildlife and Parks (MTNHP and MTFWP 2013)) are a focus of discussions because these species may be especially relevant for future management considerations. Five of the species observed along the Yellowstone River are designated Potential Species of Concern (PSOC) and are potentially vulnerable in Montana, including Black-and-white Warbler, Ovenbird, Plumbeous Vireo, Dickcissel, and Chimney Swift. Five more riparian species are designated Species of Concern (SOC) in Montana and are particularly vulnerable because of population declines or threats to habitat. These species include:

- Black-billed Cuckoo: Most often found in riparian cottonwoods, green ash, and American elm forests with a dense, shrubby understory. The western population of the closely related and ecologically similar Yellow-billed Cuckoo was recently (October 2014) designated a Threatened Species under the Endangered Species Act. The Yellow-billed Cuckoo is a Montana SOC and has been documented in the Yellowstone River Watershed (MTNHP and FWP, 2013). However, few observations of this species exist in Montana and there is no evidence of breeding behavior, so Yellow-billed Cuckoo's will not be considered for CEA.

- Bobolink: Breeds throughout Montana in tall grass and mixed grass prairies and hayfields.

- Red-headed Woodpecker: Cavity-nesting species that breeds throughout the eastern half of Montana in riparian forest along major rivers, or in open savannah with adequate canopy cover and snag density.

- Veery: Inhabits damp, deciduous forests with a dense understory; has a strong preference for riparian habitats in the West.

- Least Tern: Federally Endangered species that breeds on unvegetated sand and gravel bars of large rivers and reservoirs, particularly along the Missouri and Yellowstone Rivers in Montana.

Avian responses are derived using data from the LYR study, the UYR study, and the MA study. Sampling methods from the UYR and LYR studies were identical and the study areas do not overlap; consequently, results using data from these two studies are often combined on the same graphs. The spatial distribution of avian responses is described (when possible) in Section 4.10.2.1 of the CEA report in order to provide an understanding of general characteristics of Yellowstone River riparian bird communities, and will also be referenced in discussions about the status of riparian habitat and change in condition along the river in Section 4.10.3 when relevant.

Detailed analyses documenting the distribution of some avian species along the Yellowstone River were conducted during the LYR study and are discussed in Jones and Hansen (2009). Habitat condition is one of the most important factors influencing the distribution of species, and variation in bird distribution along the river may reflect changing gradients in habitat condition. The influences of habitat condition on bird communities are the focus of the avian component of CEA and the analyses in this Appendix, and will be discussed in Section 4.10.3. However, because the Yellowstone River floodplain encompasses a large geographic area, other factors besides habitat condition may also influence the distribution of bird species. For example, even after accounting for important characteristics of habitat, geographic location was an important indicator in the occurrence of many species in the LYR study, with some species most abundant in particular regions of the river. Geographic location as a driver of bird distribution may represent factors not reflected in metrics of habitat condition, such as regional population dynamics or continental patterns of distribution. For example, for many of the avian species observed, habitats along the Yellowstone River represent the very edge of their continental distribution, with the core of their range in eastern North America. Consequently, analyses presented in this Appendix will examine trends at the scales of the reach and the region to better understand variation in potential impacts within the river system as a whole.

Guilds of species (i.e., groups of species that use similar resources) are also useful indicators of habitat condition because they allow for an assessment of the availability of certain types of resources in a given habitat. Examining the collective responses of species in a guild may provide strong evidence for how particular changes in habitat are influencing certain types of bird species. Guilds relevant to avian communities along the Yellowstone River are based on general habitat preferences (e.g., species that use extensive forest habitats) or shared life-history characteristics impacted by change in habitat (e.g., Brown-headed Cowbird host species); consequently impacts to particular guilds are relevant to specific changes in habitat condition, and will be included in Section 4.10.3, where the status and distribution of habitat conditions are discussed.

Table 2-1
Riparian breeding bird species detected during point count surveys conducted along the Yellowstone River during the three main avian studies (UYR study, LYR study, MA study). Non-target species (ducks, raptors, upland gamebirds, and shorebirds) are excluded.

Common Name	Scientific Name
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
American Redstart	*Setophaga ruticilla*
American Robin	*Turdus migratorius*
Audubon Warbler	*Dendroica coronata auduboni*
Baltimore Oriole	*Icterus galbula*
Barn Swallow	*Hirundo rustica*
Black-and-white Warbler	*Mniotilta varia*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Black-billed Magpie	*Pica hudsonia*
Black-capped Chickadee	*Poecile atricapillus*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Jay	*Cyanocitta cristata*
Bobolink	*Dolichonyx oryzivorus*
Brewers Blackbird	*Euphagus cyanocephalus*
Brown Thrasher	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Bullock’s Oriole	*Icterus bullockii*
Cassin's Finch	*Carpodacus cassinii*
Cedar Waxwing	*Bombycilla cedrorum*
Chimney Swift	*Chaetura pelagica*
Chipping Sparrow	*Spizella passerina*
Clay-colored sparrow	*Spizella pallida*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Grackle	*Quiscalus quiscula*
Common Raven	*Corvus corax*
Common Yellowthroat	*Geothlypis trichas*
Dickcissel	*Spiza americana*
Downy Woodpecker	*Picoides pubescens*
Dusky Flycatcher	*Empidonax oberholseri*

Common Name	Scientific Name
Eastern Kingbird	*Tyrannus tyrannus*
European Starling	*Sturnus vulgaris*
Field Sparrow	*Spizella pusilla*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Catbird	*Dumetella carolinensis*
Hairy Woodpecker	*Picoides villosus*
Hammond's Flycatcher	*Empidonax hammondii*
House Finch	*Carpodacus mexicanus*
House Wren	*Troglodytes aedon*
Lark Sparrow	*Chondestes grammacus*
Lazuli Bunting	*Passerina amoena*
Least Flycatcher	*Empidonax minimus*
Mountain Bluebird	*Sialia currucoides*
Mountain Chickadee	*Poecile gambeli*
Mourning Dove	*Zenaida macroura*
Northern Flicker	*Colaptes auratus*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Northern Waterthrush	*Parkesia noveboracensis*
Orchard Oriole	*Icterus spurius*
Ovenbird	*Seiurus aurocapilla*
Pine Siskin	*Carduelis pinus*
Plumbeous Vireo	*Vireo plumbeous*
Red Crossbill	*Loxia curvirostra*
Red-breasted Nuthatch	*Sitta canadensis*
Red-eyed Vireo	*Vireo olivaceous*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-naped Sapsucker	*Sphyrapicus nuchalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Ruby-crowned Kinglet	*Regulus calendula*
Rock Dove	*Columba livia*
Savannah Sparrow	*Passerculus sandwichensis*
Say's Phoebe	*Sayornis saya*

Common Name	Scientific Name
Song Sparrow	*Melospiza melodia*
Spotted Towhee	*Pipilo maculatus*
Swainson's Thrush	*Catharus ustulatus*
Tree Swallow	*Tachycineta bicolor*
Veery	*Catharus fuscescens*
Vesper Sparrow	*Pooecetes gramineus*
Violet-green Swallow	*Tachycineta thalassina*
Warbling Vireo	*Vireo gilvus*
Western Kingbird	*Tyrannus verticalis*
Western Meadowlark	*Sturnella neglecta*
Western Tanager	*Piranga ludoviciana*
Western Wood-pewee	*Contopus sordidulous*
White-breasted Nuthatch	*Sitta carolinensis*
White-throated Swift	*Aeronautes saxatalis*
Willow Flycatcher	*Empidonax traillii*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-breasted Chat	*Icteria virens*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*

3.0 DISTRIBUTION OF AVIAN RESPONSES BY REACH

A subset of the 88 total river reaches were sampled in each of the datasets used (Figure 3-1). Bird species richness was relatively constant across most reaches sampled in the UYR and LYR studies, ranging from 7 to 9 species observed per 2.8 acres; however, richness was slightly lower in the uppermost reaches of the river (Figure 3-2). Data from the MA study suggest that richness may be higher at the very lowest reaches of the river (Figure 3-3), which were not sampled during the LYR study. The richness of conservation species remained steady across the reaches of Region PC, but increased steadily downstream of Springdale (Figure 3-4). This trend is replicated in the MA study (Figure 3-5), suggesting that reaches sampled in Regions C and D are relatively important for species of conservation concern.

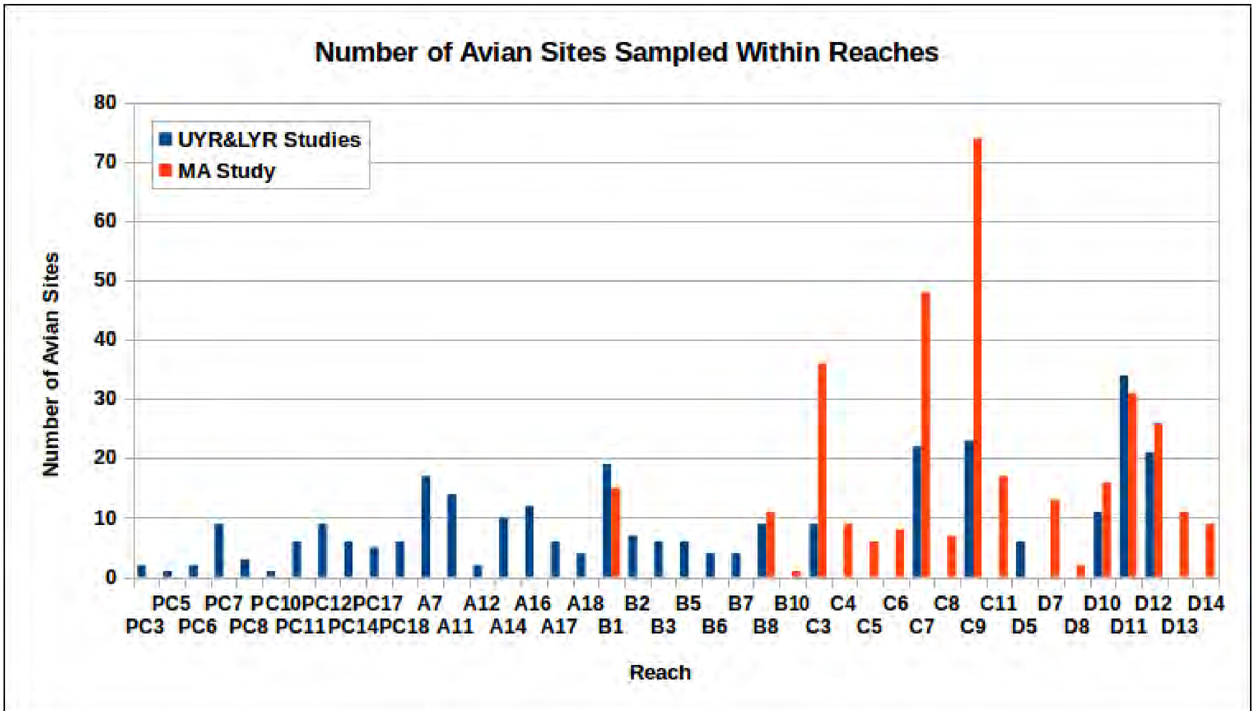


Figure 3-1 Distribution of avian sampling sites for the UYR study, the LYR study, and the MA study.

Only data from the UYR and LYR studies are included for examining the distribution of individual species of conservation concern because sample sizes from the MA study are relatively small for these species. All of the five PSOC occurred exclusively in reaches downstream from Springdale, and for most species, greater numbers of sites were occupied in the lower reaches of the river. All five species were collectively observed only in D11 and D12 (Figure 3-6). SOC that were observed at >5 cottonwood forest sampling sites were included in analyses; this included only two species, the Veery and the Red-headed Woodpecker. Veery's were observed in 7 out of the 11 reaches sampled in Region PC, while Red-headed Woodpeckers were observed in all 9 reaches sampled downstream from B7 (Figure 3-7) (see Table 3-1 for a list of reaches where the remaining SOC were observed).

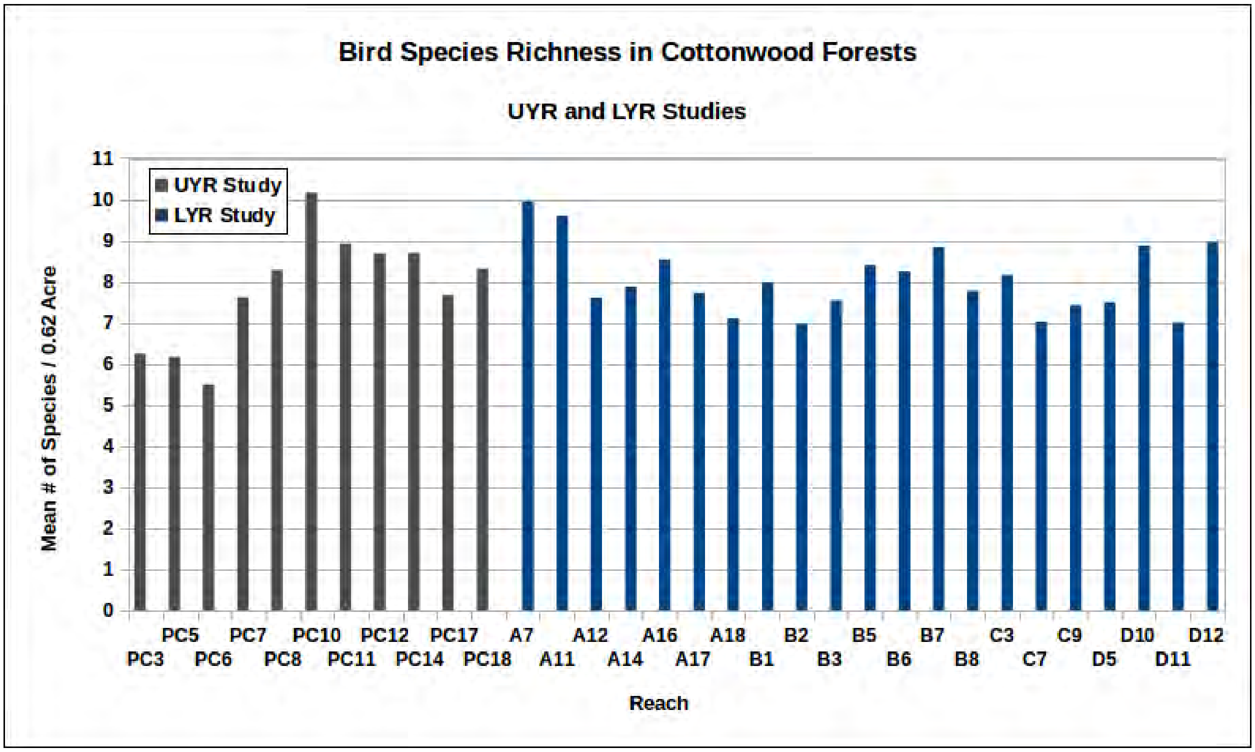


Figure 3-2 Bird species richness in cottonwood forests sampled during the UYR study (Hansen et al. 2003) and the LYR study (Jones and Hansen 2009).

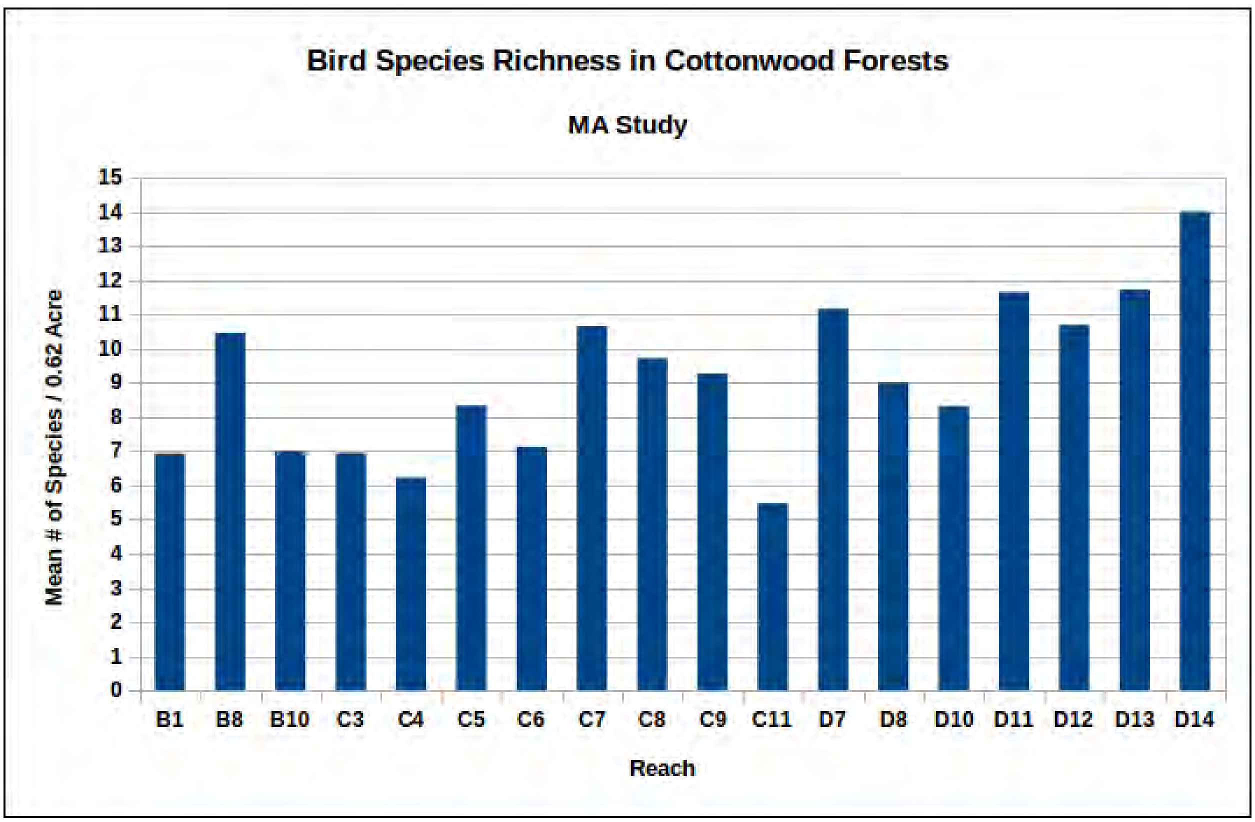


Figure 3-3 Bird species richness in cottonwood forests sampled during the MA study.

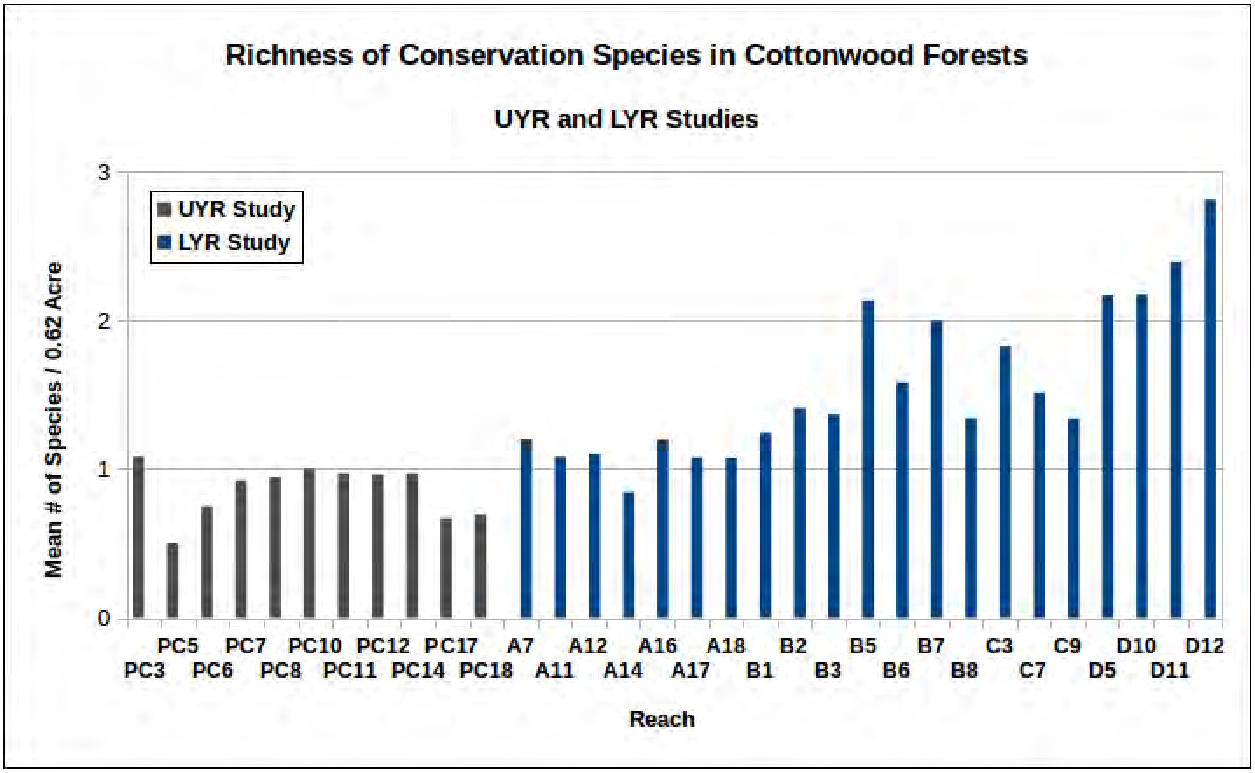


Figure 3-4 **Richness of conservation species (i.e., species currently experiencing population declines) in cottonwood forests sampled during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies.**

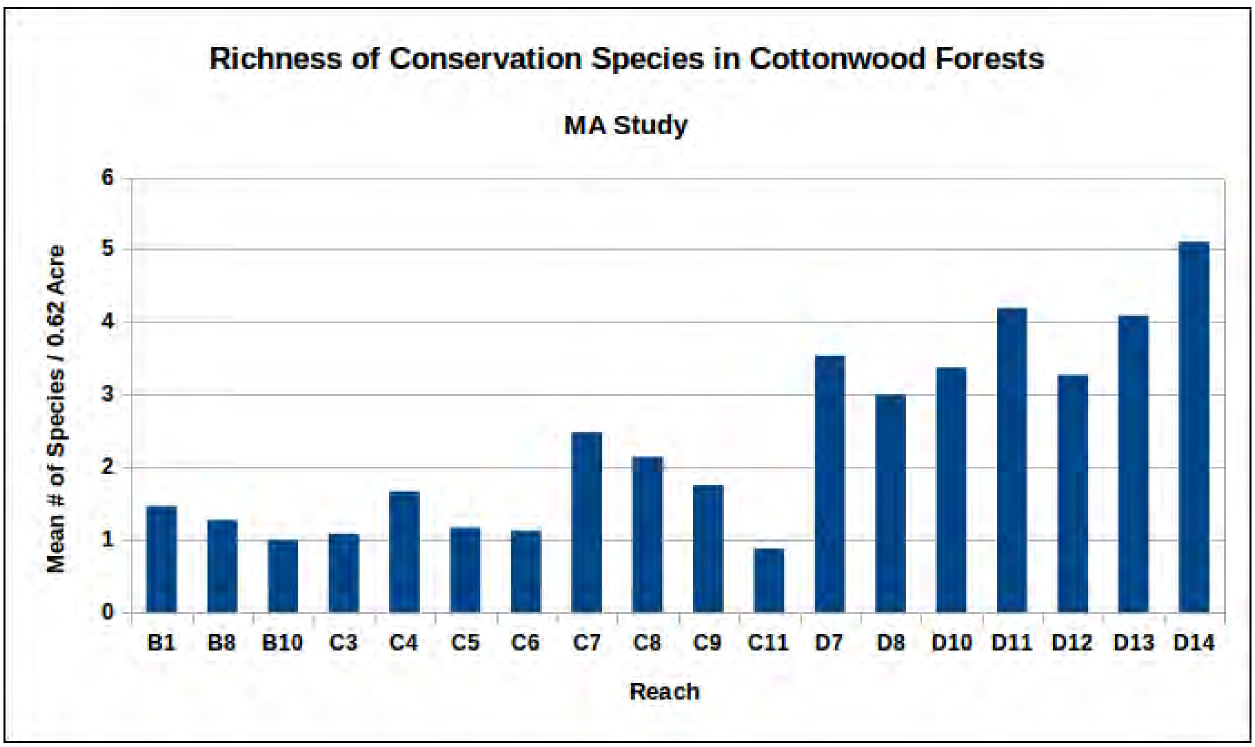


Figure 3-5 **Richness of conservation species (i.e., species currently experiencing population declines) in cottonwood forests sampled during the MA study.**

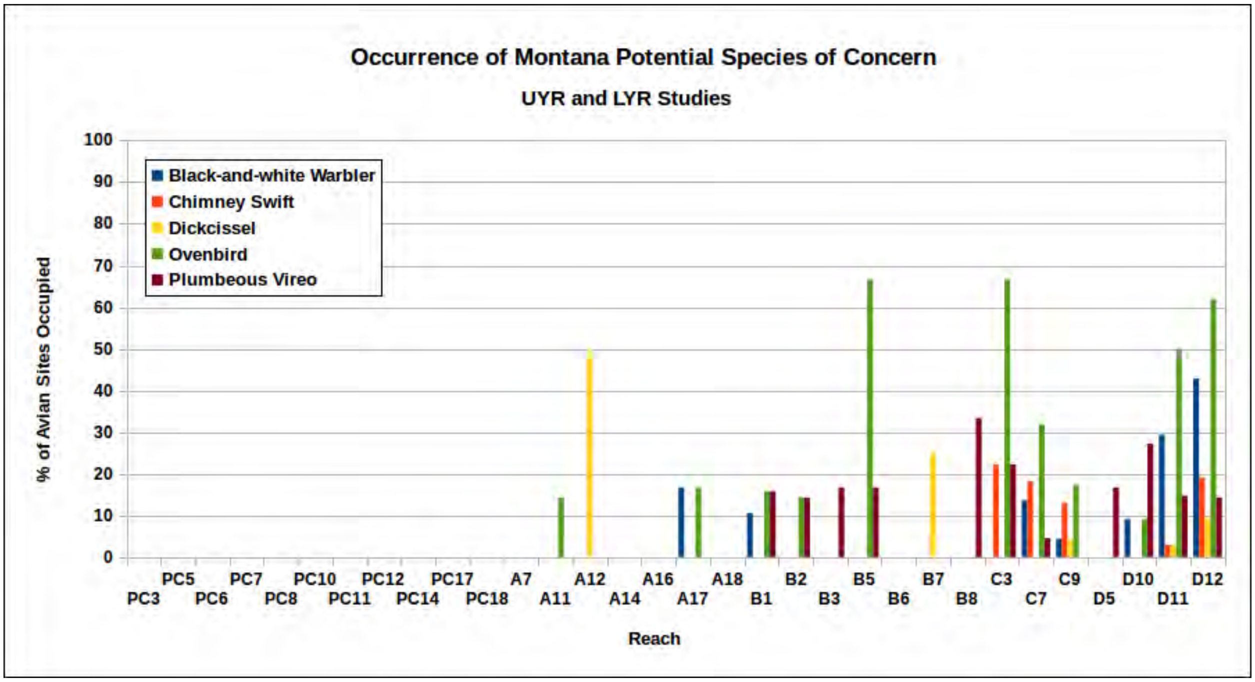


Figure 3-6 **Distribution of species designated as Potential Species of Concern in Montana (MTNHP and MTFWP 2013), documented during the UYR (Hansen et al. 2003) and LYR (Jones and Hansen 2009) studies.**

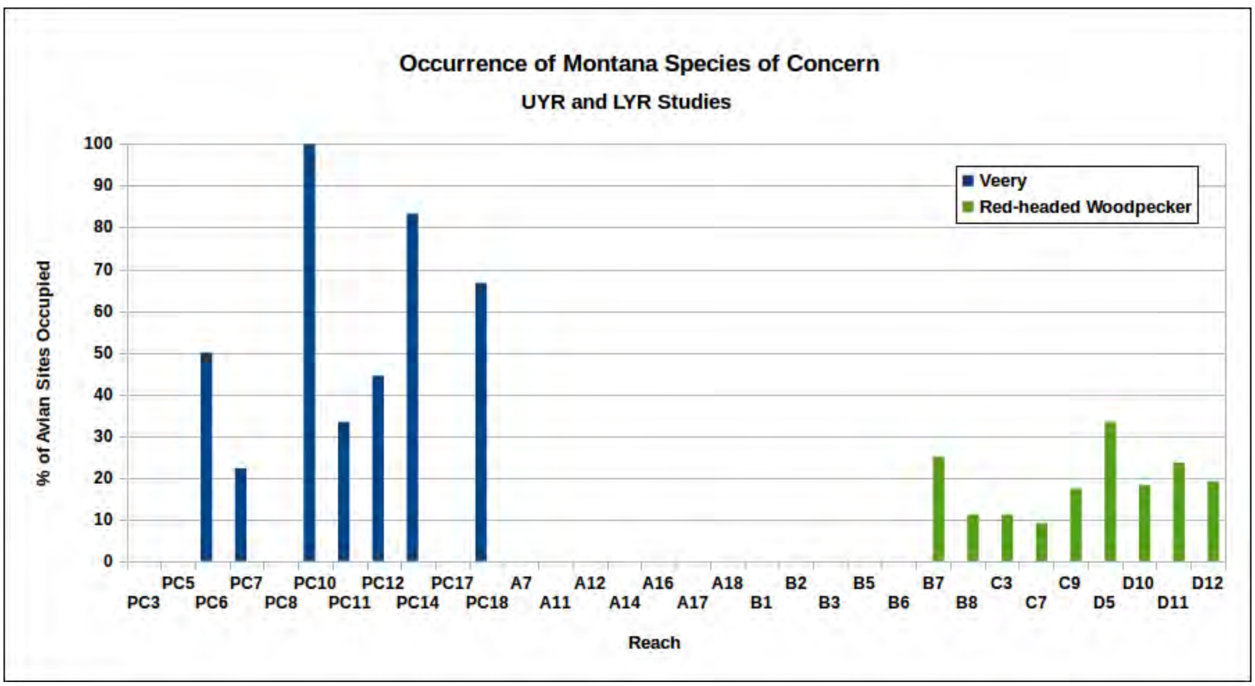


Figure 3-7 **Distribution of species designated as Species of Concern in Montana (MTNHP and MTFWP, 2013), documented during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies.**

Table 3-1
Distribution of Species of Concern observed during the UYR study, LYR study, and MA study.

Species of Concern	River Reaches Where Documented
Black-billed Cuckoo	B1, D12 (LYR study); C7, C9 (MA study)
Bobolink	A7, A11, A17, B5, C7, C9, D12 (LYR study)
Least Tern	Not sampled during the avian studies; however, documented at various reaches downstream of Miles City in Atkinson and Dood (2006)
Red-headed Woodpecker	B7, B8, C3, C7, C9, D5, D10, D11, D12 (LYR study); C7, C9, D7, D10, D13 (MA study)
Veery	PC6, PC7, PC10, PC11, PC12, PC14, PC18 (UYR study)

4.0 DISTRIBUTION OF AVIAN RESPONSES BY REGION

Avian communities were sampled in all five regions of the river (Figure 3-1). Only the UYR and LYR studies are used for regional analyses because these studies collected data in all regions, whereas the MA study focused on Regions C and D (Figure 3-1). Bird species richness is relatively constant across regions, with approximately 8 species observed per 2.8 acres (Figure 4-1). However, the richness of conservation species increases steadily downstream from Region PC, with more than twice as many conservation species observed on average at study sites in Region D compared with Region PC (Figure 4-1). As with the reach-scale analyses, this suggests that cottonwood forest habitats in regions at the lower end of the river are relatively important for species that are experiencing population declines.

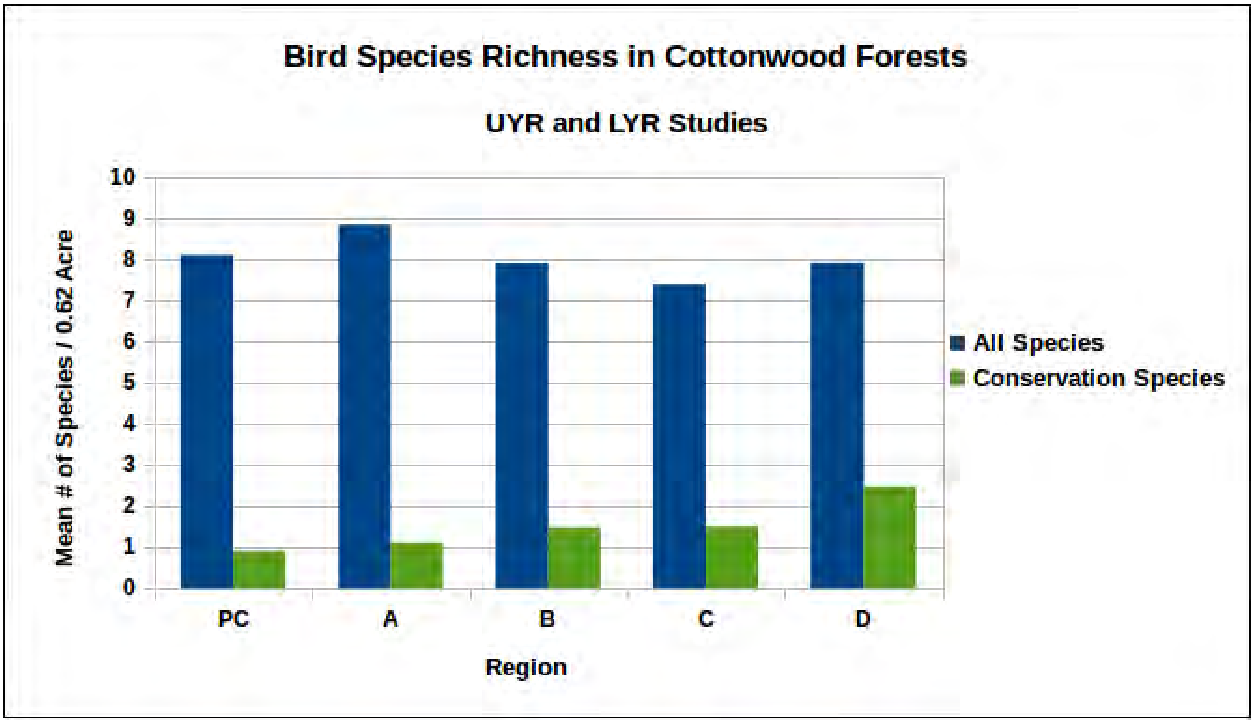


Figure 4-1 **Bird species richness and the richness of conservation species (i.e., species currently experiencing population declines) in cottonwood forests sampled during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies.**

None of the five PSOC were observed in Region PC, and all five were observed in both Regions C and D. Distribution varied across regions for all species, suggesting some regions may be more important to certain species. For example, the occurrence of both Black-and-white Warblers and Ovenbirds increased steadily downstream and was highest in Region D (Figure 4-2), similar to SOC Red-headed Woodpecker (Figure 4-3). The Veery was observed only in Region PC (Figure 4-3).

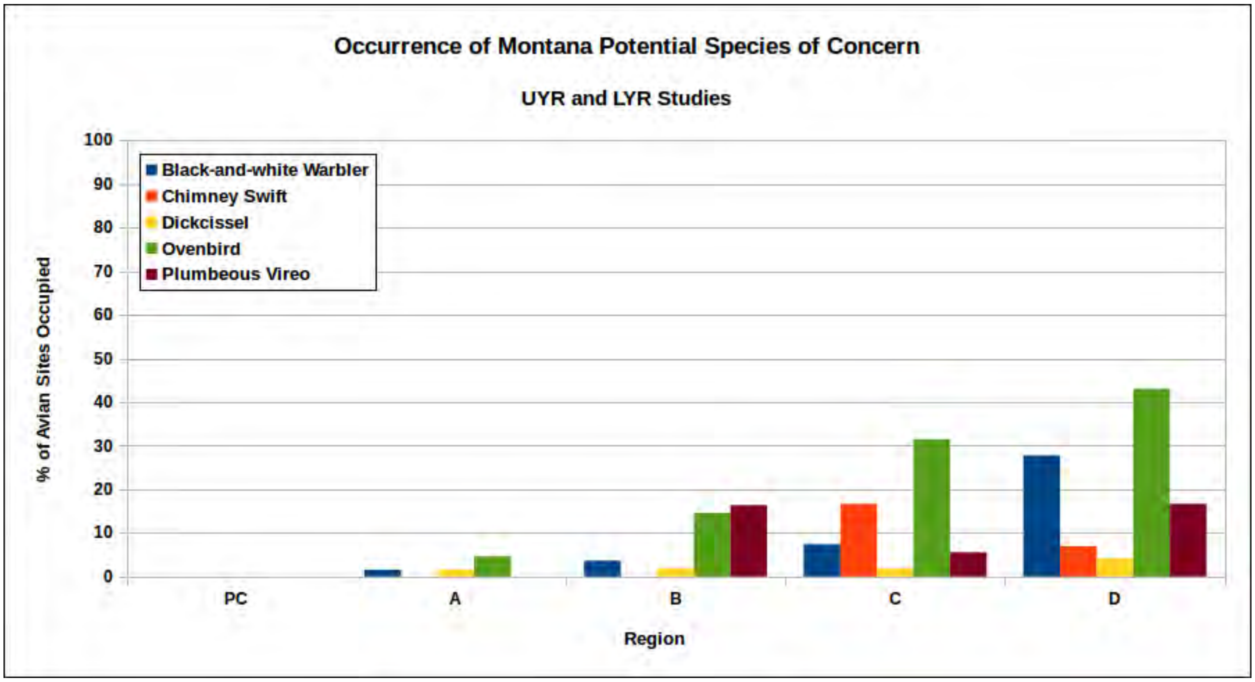


Figure 4-2 **Regional distribution of species designated Potential Species of Concern in Montana (MTNHP and MTFWP, 2013), documented during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies.**

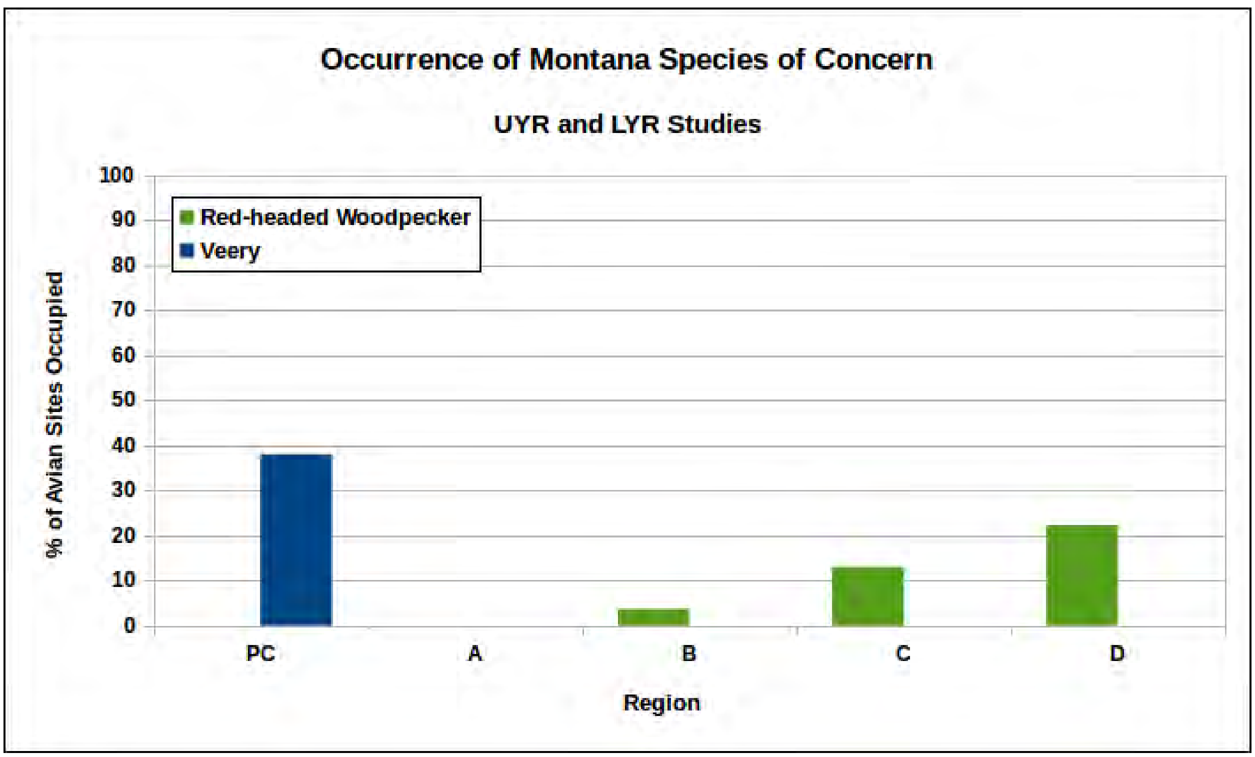
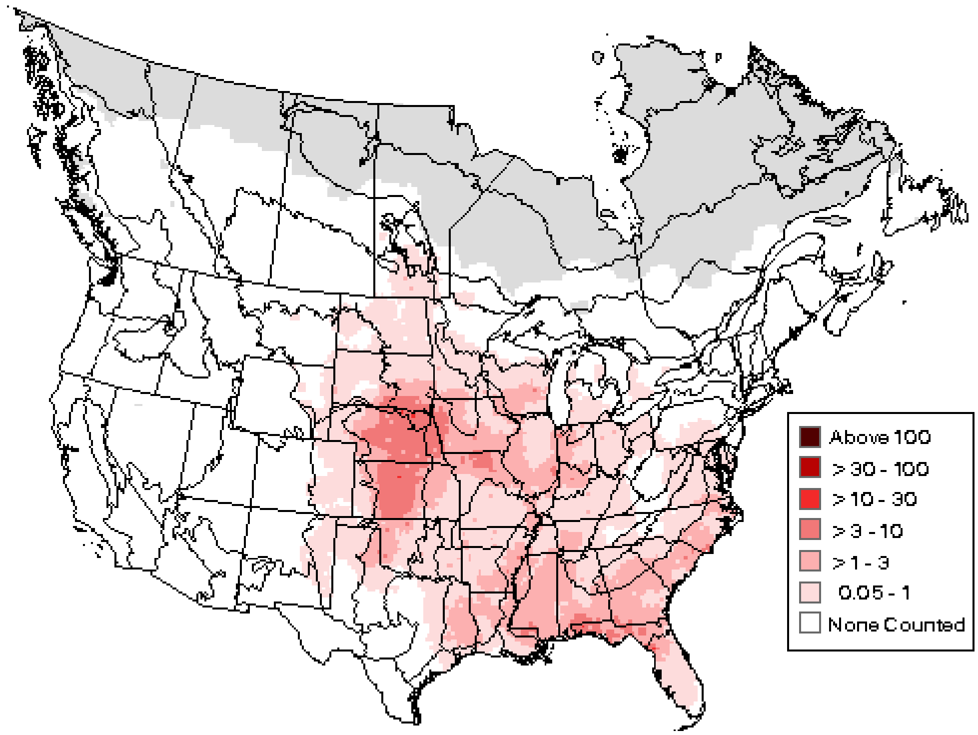


Figure 4-3 **Regional distribution of species designated Species of Concern in Montana (MTNHP and MTFWP, 2013), documented during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies.**

The greater number of conservation species and the higher occurrence of most of the SOC and PSOC species observed in the lower regions of the river could reflect responses to changing gradients in habitat condition that occur along the river, such the extent of forest habitat in the floodplain. These potential relationships will be further examined in Section 4.10.3 of the CEA report. Observed trends in distribution could also partially reflect larger scale factors, such as the influence of the continental distribution of individual species. All four of the PSOC and SOC that are observed at highest abundance in the lower regions of the river are species with the core of their continental distribution in eastern and northeastern North America, and these species are observed breeding only in the eastern half of Montana. For example, Red-headed Woodpeckers (SOC) are found in greatest abundance in the eastern deciduous forest of North America (Figure 4-4a), and distribution in Montana (Figure 4-4b) represents the very western edge of the range of this species. Therefore, the distribution of species likely reflects a combination of the influences of habitat condition and other factors such as large scale geographic distribution.



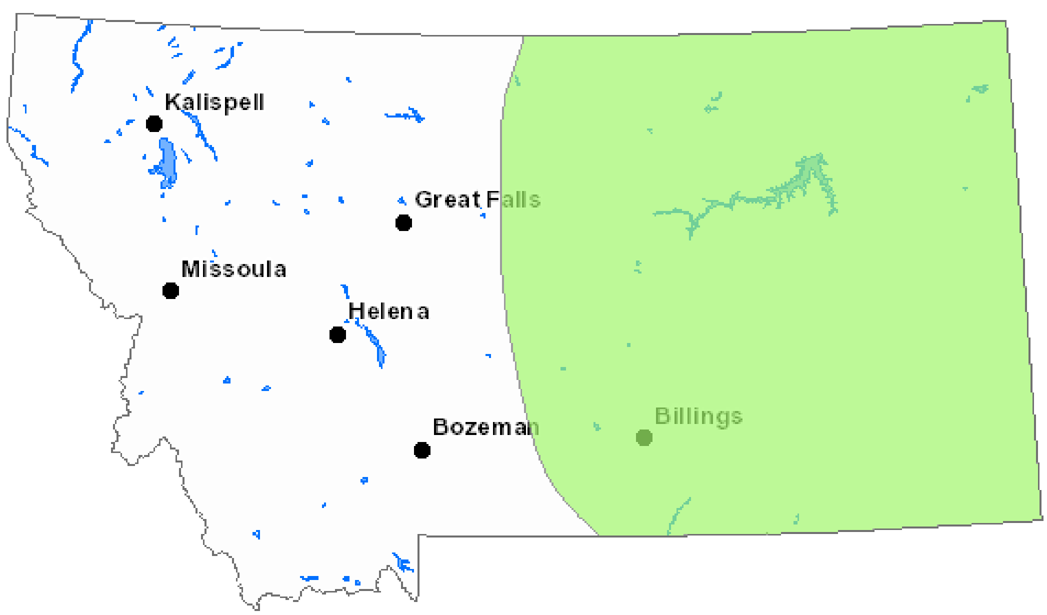


Figure 4-4 Distribution of Red-headed Woodpeckers in North America (a) and Montana (b). The map of North American distribution depicts average annual relative abundance at locations surveyed during the Breeding Bird Survey (Sauer et al., 2014), while the map of Montana distribution depicts the summer range of the species in the state (MTNHP and MTFWP, 2013).

5.0 IMPACTS OF CHANGE IN HABITAT CONDITION ON AVIAN RESPONSES

In this section, important relationships between avian responses and metrics of habitat condition (identified in Jones (2014)) are summarized. Results are presented from analyses that validate these relationships and the use of particular metrics as indicators of habitat condition for CEA.

5.1 Decline in the Extent of Forest Habitat

Following is a summary of key avian-habitat relationships related to the impacts of riparian forest loss for avian communities (from Jones, 2014):

1. In general, the amount of forest habitat in the landscape has a strong effect on characteristics of riparian bird communities and is usually measured as the total area of forest habitat in the landscape, the width of the riparian forest, or the size and area of forest patches.

2. Total species richness, species richness of the 'forest specialist' guild (representing species that prefer habitats comprised of extensive forest), and abundances of individual 'forest specialist' species are avian responses that exhibit strong and consistently positive relationships with measures of forest area.

3. Forest specialists that are also species of special conservation concern in Montana include:

    - Black-and-white Warbler (PSOC)
    - Ovenbird (PSOC)
    - Plumbeous Vireo (PSOC)
    - Black-billed Cuckoo (SOC)
    - Veery (SOC)

4. Land use drivers of change in forest extent along the Yellowstone River include:

    - Human influences that restrict natural channel migration, resulting in decreased rates of riparian turnover and subsequent declines in the regeneration of cottonwood forest habitat
        - Physical floodplain features
        - Hydrological alterations that cause reduced peak flows
        - Floodplain isolation
    - Conversion of forest to other land uses, particularly agriculture

Based on these relationships, metrics representing the impacted habitat resource were identified for CEA, including:

1. **Total forest area**: Total amount of forested habitat in the surrounding landscape.

2. **Patch size**: Total area of each distinct forest patch in the riparian zone.
3. **Forest width**: Average width of the riparian forest bordering the river.

Eighteen of the 64 species documented along the Yellowstone River during the LYR study are considered to be forest specialist species, and 7 of those species are conservation species (see Table 1 in Jones, 2014). Data collected during the LYR study can be used to validate the existence of relationships between avian responses and metrics of habitat condition. A metric representing forest width was not readily available for the Yellowstone River, so this metric will not be considered for inclusion in CEA.

Floodplain processes that influence the amount of cottonwood forest in the riparian zone may also be indicators of change in the extent of forest habitat along the river. Floodplain turnover measures the exchange of area between channel and riparian vegetation through time, and represents a measure of disturbance that drives cottonwood recruitment. Analyses regarding trends in rates of floodplain turnover through time are presented in Appendix 4.7, and will be summarized as a driver of change in habitat condition in Section 4.10.4 of the CEA report

Total Forest Area: During the LYR study, the amount of forest habitat in the surrounding landscape was quantified for each avian sampling site. Using aerial photos from 2001, a circle with a 650 foot radius (i.e. area equal to approximately 31 acres) was centered over each avian sampling site, and the percent of the landscape with forest canopy cover was recorded. There was no evident relationship between species richness and the amount of forest habitat in the landscape (Figure 5-1), suggesting that other aspects of habitat condition along the Yellowstone River may be more influential for this avian response. However, there was a positive relationship between the richness of forest specialist species and the amount of forest habitat, suggesting that the extent of forest cover in the surrounding landscape is an important aspect of habitat condition for this guild (Figure 5-2). This positive relationship is also observed for conservation species that are forest specialists (Figure 5-3). Consequently, changes in the extent of forest habitat along the Yellowstone River may most strongly impact forest specialist species, many of whom are conservation species that are already experiencing population declines.

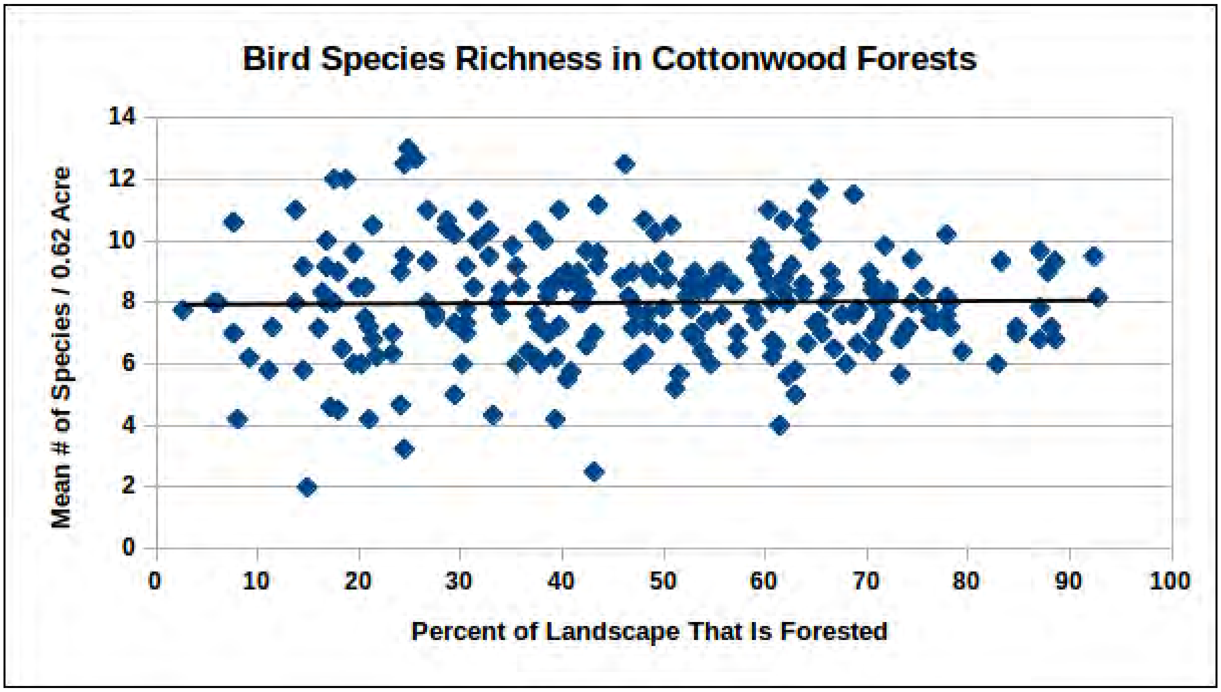


Figure 5-1 **Relationship between bird species richness and percent of the surrounding landscape that is forested, measured at avian sampling sites using 2001 aerial photographs (Jones and Hansen, 2009).**

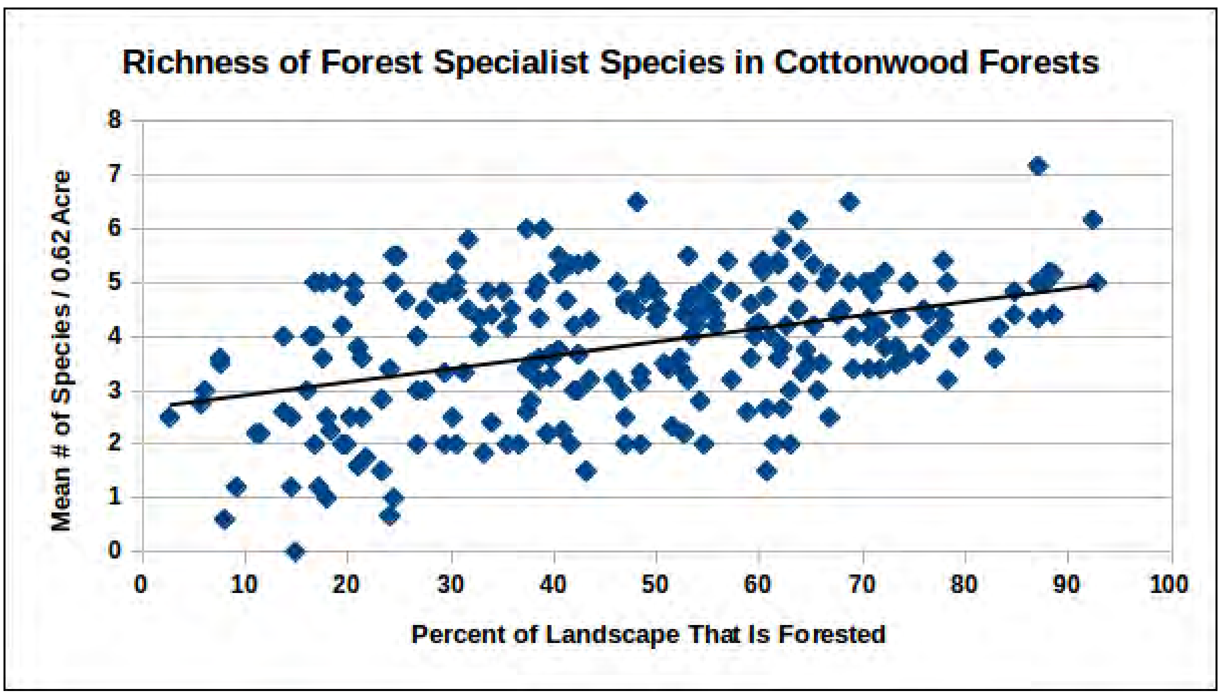


Figure 5-2 **Relationship between richness of forest specialist species and percent of the surrounding landscape that is forested, measured at avian sampling sites using 2001 aerial photographs (Jones and Hansen, 2009).**

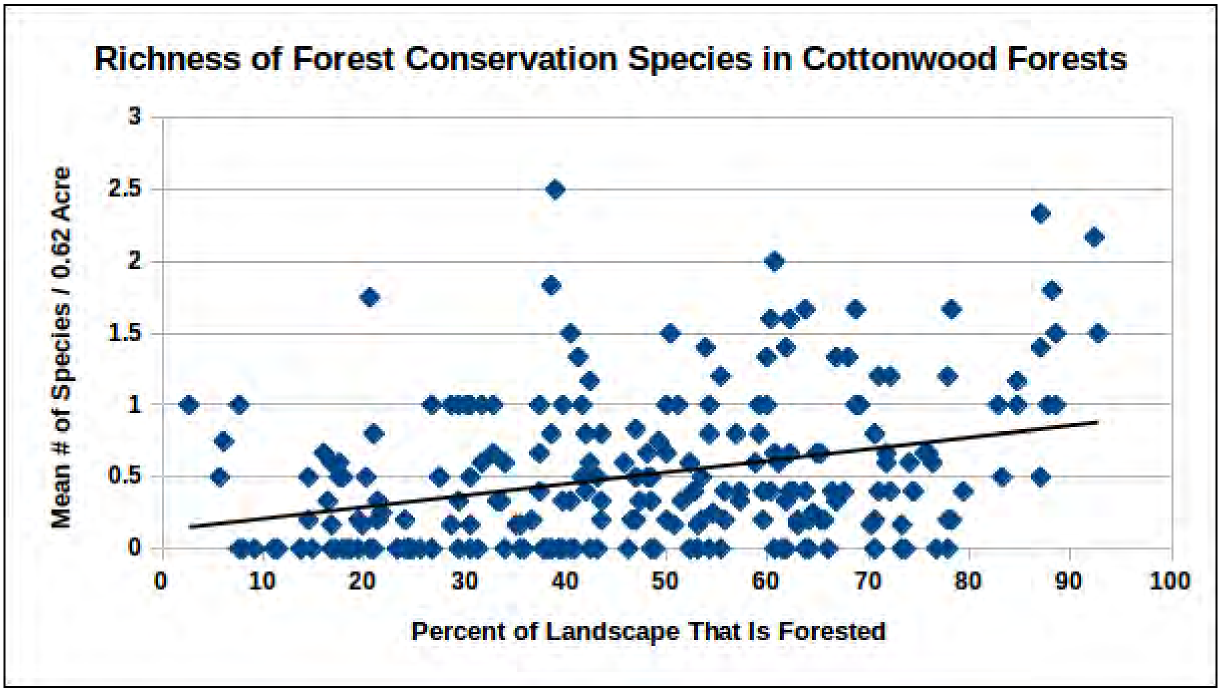


Figure 5-3 **Relationship between richness of forest specialist species that are experiencing population declines (i.e., conservation species) and percent of the surrounding landscape that is forested, measured at avian sampling sites using 2001 aerial photographs (Jones and Hansen, 2009).**

Two types of cottonwood forest habitat were identified in the Riparian Habitat Map (DTM and AGI, 2008), including Closed Timber ('TC') patches containing >20-percent forest canopy cover, and Open Timber ('TO') patches containing <20-percent forest canopy cover. Based on the 2001 Riparian Habitat Map (DTM and AGI, 2008), TC and TO habitat types were assigned to avian sites to compare avian responses across habitat types and determine if these habitat types may represent a measure of habitat condition for forest specialist species. The richness of forest specialist species, including conservation species, was greater in TC habitat than TO in general (Figure 5-4), and this pattern existed across all regions (Figure 5-5), suggesting that the amount of TC habitat may be a reliable indicator of habitat condition for this guild. Consequently, this metric of habitat condition will be included in CEA.

Patch Size: Riparian Habitat Map (DTM and AGI 2008) data from 2001 were referenced with locations of avian sampling sites to assign a forest patch size for each cottonwood forest site where avian data were collected in the LYR Study. There was no strong relationship between species richness and forest patch size (Figure 5-6), or the richness of forest specialist species and patch size (Figure 5-7). Consequently, patch size may not be a reliable indicator of habitat condition for Yellowstone River birds and will not be included as a metric for CEA.

Riparian areas consist of a complexity of patches, and birds may instead be responding to patch size at a larger landscape scale. If this is true, the proximity and total area of similar types of nearby forest patches (i.e., 'neighbors') may be a better indicator of habitat condition than patch size. Using the TC habitat type from the 2001 Riparian Habitat Map and avian data from the LYR study, it was determined whether the sampled forest patch was within 164 feet (50 meters) of at least one 'neighbor'. The total area of the patch sampled plus the area of all 'neighbor' patches surrounding the avian site was also calculated. There was no apparent difference between the richness of forest specialist species at avian sites in close proximity to 'neighbor' patches and those without 'neighbors' (Figure 5-8), and no apparent relationship between richness and the total area of the sampled patch and 'neighbor' patches (Figure 5-9). This trend (or lack of) is relatively consistent across regions (Figure 5-8), providing a measure of confidence through replication. This suggests that the proximity of other forest patches in the landscape may not represent an important aspect of habitat condition for Yellowstone River forest specialist species, so metrics quantifying characteristics of neighboring patches will not be included in CEA.

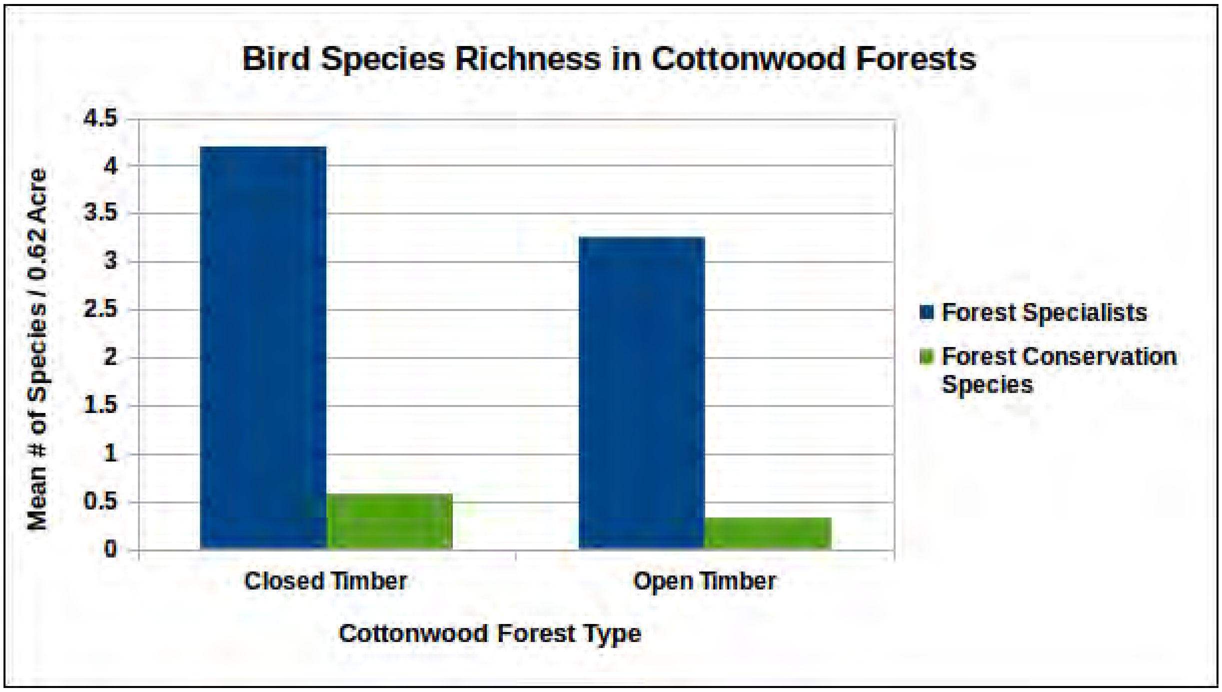


Figure 5-4 **Richness of all forest specialist species and forest conservation species (i.e., forest specialists that are experiencing population declines) in two types of cottonwood forest habitats. 'Open Timber' and 'Closed Timber' designations were assigned based on the 2001 Riparian Habitat Map (DTM and AGI, 2008).**

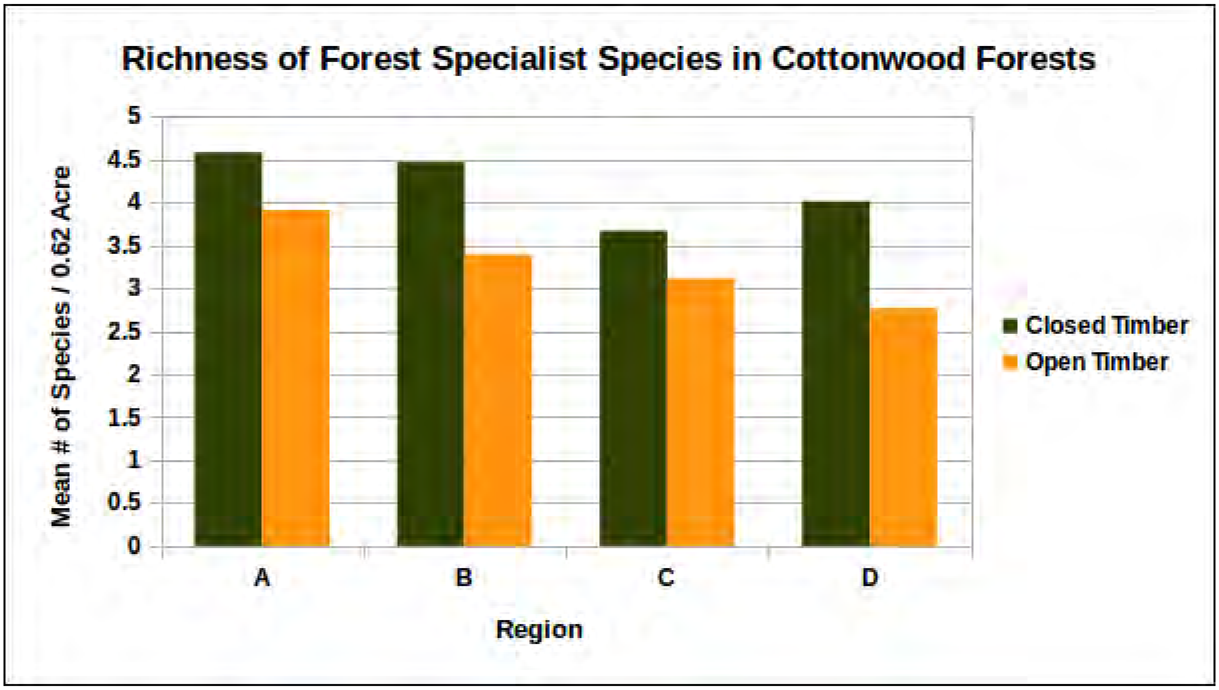


Figure 5-5. **Richness of forest specialist species in two types of cottonwood forest habitats across regions of the Yellowstone River. 'Open Timber' and 'Closed Timber' designations were assigned based on the 2001 Riparian Habitat Map (DTM and AGI, 2008).**

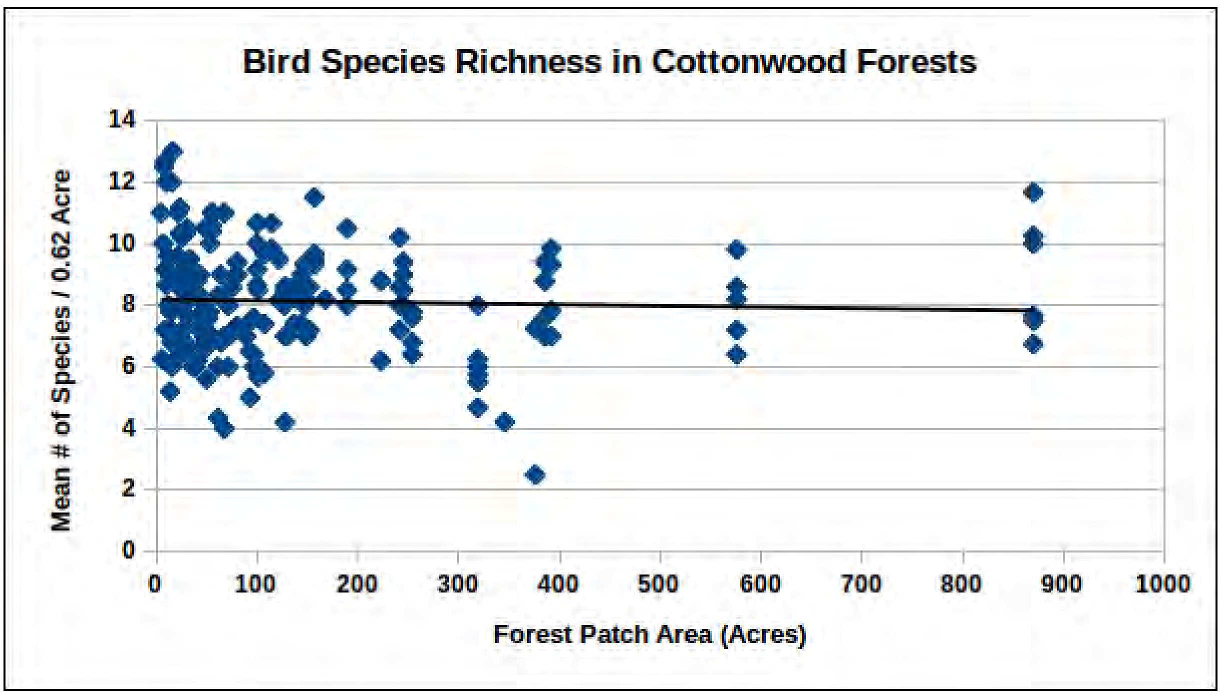


Figure 5-6 **Relationship between bird species richness and forest patch size observed during the LYR study (Jones and Hansen, 2009). Patch size was calculated from the 2001 Riparian Habitat Map (DTM and AGI, 2008).**

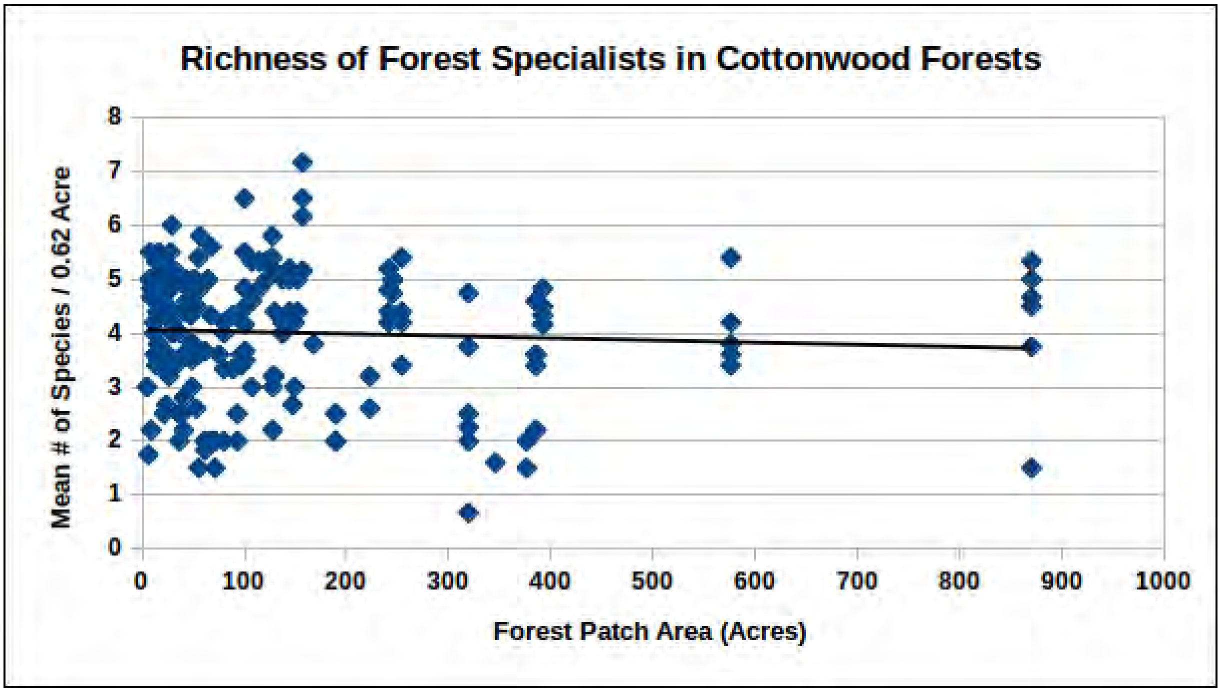


Figure 5-7 **Relationship between richness of forest specialist species and forest patch size observed during the LYR study (Jones and Hansen, 2009). Patch size was calculated from the 2001 Riparian Habitat Map (DTM and AGI, 2008).**

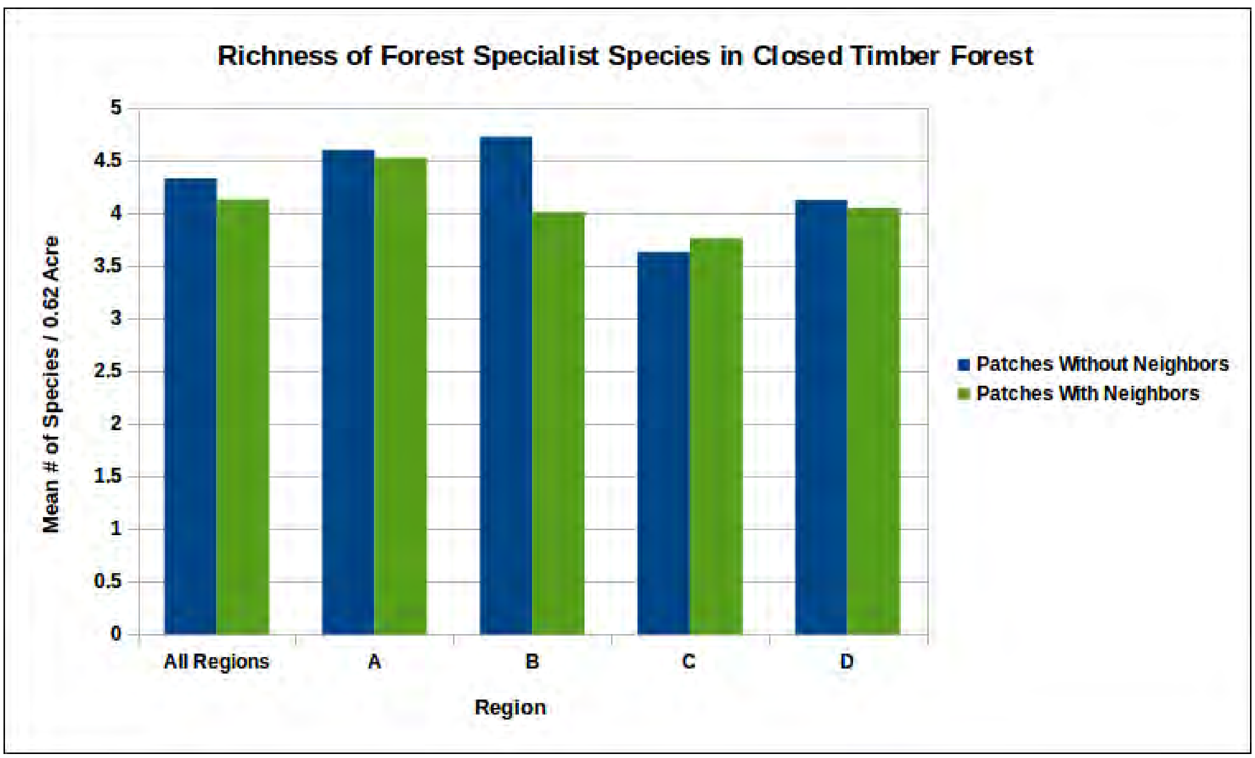


Figure 5-8 **Bird species richness in Closed Timber forest patches with other Closed Timber patch types (i.e., 'neighbors') nearby versus patches that did not have 'neighbors' close by, based on the 2001 Riparian Habitat Map (DTM and AGI, 2008).**

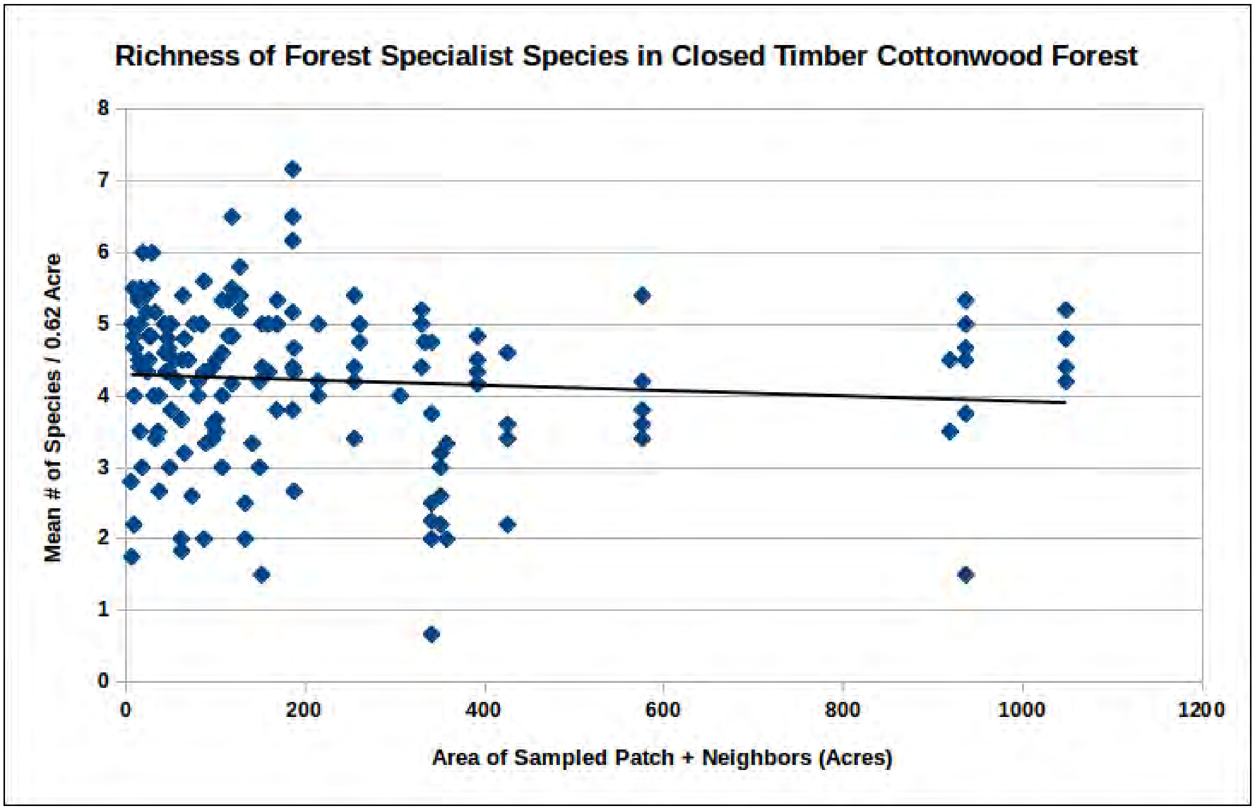


Figure 5-9 **Relationship between the richness of forest specialist species and the total area of the sampled Closed Timber forest patch plus the area of all 'neighbor' patches (i.e., other Closed Timber patches within 164 feet), based on the 2001 Riparian Habitat Map (DTM and AGI, 2008).**

5.2 Loss of Structurally Complex Habitat Types

Following is a summary of the key findings and relationships related to the loss of structurally complex riparian forest habitat (from Jones (2014)):

1. The structural complexity of riparian forest has a strong effect on characteristics of riparian bird communities and can be measured either at a local scale by quantifying the vertical density of vegetation in the forest, or at a landscape scale by quantifying the amount of forest with greater structural complexity.

2. Total species richness, species richness of the 'understory specialist' guild (representing species that forage or nest in the shrub layer of riparian forest), and abundances of individual 'understory specialist' species all exhibit strong and consistent positive relationships with measures of structural complexity.

3. Understory specialists that are also species of special conservation concern in Montana include

    - Black-billed Cuckoo (SOC)

    - Veery (SOC)

4. Land use drivers of change in structural complexity of cottonwood habitat along the Yellowstone River include:

- Human influences that restrict natural channel migration, resulting in decreased rates of riparian turnover and subsequent declines in the regeneration of structurally complex early and mid-successional cottonwood forest habitat
  - Physical floodplain features
  - Hydrological alterations that cause reduced peak flows
  - Floodplain isolation
- Heavy livestock grazing in cottonwood forest that results in the simplification of the forest understory

Based on these relationships, metrics representing the structural complexity of habitats were identified for CEA, including:

1. **Vegetation within the forest stand**: Characteristics of vegetation representing stand structure, particularly shrub and canopy cover.
2. **Area of forest with different canopy cover characteristics**: Forest patches with higher canopy cover may represent stands with greater structural complexity.

Twelve of the 64 species documented along the Yellowstone River during the LYR study are considered to be 'understory specialist' species, and 3 of those species are conservation species (see Table 1 in Jones, 2014), including the Black-billed Cuckoo (SOC). Data collected in the LYR study can be used to validate the existence of relationships between avian responses and metrics of habitat structure.

Structural Complexity: During the LYR study, local vegetation was recorded at each avian sampling site. Measures of canopy density and shrub density from these data were used to represent characteristics of habitat structure that may influence birds. Percent canopy density within the forest stand did not influence bird species richness (Figure 5-10) or the richness of understory specialist species (Figure 5-11), suggesting that characteristics of the forest understory are most important. The density of large shrubs (>4 feet tall), which add significant structure to the understory of the forest stand, did positively influence bird species richness in cottonwood forests (Figure 5-12), particularly for understory specialist species (Figure 5-13), suggesting that this is an important metric of habitat condition for this guild.

Results from the LYR study provide further insight into characteristics of structurally complex forest and relationships with avian responses. In that study, cottonwood forest sampling sites were grouped into habitat types based on characteristics of habitat structure. Structurally complex cottonwood forest habitat types were relatively abundant (112 of 234 cottonwood sites sampled), and were evenly distributed along the river. Structurally complex habitats had moderate numbers of big and small cottonwood trees and high densities of large native shrubs. These habitats had greater bird species richness and more understory specialist species than forest habitats that were structurally simple, which were grassy in the understory or had only low shrubs. Many understory specialist species occurred more often in the structurally complex forest types compared with the more simple habitats.

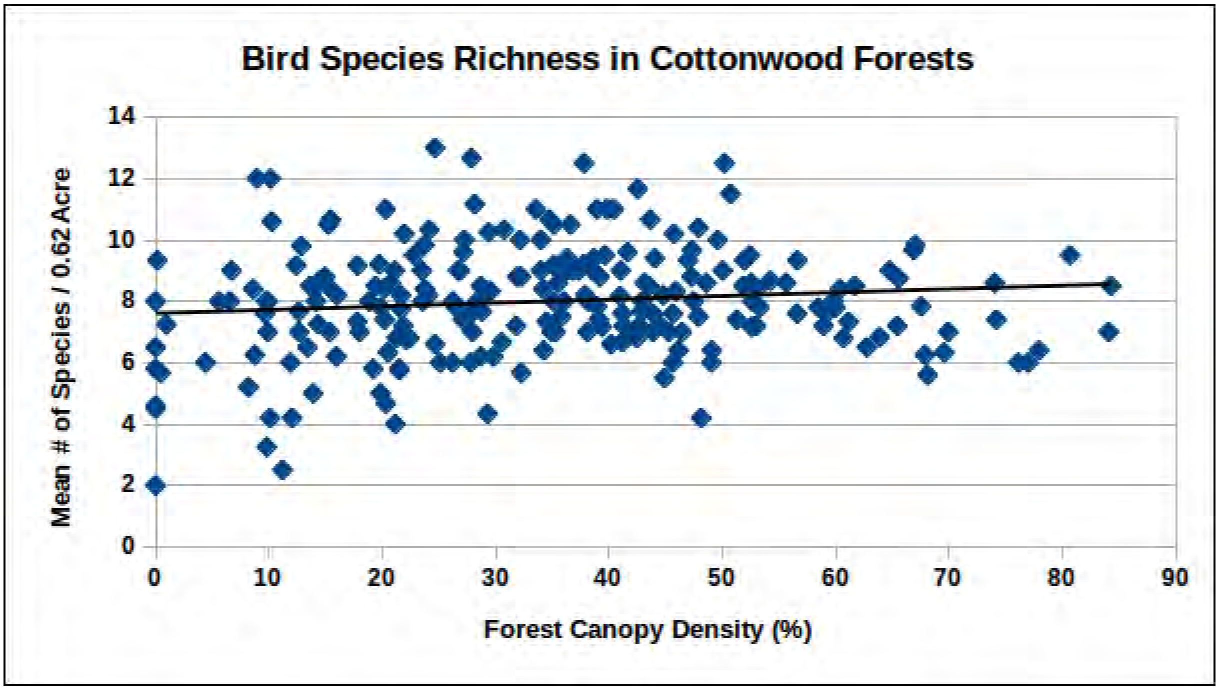


Figure 5-10 Relationship between bird species richness and local-scale canopy density in cottonwood forests sampled during the LYR study (Jones and Hansen, 2009).

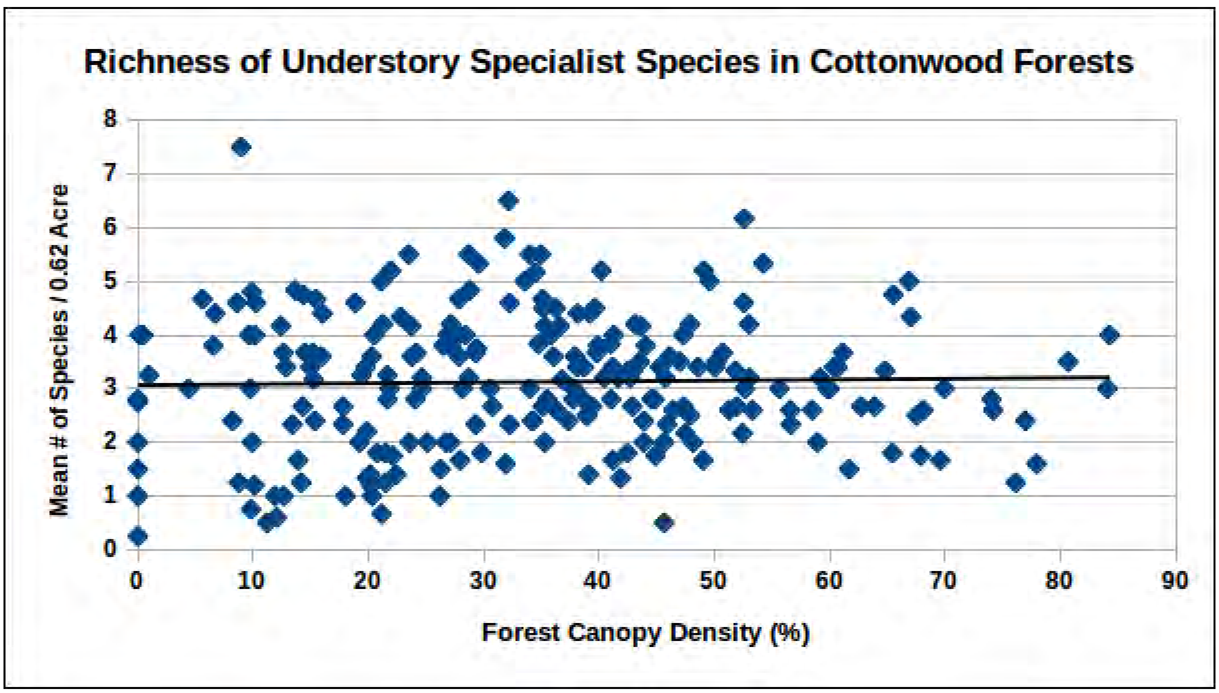


Figure 5-11 Relationship between the richness of understory specialist species and local-scale canopy density in cottonwood forests sampled during the LYR study (Jones and Hansen, 2009).

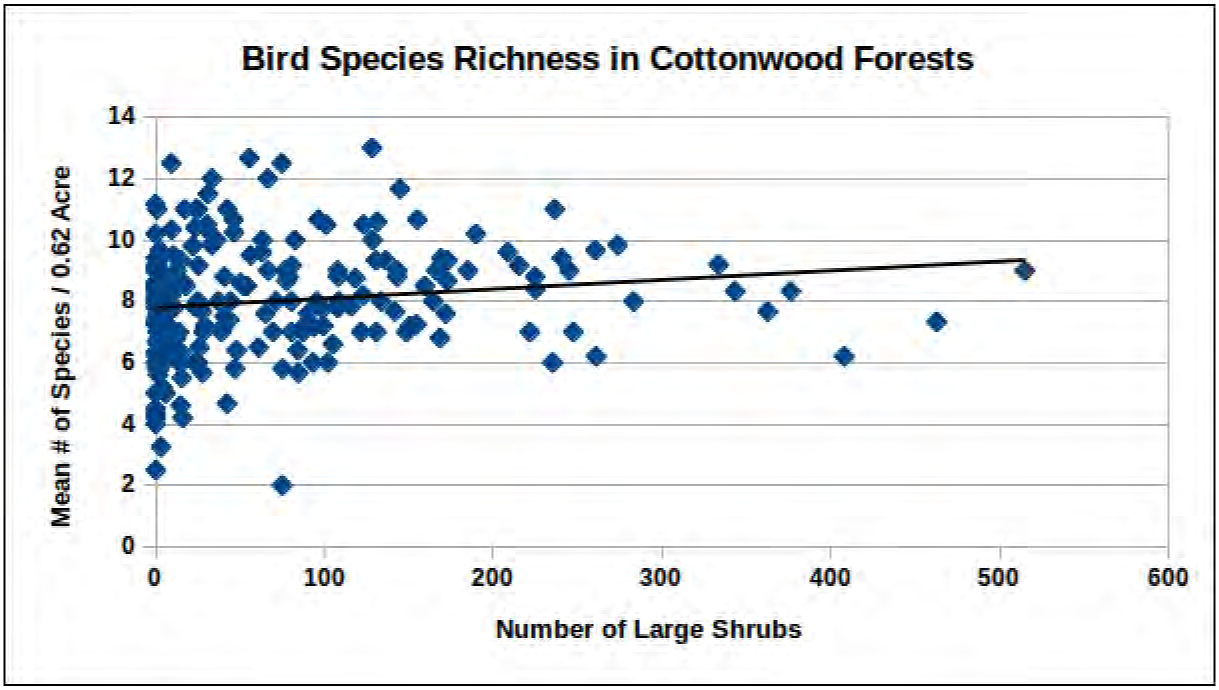


Figure 5-12 **Relationship between bird species richness and understory shrub density in cottonwood forests sampled during the LYR study (Jones and Hansen, 2009).**

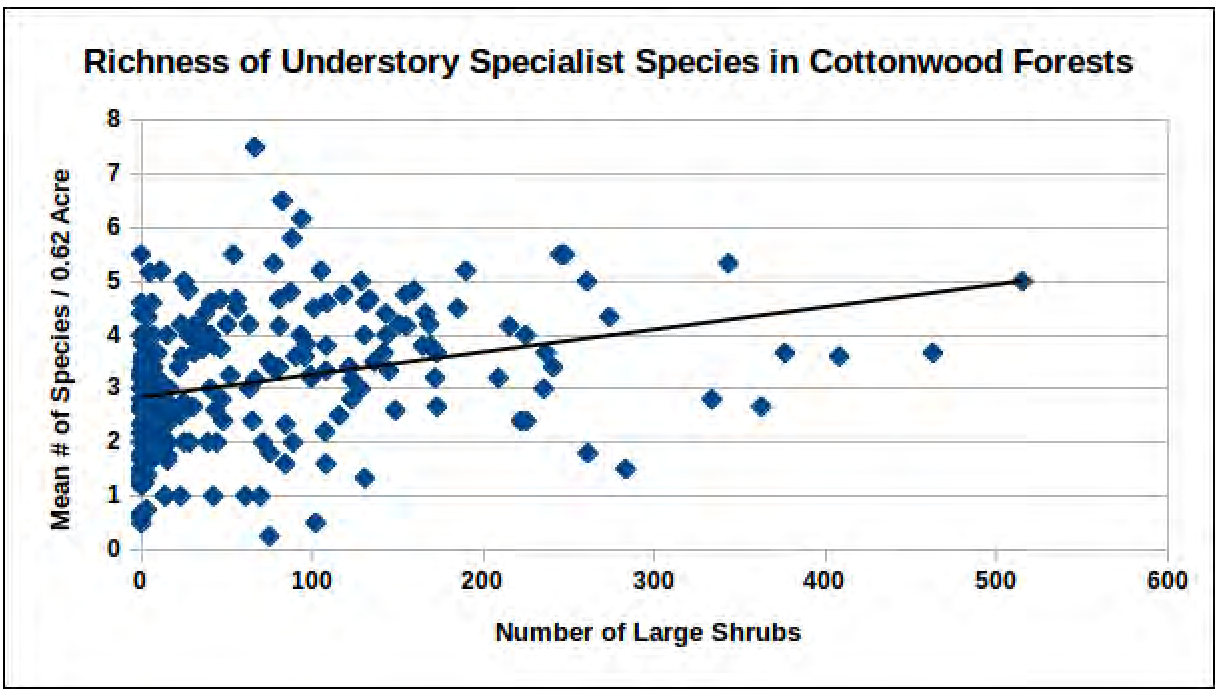


Figure 5-13 **Relationship between the richness of understory specialist species and understory shrub density in cottonwood forests sampled during the LYR study (Jones and Hansen, 2009).**

Data quantifying forest understory characteristics do not exist at the scale of the river system, so cannot provide a metric of habitat condition for CEA. The only metrics of cottonwood forest that exist at a landscape-scale are the TC and TO habitats included in the Riparian Habitat Map (DTM and AGI, 2008), but these habitats were delineated based on characteristics of forest canopy cover rather than the forest understory. Based on the 2001 Riparian Habitat Map (DTM and AGI, 2008), TC and TO habitat types were assigned to avian sites to compare avian responses across habitat types and determine if these habitat types may represent a measure of habitat condition for understory specialist species. Bird species richness and the richness of understory specialist species did not differ across habitat types, and was relatively high in both TC and TO forest (Figure 5-14), suggesting that there is no evidence that either one of these habitat types is an indicator of habitat condition for understory specialist species or total species richness.

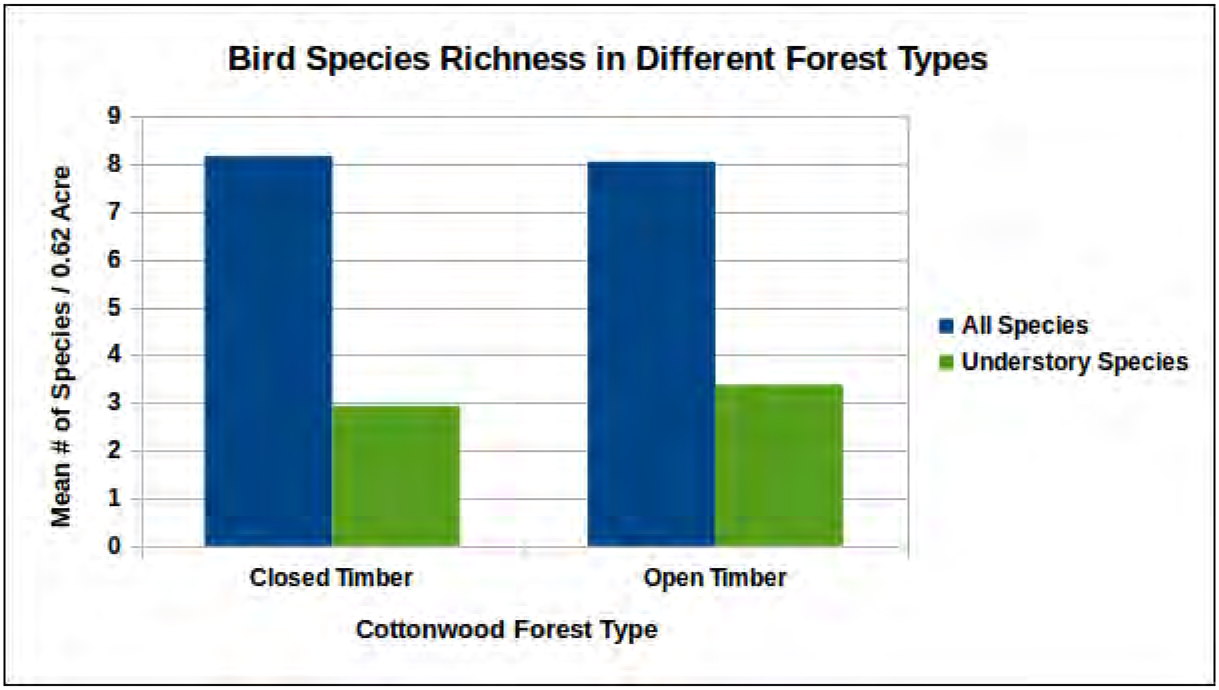


Figure 5-14 Bird species richness in two types of cottonwood forest habitats observed during the LYR study (Jones and Hansen, 2009). 'Open Timber' and 'Closed Timber' categories were assigned from the 2001 Riparian Habitat Map (DTM and AGI, 2008)

Structurally complex forests habitats are mid-successional forests that are created and maintained by floodplain processes that drive cottonwood succession and renewal. Consequently, metrics representing these floodplain processes for the Yellowstone River may be the best indicators for potential changes in the extent of structurally complex habitat types. Floodplain turnover measures the exchange of area between channel and riparian vegetation through time, and represents a measure of disturbance that drives cottonwood succession. Areas with rates of floodplain turnover that are out of balance (i.e., more area transitioning to forest than to channel) may be experiencing directional changes in characteristics of riparian forest, with less young complex forest and more forest that is decadent and simplified in structure (Appendix 7). This would indicate a change in habitat availability for avian species that depend upon structurally complex forest. Analyses regarding trends in rates of floodplain turnover through time are presented in (Appendix 7), and will be summarized as a driver of change in habitat condition in Section 4.10.4.

The structural complexity of cottonwood forest habitats is potentially reduced when heavy livestock grazing results in a loss of understory vegetation. See Appendix 7 for a discussion of impacts of heavy grazing on riparian plant communities (see Jones (2014) for a discussion of the potential impacts of livestock grazing on riparian bird communities in the western US). No data exist to quantify the timing and intensity of livestock grazing in riparian habitats along the Yellowstone River, so it is not possible to use this as a metric of potential impacts to structurally complex habitats. However, the loss of structural complexity in forest habitats that are heavily grazed by livestock, and the subsequent negative impacts to understory bird species, has been well documented in other similar riparian systems in the West. Consequently, the potential impacts of livestock grazing on riparian birds will be discussed whenever relevant in CEA.

5.3 Expansion of Detrimental Species: Brown-headed Cowbirds

Brown-headed Cowbirds lay their eggs in the nests of other avian species (i.e., cowbird 'hosts'), usually resulting in reduced reproductive output for the host species. Cowbirds were originally limited to the short-grass plains of central North America, where they foraged on insects disturbed by the movements of buffalo herds. Their distribution has significantly expanded in the past century; Cowbirds are now primarily associated with agricultural and developed landscapes throughout North America (see Jones, 2014 for a thorough review). Cowbirds have two required habitats: foraging areas with high insect abundance, such as livestock areas (e.g., corrals, feedlots, or actively grazed pastures), agricultural lands, and residential areas; and breeding areas with many host species, particularly cottonwood forests in the western US (Jones, 2014). Cowbirds commute daily between these two habitats, spending mornings in breeding habitats and afternoons in foraging areas. Consequently, the existence of land use that provides foraging habitat for Cowbirds in close proximity to cottonwood forest is the primary driver of habitat degradation by parasitism in the riparian zone. Following is a summary of the key findings and relationships related to the effect of habitat degradation due to Cowbird parasitism in riparian habitats:

1. Livestock grazing and the expansion of agriculture and residential development in the riparian zone provide feeding sites for Cowbirds, and may result in increased Cowbird abundance in riparian forest habitat (i.e. preferred Cowbird breeding habitat) along the Yellowstone River.

2. The amount of habitat degradation caused by Cowbird parasitism is measured either directly by the presence or abundance of Cowbirds in a given area, or indirectly by the extent of land use that provides foraging habitat for Cowbirds.

3. Species that experience Cowbird parasitism are negatively impacted through reduced reproductive success; other characteristics of avian communities (such as species richness) do not reflect the negative impacts of parasitism and are not good indicators of habitat condition.

4. Cowbird hosts that are species of special conservation concern in Montana include:

    - Black-and-white Warbler (PSOC)
    - Ovenbird (PSOC)
    - Plumbeous Vireo (PSOC)
    - Veery (SOC)

5. Human influences on the expansion of Brown-headed Cowbirds into riparian habitat along the Yellowstone River include land uses that provide foraging habitat in close proximity to riparian habitats, such as:

    - Livestock grazing

- Conversion of land to residential areas
- Conversion of land to agriculture

Land-use impacts habitat condition for birds by directly influencing the expansion of Cowbirds into riparian habitats, rather than by indirectly changing physical characteristics or availability of habitat. Consequently, metrics identified for CEA that represent the impacts of Cowbird parasitism on avian communities do not quantify changes in habitat, but instead include:

1. **Cowbird Abundance**
2. **Proximity of Forest to Cowbird Foraging Habitats, including:**
    - Livestock areas (corrals, feedlots, or actively grazed pastures)
    - Urban or exurban residential areas
    - Agricultural lands (tilled land or pasture)

Twenty-seven of the 64 species documented in the LYR study are Cowbird host species (see Table 6 in Jones 2014). Of these host species, 11 are conservation species that may be especially vulnerable to the negative impacts of parasitism, including 4 PSOC. Three additional Cowbird host species were observed during the UYR Study, including the Veery (SOC). Data from the avian studies can be used to validate the existence of relationships between avian responses and metrics of habitat degradation from Cowbirds.

Cowbird Abundance: Cowbird abundance was recorded at sampling sites in all three avian studies. Of the reaches sampled in the UYR and LYR studies, abundance was greatest in PC8 and PC14, and was generally highest in the upper reaches of the river (Figure 5-15). Data from the MA study also suggest that Cowbird abundance is lower in the lowest reaches of the river (Figure 5-16). Cowbird abundance observed at the regional scale reflect these trends, with abundance highest in Regions PC and A, and lowest in Region D. Three times as many Cowbirds were observed on average at sampling sites in Region A compared with Region D (Figure 5-17).

The richness of Cowbird host species (i.e. those species that are negatively impacted by Cowbird parasitism) was lowest in the upper reaches of the river and increased downstream. This trend is especially evident for host species that are also conservation species; more of these species occur in Reaches D11 and D12 than any of the other sampled reaches (Figure 5-18). At the regional scale, richness of Cowbird hosts is lowest in Region PC and equally high in Regions B, C, and D, while richness of conservation species increases steadily from Region PC to Region D (Figure 5-19). Four times as many conservation host species were observed at sites in Region D than in the upper regions of the river. These results suggest that, on average, fewer species that are impacted by Cowbird parasitism occur in the regions where Cowbird abundance is currently highest. Furthermore, conservation host species that occur most often in Regions C and D, such as Black-and-white Warblers and Ovenbirds (PSOC; Figure 4-2), may currently experience lower risk of Cowbird parasitism than species that occur most often in the upper Regions of the river, such as the Veery (SOC; Figure 4-3).

Cowbird abundance is an important metric of habitat condition, but these data are not available at the scale of the entire Yellowstone River and are only available for the current time period, so will not be included in CEA. However, knowledge about the distribution of Cowbirds provides information for comparing the reaches that were sampled and looking at relative impacts along the river, and allows for discussion about the current status of habitat condition in those reaches.

Proximity to Cowbird Foraging Habitat: In general, Cowbird abundance is greatest in cottonwood forest stands that are in close proximity to preferred Cowbird feeding areas (Jones, 2014). During the LYR study (Jones and Hansen, 2009), areas of human settlement (including urban and exurban residential areas and farmsteads where humans and livestock resided) and cropland that were in close proximity to avian sampling sites were digitized, and the distances from sampled cottonwood stands to these Cowbird foraging areas were measured. With these data, it is possible to examine relationships between Cowbird abundance in cottonwood forest stands and the proximity of Cowbird foraging habitats. There was strong evidence that Cowbirds were more abundant in forest that was closer to human settlement than in forest that was farther away from settlement (Figure 5-20). Alternatively, there was no evidence that the proximity to cropland, another potential foraging habitat for Cowbirds, was related to Cowbird abundance in cottonwood forest (Figure 5-21). These results suggest that human settlement and the presence of livestock are important drivers of Cowbird abundance in riparian habitats along the Yellowstone River, and the extent and distribution of these land use types are good indicators of habitat degradation due to Cowbird parasitism. Areas of human settlement were identified for 1950, 1976, 2001, and 2011 for the entire river corridor in the Land Use Mapping effort (DTM, 2013). These data will be used in CEA as a metric of the current status of habitat degradation due to potential Cowbird parasitism, and for quantifying how the extent and distribution of potentially degraded habitat has changed over time. Areas with grazing livestock also provide important cowbird foraging habitat (Jones, 2014), but data do not exist to quantify the distribution of livestock in the riparian corridor.

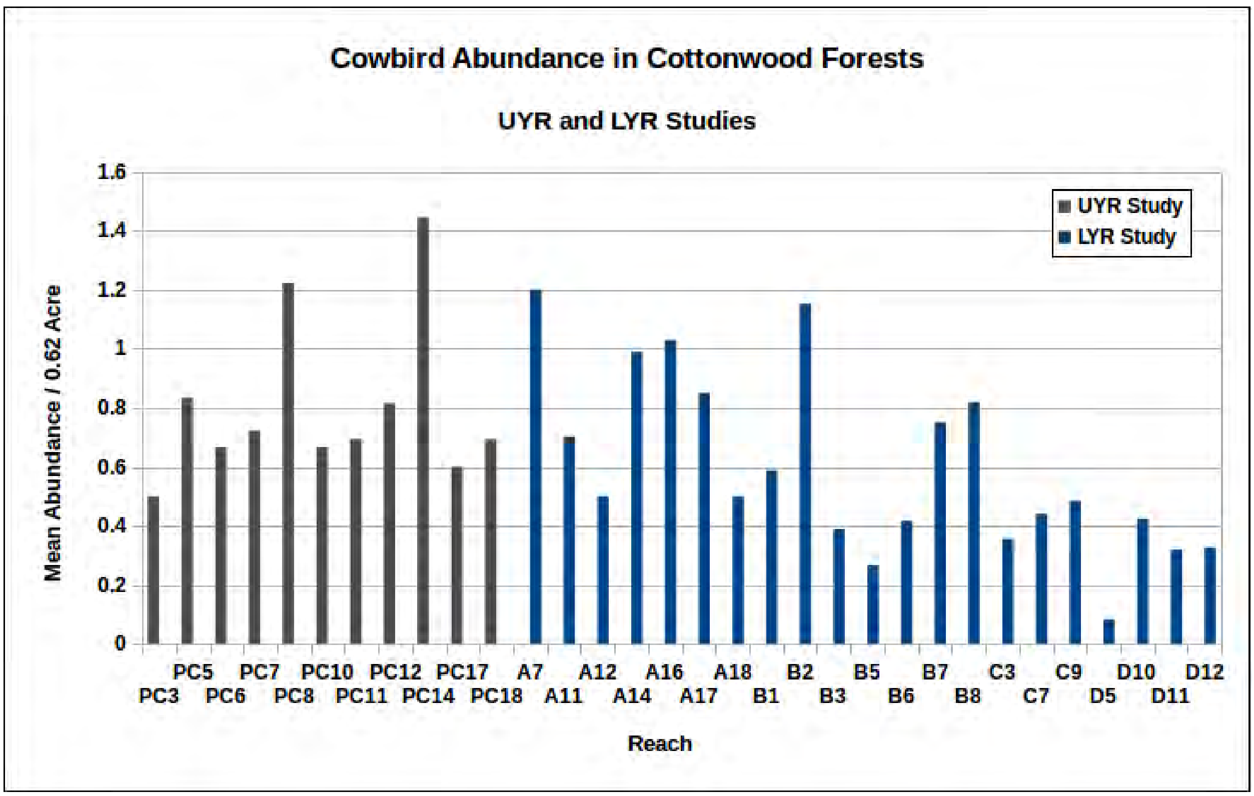


Figure 5-15 Cowbird abundance observed at cottonwood forest sites sampled during the UYR (Hansen et al. 2003) and LYR (Jones and Hansen 2009) studies.

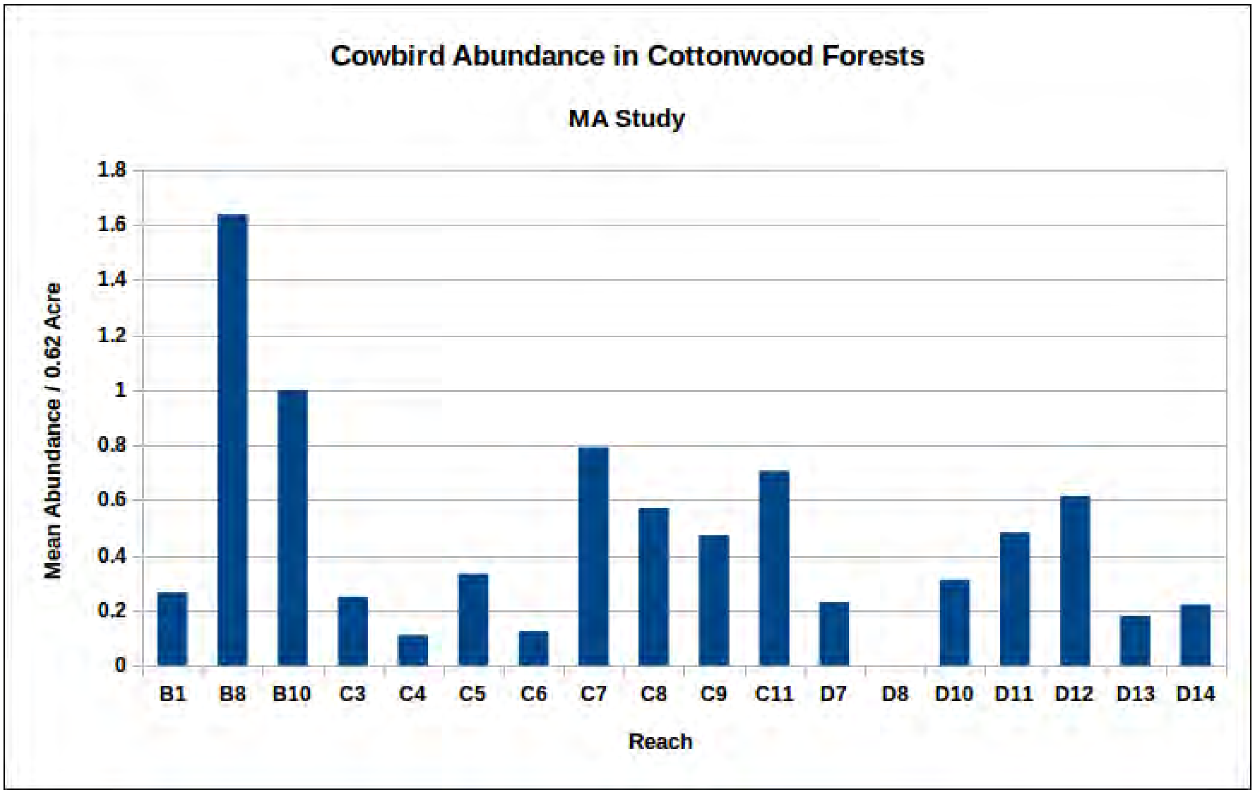


Figure 5-16 **Cowbird abundance observed at cottonwood forest sites sampled during the MA study.**

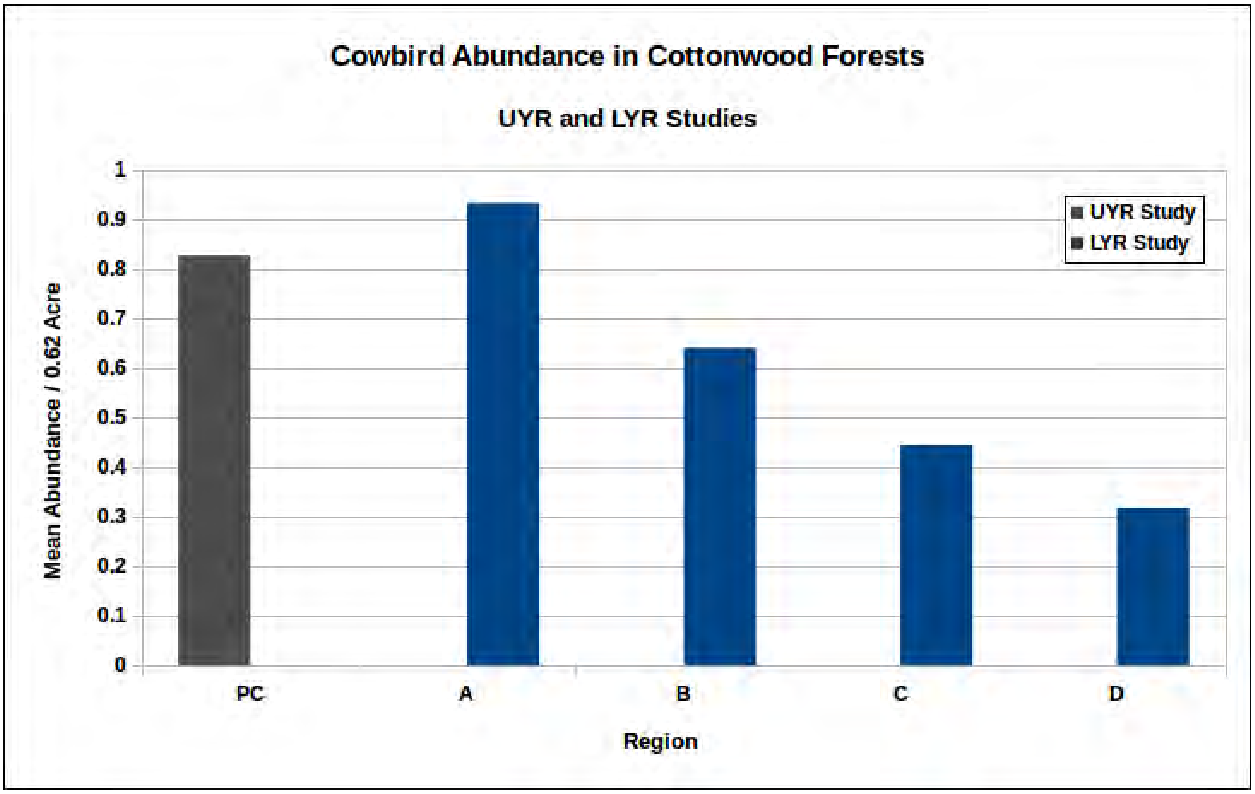


Figure 5-17 Abundance of Cowbirds within cottonwood forests of different regions of the Yellowstone River sampled during the UYR (Hansen et al. 2003) and LYR (Jones and Hansen, 2009) studies.

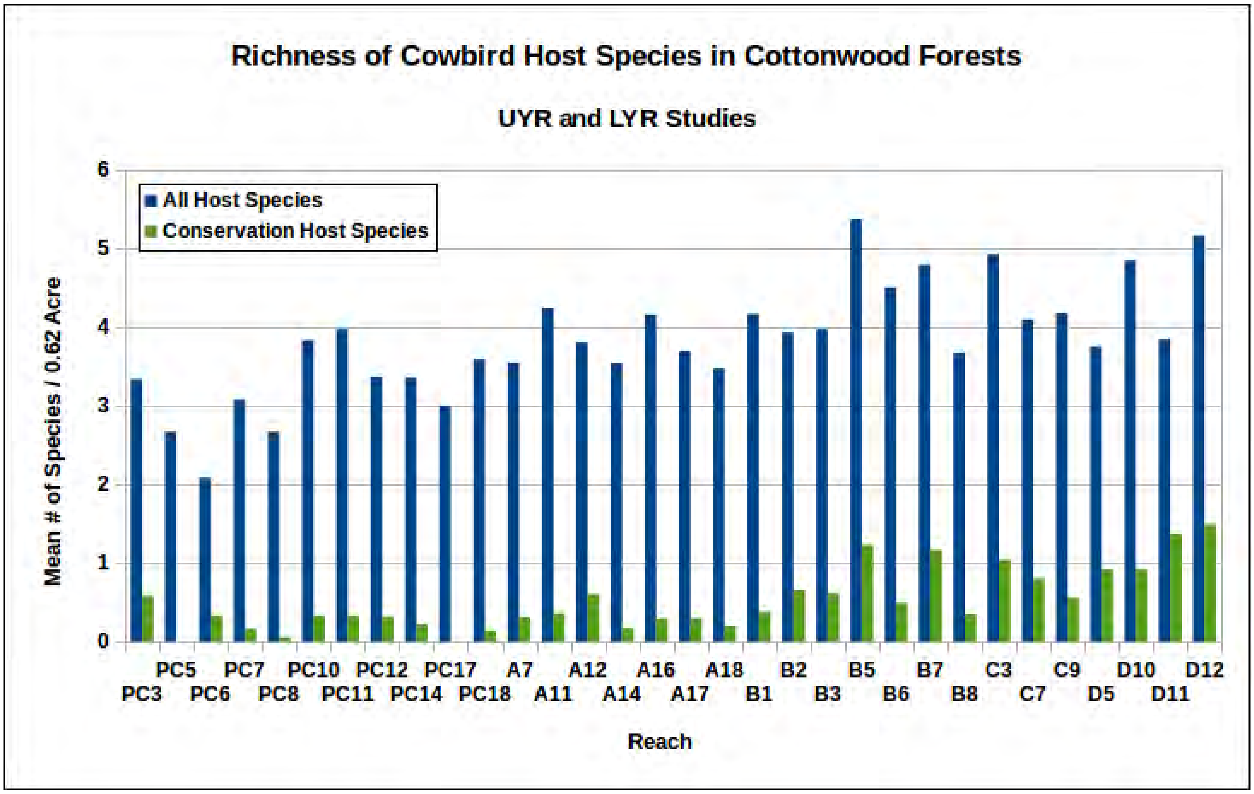


Figure 5-18 **Richness of species that are Cowbird hosts, observed within reaches sampled during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies, as well as richness of conservation host species (i.e., host species experiencing population declines).**

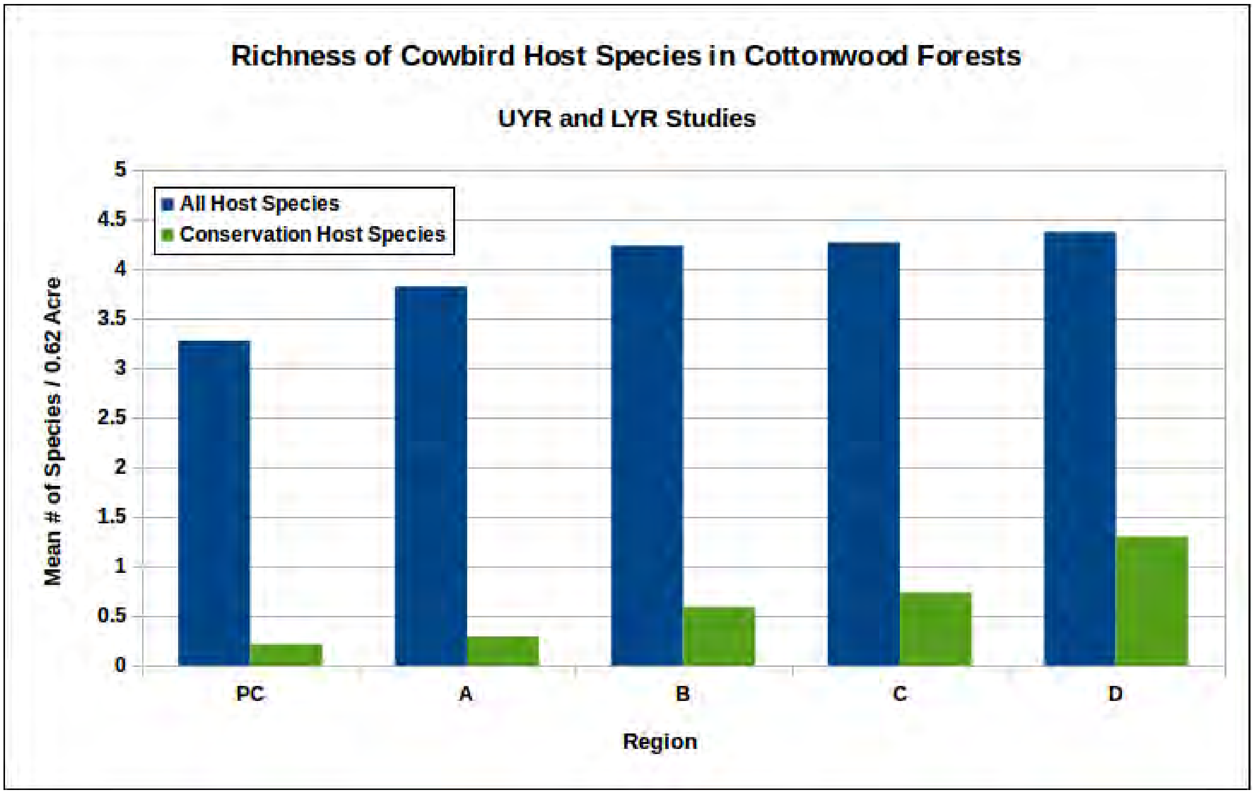


Figure 5-19 **Richness of species that are Cowbird hosts, observed within regions sampled during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies, as well as richness of conservation host species (i.e., host species experiencing population declines).**

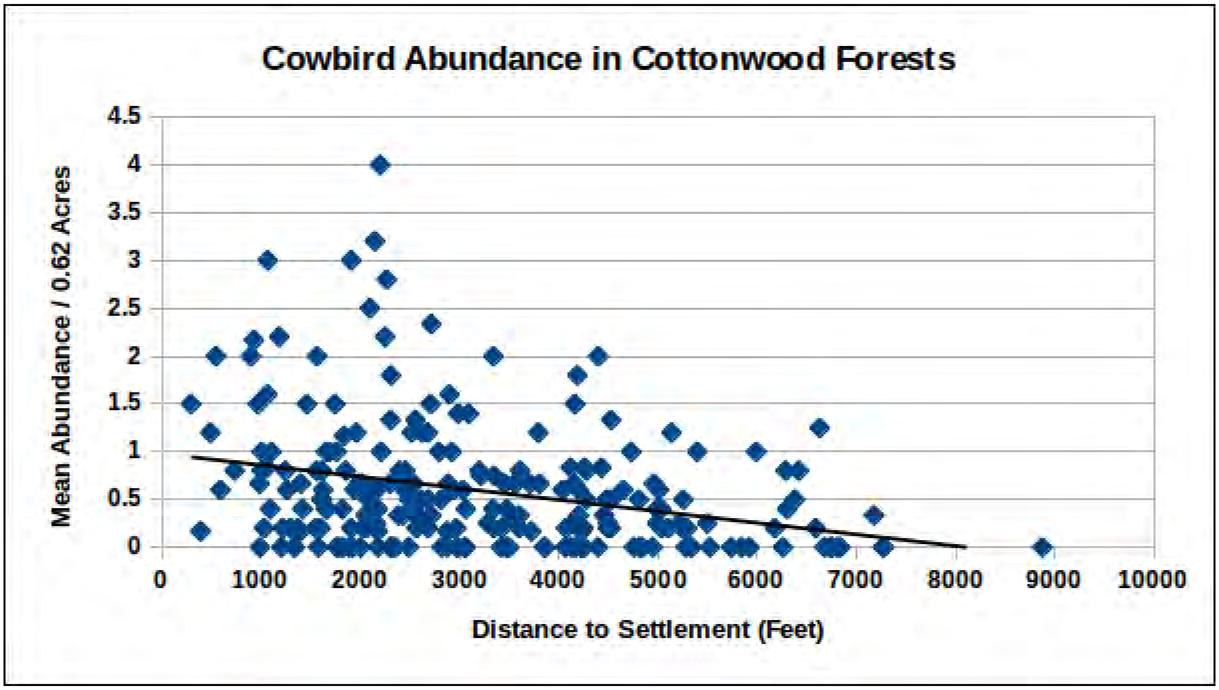


Figure 5-20 **Relationship between Cowbird abundance in cottonwood forest and proximity to areas of human settlement (i.e., residential areas and farmsteads with infrastructure) observed during the LYR study (Jones and Hansen, 2009).**

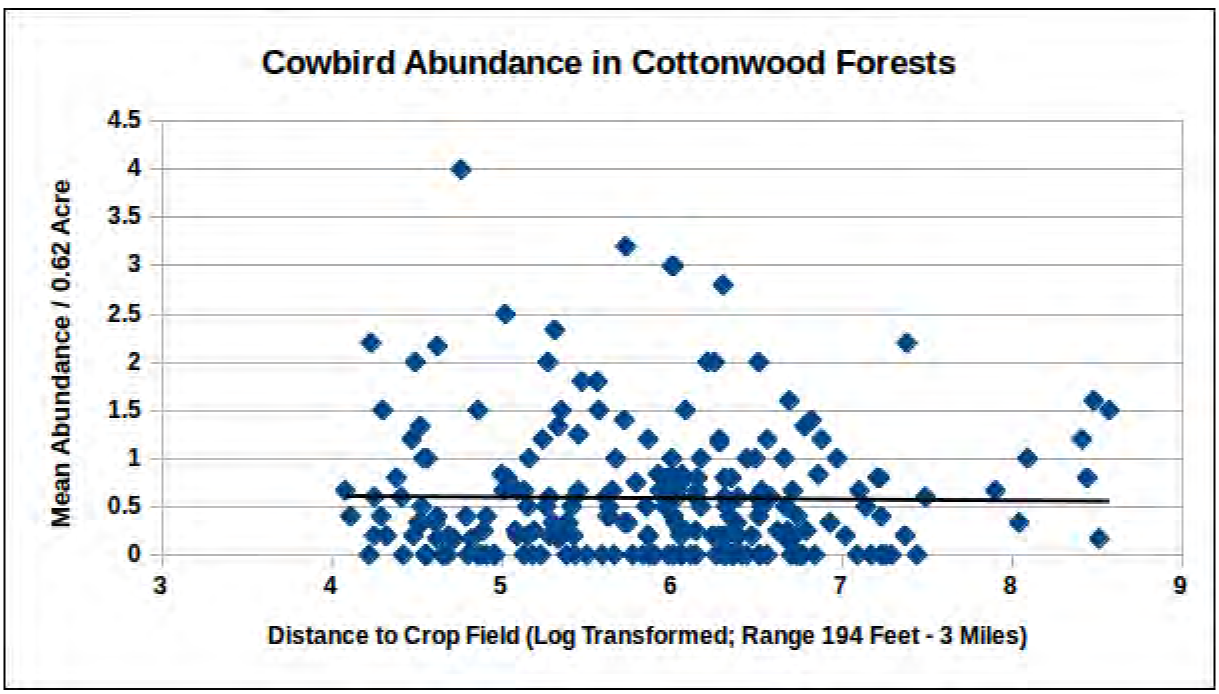


Figure 5-21 **Relationship between Cowbird abundance in cottonwood forest and proximity to agricultural fields observed during the LYR study (Jones and Hansen 2009).**

5.4 Alteration of Riparian Grassland Habitat

Grasslands are included in discussions of important riparian habitat because many species observed along the Yellowstone River are dependent upon this habitat type, and riparian grasslands have been substantially impacted by land use along the river. Limited sampling of grasslands occurred during both the UYR and LYR studies, which provides basic knowledge about species associated with grassland habitats along the river. Thirty grassland sites were sampled during the LYR Study, mostly in reaches A7, A11, and C7, while 13 sites were sampled during the UYR Study throughout Region PC. Nine grassland-dependent species were documented, including Bobolinks (SOC), Dickcissels (PSOC), and three other conservation species; many other avian species observed are known to use grassland habitats regularly.

Riparian grassland habitat is lost when herbaceous lands are converted to agricultural crops, because grassland-dependent bird species will not use cropland for nesting or foraging. No quantitative analyses are completed herein to describe the status and distribution of natural riparian grasslands along the river because it is difficult to distinguish grasslands from other types of herbaceous cover (including agriculture) using aerial photographs (DTM and AGI, 2008). However, the distribution of herbaceous lands, including grasslands, and change through time were quantified in the Land Use Mapping effort (DTM, 2013), and may provide a metric of general changes in habitat condition for grassland bird species.

Management of riparian grasslands may further impact grassland-dependent bird species. The conversion of natural herbaceous lands to irrigated hayfields often represents a degradation of habitat for birds. Although hayfields seemingly provide high-quality riparian habitat where many grassland species breed, they are usually mowed regularly during the breeding season (late May to early July), which destroys nests and often kills adult birds (see Jones, 2014 for a complete review of this topic). No data exist for quantifying relationships between mowing and grassland bird communities along the Yellowstone River, and consequently the potential impacts will not be discussed further. However, studies in other regions of North America have documented severe negative impacts of mowing for Savannah Sparrows, which were recorded at 40 percent of riparian grassland sites sampled during the LYR study. Potential impacts to Bobolinks (SOC), observed in every region downstream from Springdale, Montana, deserve special consideration. Mowing during the breeding season has been suggested as one of the most important factors influencing population declines for this species in North America (Jones, 2014). Changes in habitat condition that are potentially detrimental for Bobolinks are likely detrimental for many other grassland species that breed along the Yellowstone River, including Dickcissels, a PSOC in Montana, and Western Meadowlarks, a declining species (Jones, 2014).

Riparian management of grasslands may impact species in other ways as well. For example, baling twine is often used by Ospreys (*Pandion haliaetus*) as nesting material, and has been found to entangle young, resulting in increased rates of mortality (Seacor and Ostovar, 2013).

5.5 Loss of Landscape-Level Habitat Heterogeneity

The habitat heterogeneity found within the floodplain of the Yellowstone River provides a variety of resources for birds, and contributes to overall bird diversity within the riparian landscape. Analyses documenting relationships between avian responses and habitat heterogeneity are not presented herein because avian data do not exist to adequately quantify diversity at a landscape scale. However, results from analyses presented during the UYR (Hansen et al., 2003) and LYR (Jones and Hansen, 2009) studies discuss relationships between avian diversity and habitat heterogeneity. These results suggest that different types of habitats within the floodplain provide different types of resources for birds, and that species are often associated with particular habitat types. Key results from these studies include:

- Various habitat types, including cottonwood forest, riparian shrub, gravel bar, and grassland supported different riparian bird species, with habitat preferences reflecting niche requirements of species (UYR study).

- Different cottonwood forest habitat types differed in structural characteristics of the understory and canopy; many bird species exhibited an association with at least one cottonwood habitat type, indicating that different species were using different habitat types (LYR study).
- Particular guilds of species were associated with certain cottonwood habitats, suggesting that different habitats provide different types of resources for birds (LYR study).

These results indicate that the existence of habitat heterogeneity within the floodplain of the Yellowstone River contributes to overall bird diversity within the riparian landscape. Metrics quantifying the distribution of different habitat types in the floodplain represent a measure of habitat heterogeneity; change in the extent or proportion of particular habitats through time would suggest a change in habitat condition that likely impacts riparian bird diversity. Analyses describing changes in the distribution of different riparian habitats along the Yellowstone River through time are presented in Appendix 7, and will be summarized as a metric of habitat heterogeneity in Section 4.10.4.

Much of the habitat heterogeneity within the floodplain is created and sustained by successional processes, with different types of habitats likely representing different successional stages. Consequently, the presence of the full range of successional stages within the floodplain maintains habitat for a variety of bird species, and the disappearance of particular successional stages would likely result in the loss of certain riparian bird species and a decline in overall diversity. Consequently, metrics quantifying floodplain processes that drive succession along the Yellowstone River may also be good indicators of change in habitat condition related to habitat heterogeneity. Floodplain turnover measures the exchange of area between channel and riparian vegetation through time, and represents a measure of disturbance that drives cottonwood succession. Changes in rates of floodplain turnover may indicate changes in the amount of habitat heterogeneity in the floodplain through time. Analyses regarding trends in rates of floodplain turnover through time are presented in Appendix 7, and will be summarized as a driver of change in habitat condition in Section 4.10.4.

Land-use drivers of change in habitat heterogeneity within the floodplain of the Yellowstone River include human influences that restrict natural channel migration, resulting in decreased rates of riparian turnover and subsequent declines in the creation and maintenance of a variety of successional habitats in the floodplain. These include:

- Physical floodplain features
- Hydrological alterations that cause reduced peak flows
- Floodplain isolation

5.6 Spread of Invasive Plant Species

Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix* spp.) are two of the most invasive exotic plants to become naturalized in riparian areas of the West. Both saltcedar and Russian olive grow as dense monotypic stands within the floodplain, and Russian olive also establishes in the understory of mature cottonwood forest. See Appendix 7 for a discussion about these invasive plant species.

Following is a summary of the key findings and relationships (from Jones, 2014) related to the effect of the spread of Russian olive and saltcedar on habitat condition for riparian birds:

1. Cottonwood forest with Russian olive in the understory is often as structurally complex as forest with native shrub, and there is little evidence that habitat condition is degraded for riparian birds in forest with Russian olive along the Yellowstone River.

2. However, if monotypic stands of Russian olive or saltcedar completely replace structurally complex native cottonwood forest, habitat condition will be degraded for many riparian bird species, particularly for cavity-nesting and bark-gleaning species that depend upon large trees and snags that are absent from Russian olive and saltcedar stands.

3. This is an important consideration for Red-headed Woodpeckers (SOC) and Chimney Swifts (PSOC), as well as for twelve other avian species observed during the LYR Study that depend upon large live and dead cottonwood trees for foraging and nesting habitat.

4. Standing dead trees are a crucial component of riparian forest habitat for many other non-avian species that occur along the Yellowstone River, such as hoary bats, a Montana SOC, that hibernates in hollow trees and snags, and silver-haired bats, a PSOC, that roost and breed in old woodpecker cavities. Porcupines and white-footed mice, also Montana PSOC, use hollow trees in riparian forest for denning.

5. Land use drivers of the spread of invasive plant species within the floodplain of the Yellowstone River include:

    - Physical floodplain features that limit channel migration and alter rates of riparian turnover

    - Hydrological alterations that cause reduced peak flows and summer low flows

Metrics that represent the extent of monotypic Russian olive and saltcedar in the floodplain may be indicators of habitat degradation for cavity-nesting species. The distribution of Russian olive stands were mapped in 2008 for all counties along the river corridor, while saltcedar has been mapped for part of the corridor. Analyses regarding the distribution of Russian olive and saltcedar are presented in Appendix 7, and will be summarized as a metric of habitat condition in Section 4.10.4.

Additionally, Russian olive and saltcedar have a competitive advantage over cottonwood when natural hydrologic regimes are modified by land use, and invasion by these species is often enhanced along river systems with altered hydrology and reduced disturbance. Consequently, metrics that quantify changes in hydrology and riparian processes that drive disturbance in the floodplain may be good indicators of potential habitat degradation for birds due to the spread of invasive species. Floodplain turnover measures the exchange of area between channel and riparian vegetation through time, and represents a measure of disturbance that influences the spread of invasive plant species. Analyses regarding trends in rates of floodplain turnover through time are presented in Appendix 7, and will be summarized as a driver of change in habitat condition in Section 4.10.4.

5.7 Alteration of In-channel Habitats for Least Tern

Federally Endangered Least Terns were not surveyed during the three avian studies. However, the following information summarizes key avian-habitat relationships related to the alteration of in-channel habitats for Least Terns (from Atkinson and Dood. 2006):

1. Nesting habitat includes midstream sand and gravel bars relatively free of vegetation.

2. Foraging areas include side channels and other shallow water habitats (<3 feet deep, ideally approximately 6 inches deep) where small surface schooling fish congregate.

3. Essential breeding habitat includes areas that contain foraging habitat in close proximity to nesting sites. Consequently, most breeding sites along the Yellowstone River occur in unconfined or braided sections where channel sinuosity is high and there is greater incidence of bars and islands surrounded by channel.

4. Other avian species that forage in shallow water habitats along the Yellowstone River, such as the Great Blue Heron (SOC), are potentially similarly impacted by these threats to habitat condition. A large proportion of Great Blue Heron colonies and nests observed in Montana are located within the Yellowstone River watershed (MTNHP and MTFWP, 2013).

The UYR, LYR, and MA studies all focused on sampling bird communities in riparian habitats, so no data exist to quantify the distribution of Least Terns along the Yellowstone River or relationships with metrics of habitat condition. However, Least Terns have been documented breeding at various locations in Regions C and D, downstream from the Tongue River confluence. Breeding and foraging habitats in reaches with high floodplain complexity in these regions of the river are likely crucial for sustaining populations of Least Terns.

Floodplain complexity is sustained by natural hydrologic processes that drive lateral channel migration and disturbance. Consequently, metrics quantifying floodplain processes that drive channel migration and turnover along the Yellowstone River may also be good indicators of change in habitat condition for Least Terns. Alterations to hydrology that result in lower rates of channel migration, less disturbance within the floodplain, and the dewatering of shallow-water habitats may indicate a reduction in the creation and maintenance of nesting and foraging habitats for Least Terns. Analyses quantifying hydrologic alteration along the Yellowstone River through time are presented in Appendix 2, and will be summarized as a driver of change in habitat condition in Section 4.10.4.

Furthermore, trends in floodplain turnover, which measures the exchange of area between channel and riparian vegetation, may also indicate changes to overall floodplain complexity through time. Floodplain turnover measures the exchange of area between channel and riparian vegetation through time, and represents a measure of disturbance that maintains floodplain complexity and Least Tern nesting and foraging habitats. Analyses regarding trends in rates of floodplain turnover through time are presented in Appendix 7, and will be summarized as a driver of change in habitat condition in Section 4.10.4.

Specific land-use drivers of change in habitat condition for Least Terns along the Yellowstone River include:

- Physical floodplain features that limit channel migration and alter rates of riparian turnover
- Hydrological alterations that cause reduced peak flows and summer low flows
- Isolation of floodplain that results in channelization and the loss of side channels

5.8 Metrics of Habitat Condition along the Yellowstone River

Current status and change over time for important metrics of habitat condition identified in Section 4.10.3 are discussed in this section, including results from analyses describing the extent of all cottonwood forest, the extent of TC forest, the distribution of land uses that provide foraging habitat for Cowbirds, and the area of cottonwood forest habitat that is potentially impacted by Cowbird parasitism. Analyses conducted by other investigators that describes metrics of habitat condition for avian responses will also be summarized.

5.8.1 Extent of Cottonwood Forest Habitat

The extent of cottonwood forest in the riparian landscape was the most important metric of habitat condition for forest specialist species, particularly the extent of TC forest. Data from the Riparian Habitat Map (DTM and AGI, 2008) were used to quantify how the extent of forest varies over space and time. When ranked by the total amount (acres/valley mile) of cottonwood forest (Figure 5-22) and the total amount of TC forest (Figure 5-23) in 2001, all regions were represented in the top 25 percent of reaches, but most reaches were located in Regions C and D. The top 25 percent of reaches contained more than half of all cottonwood forest and all TC forest acreage within the Yellowstone River floodplain downstream from Springdale, Montana, and consequently represent relatively important areas of avian forest habitat. Reaches A17, A18, and B3 were included in the top reaches, and contained substantially more forest than most other reaches in Regions A and B, suggesting that these reaches provide relatively important areas of forest habitat within those regions. The greatest amounts of all cottonwood forest and TC forest were both located in Reach D16 which contained almost 500 acres/valley mile of forest, more than twice as much forest as most other reaches (Figure 5-22 and Figure 5-23). Most of the top reaches were Anabranching reach types (UA or PCA; Table 5-1) characterized by a threaded channel with forested islands; however, D16 was an Unconfined Straight reach type(US/I). For both total cottonwood forest and TC forest, three-quarters of the top reaches were included in the top 25 percent for all three time periods (Table 5-1), suggesting that the reaches with the greatest amounts of forest are consistently important through time. In 2001, the top 6 reaches with the greatest amounts of TC forest were located in Region D (Figure 5-23); this is a deviation from previous time periods, where the reaches with the greatest amounts of TC forest represented other regions as well (Table 5-1).

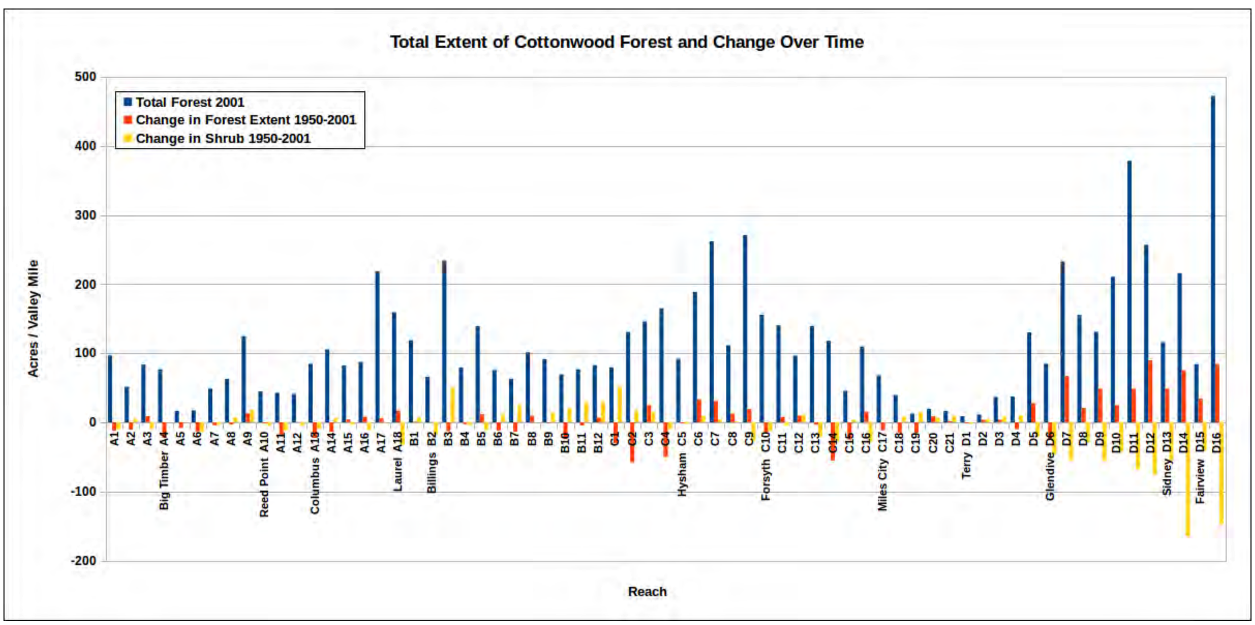


Figure 5-22 **Total extent (acres/valley mile) of cottonwood forest (TC + TO habitats) within reaches in 2001, as well as change in acreage of forest and shrub over time. Reaches are ordered by location along the river.**

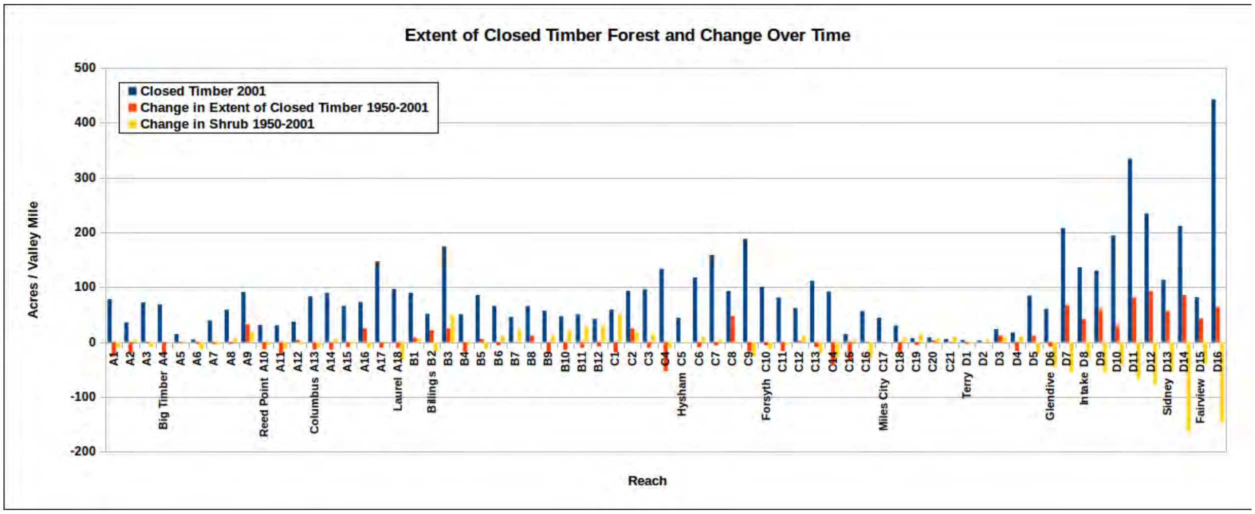


Figure 5-23 **Total extent (acres/valley mile) of TC cottonwood forest within reaches in 2001, as well as change in acreage of forest and shrub over time. Reaches are ordered by location along the river.**

Table 5-1
Top 25 percent of reaches with greatest amounts (acres/valley mile) of cottonwood forest (TC+TO) and TC forest through time. Reach types are in parentheses.

CW Forest 2001	TC Forest 2001	CW Forest 1976	TC Forest 1976	CW Forest 1950	TC Forest 1950
D16 (US/I)	**D16** (US/I)	**D11*** (PCA)	**D11*** (PCA)	**D16** (US/I)	**D16** (US/I)
D11 (PCA)	**D11** (PCA)	**C9** (UA)	**D12** (PCA)	**D11** (PCA)	**D11** (PCA)
C9 (UA)	**D12** (PCA)	**C7** (UA)	**C7** (UA)	**C9** (UA)	**C9** (UA)
C7 (UA)	**D14** (PCM/I)	**A17** (UA)	**C9** (UA)	**B3** (UB)	**C4** (PCB)
D12 (PCA)	**D7** (PCA)	**D12** (PCA)	**B3** (UB)	**C7** (UA)	**C7** (UA)
B3 (UB)	**D10** (PCA)	**B3** (UB)	**A17** (UA)	**C4** (PCB)	**D10** (PCA)
D7 (PCA)	**C9** (UA)	**D10** (PCA)	**D14** (PCM/I)	**A17** (UA)	**A17** (UA)
A17 (UA)	**B3** (UB)	**D14** (PCM/I)	**D10** (PCA)	**C2** (PCB)	**B3** (UB)
D14 (PCM/I)	**C7** (UA)	**D8** (PCA)	**D7** (PCA)	**D10** (PCA)	**D12** (PCA)
D10 (PCA)	**A17** (UA)	**C6** (UA)	**D8** (PCA)	**C14** (PCM/I)	**D7** (PCA)
C6 (UA)	**D8** (PCA)	**D7** (PCA)	**C6** (UA)	**C10** (PCM)	**C14** (PCM/I)
C4 (PCB)	**C4** (PCB)	**C10** (PCM)	**C10** (PCM)	**D12** (PCA)	**C6** (UA)
A18 (UA)	**D9** (PCM/I)	**C4** (PCB)	**C4** (PCB)	**D7** (PCA)	**D14** (PCM/I)
C10 (PCM)	**C6** (UA)	**A18** (UA)	**C13** (PCM/I)	**C6** (UA)	**C13** (PCM/I)
D8 (PCA)	**D13** (PCM/I)	**C2** (PCB)	**C2** (PCB)	**C13** (PCM/I)	**A18** (UA)
C3 (UA)	**C13** (PCM/I)	**C13** (PCM/I)	**A18** (UA)	**A18** (UA)	**C3** (UA)

* Data were not available for quantifying forest acreage in reaches D15 and D16 in 1976.

Most of the top 25 percent of reaches experienced gains in cottonwood forest (Figure 5-22) and TC forest (Figure 5-23) acreage from 1950-2001. Reach D12 gained almost 90 acres of cottonwood forest and TC forest per valley mile, the greatest of all reaches. However, most of the top reaches also experienced substantial declines in the acres of shrub per valley mile (Figure 5-22 and Figure 5-23). For example, Reach D16, which gained over 80 acres of forest per valley mile, lost almost twice that much area of shrub in the same time period. The shrub vegetation type often represents young stands of cottonwood forest, and consequently the extent of shrub habitat provides a measure of cottonwood forest regeneration (DTM and AGI, 2008; Appendix 7). The loss of shrub acreage through time suggests a decline in regeneration that could result in a long term loss of forest within these reaches that have historically provided the greatest extent of cottonwood forest, particularly the TC forest habitat type.

Trends in the extent and distribution of cottonwood forest at a regional scale were quantified by averaging across reaches within a region. Forest acreage increased steadily in the downstream direction, with lowest acreage per valley mile in reaches of Region A and highest in Region D (Figure 5-24). There was approximately twice as much acreage of TC forest in Region D compared with the other regions. Reaches in Region D experienced an overall increase in acreage of cottonwood forest and TC forest from 1950-2001, gaining on average 34 acres of cottonwood forest per valley mile, while other regions remained relatively stable or lost acreage. However, reaches in Region D lost almost 50 acres of shrub habitat per valley mile while shrub acreage in the other regions remained relatively stable or experienced small gains. Similar to results from the reach-scale analyses, these results suggest that the extent of cottonwood forest, particularly TC forest habitat, has increased in Region D since 1950 through the regeneration and maturation of existing younger stands, but declines in current rates of regeneration suggest potential long term losses in the extent of forest habitat in this region.

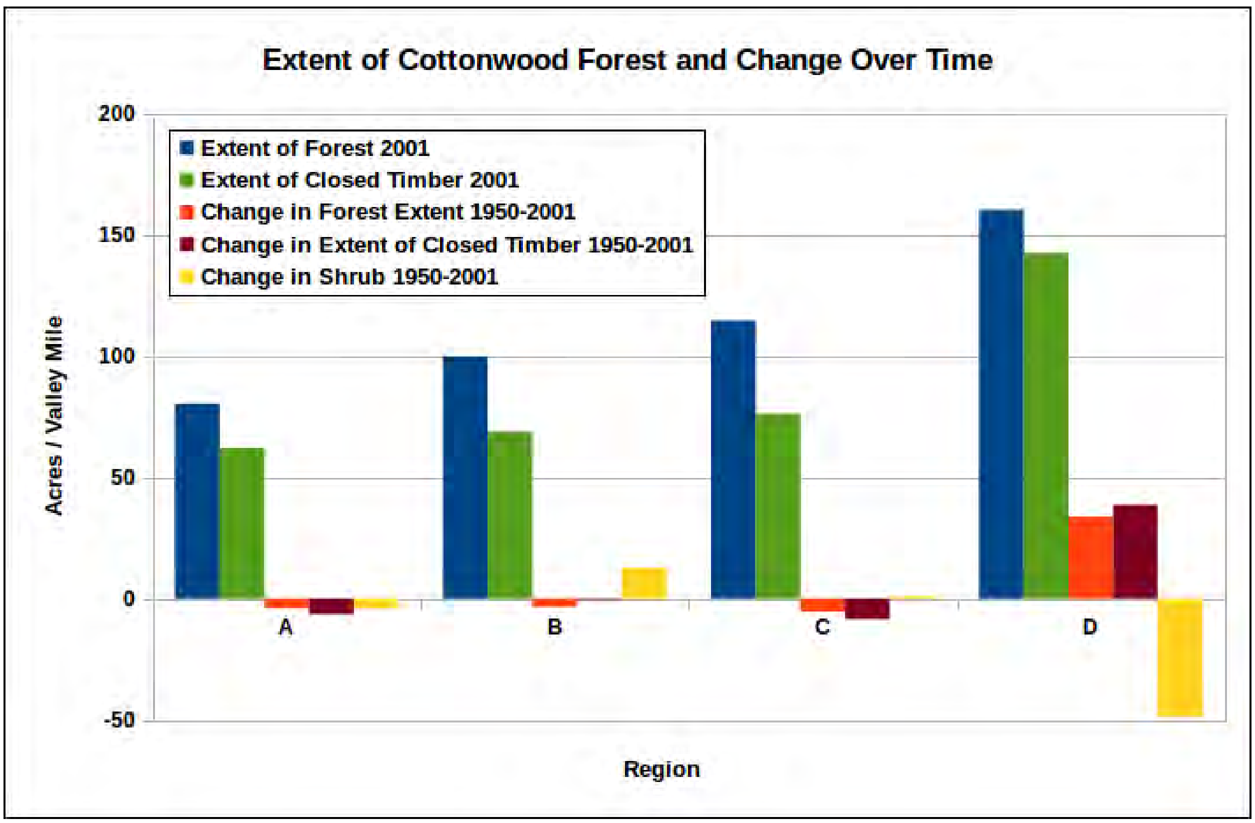


Figure 5-24 **Total extent (acres/valley mile) of all cottonwood forest (TC+TO) and TC forest within regions in 2001, as well as change in acreage of forest and shrub over time.**

The US/I reach type contained approximately three times more acreage of cottonwood forest and TC forest per valley mile than any other reach type along the river (Figure 5-25). However, D16 is the only reach that is classified as this type of channel, so results from the US/I reach type reflect conditions in this reach only. The 22 reaches that represent the Anabranching reach types (UA and PCA) contained on average the greatest amounts of cottonwood forest and TC forest compared to all remaining reach types, while confined reaches contained the least amount of forest (Figure 5-25). This trend was consistent across all regions of the river except in Region B, where acreage in Anabranching reaches was second to Unconfined Braided (UB) reaches (Figure 5-26). However, differences in TC forest acreage between Braided and Anabranching reach types were small, particularly in Regions B and C (Figure 5-27), suggesting that these dynamic reach types in general contain greater amounts of TC forest habitat. When UA and PCA reaches both existed in a single region (i.e., Regions A and B, Figure 5-26), unconfined reaches contained greater amounts of forest than Partially Confined reaches. These results suggest that Anabranching reaches, particularly unconfined ones, are relatively important because they contain the most extensive forest habitats of all reach types.

5.9 Distribution of Land Uses that Provide Cowbird Foraging Habitat

Land uses that provide foraging habitat for Cowbirds include urban and ex-urban residential areas, and farmsteads with infrastructural outbuildings for livestock and feed. These land uses correspond with Level 3 land use categories that were identified for 1950, 1976, 2001, and 2011 for the entire river corridor in the Land Use Mapping effort (DTM, 2013), including Other Agricultural Infrastructure ('AgInf'; feedlots, corrals, outbuildings, etc.), Ex-urban Residential, and Urban Residential. For these analyses, Exurban and Urban categories were combined to create one Residential category ('Res').

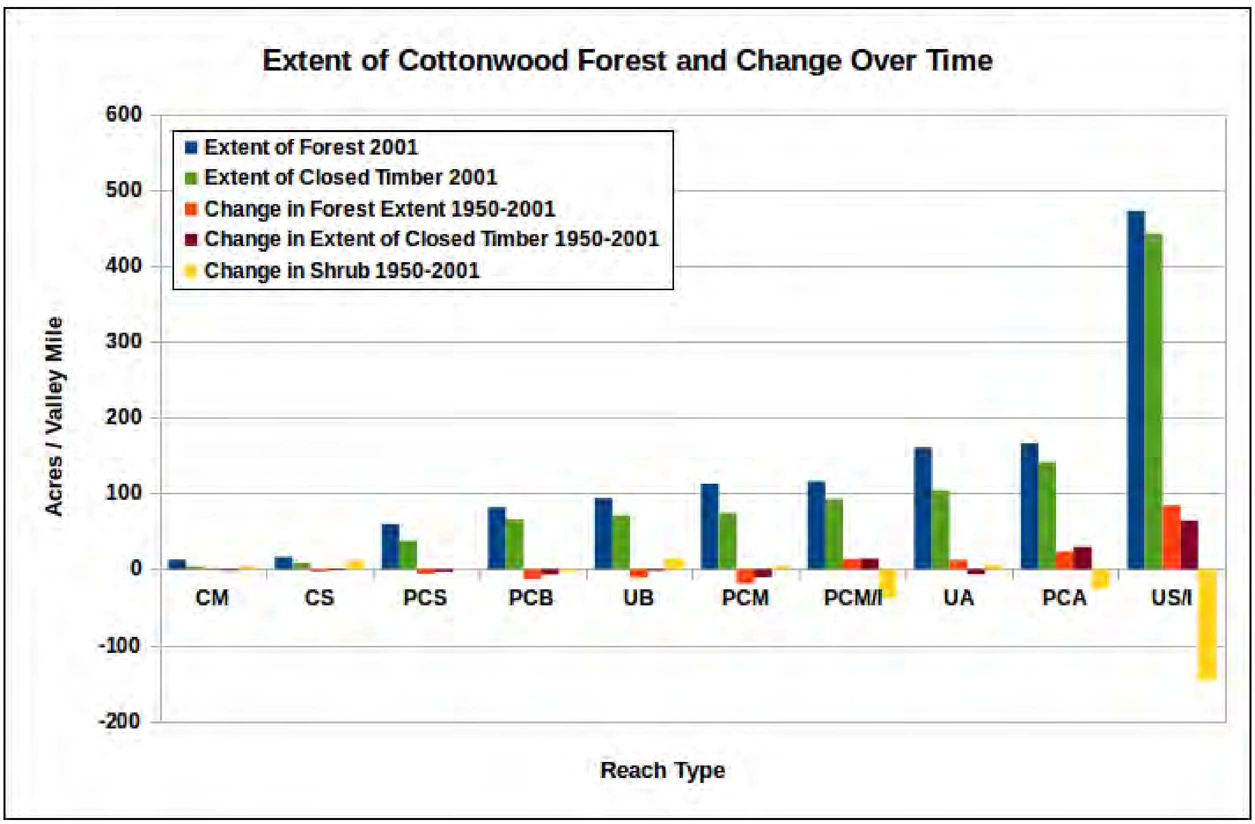


Figure 5-25 Total extent (acres/valley mile) of all cottonwood forest (TC+TO) and TC forest within reach types in 2001, as well as change in acreage of forest and shrub over time. Reach types are ordered by total forest extent.

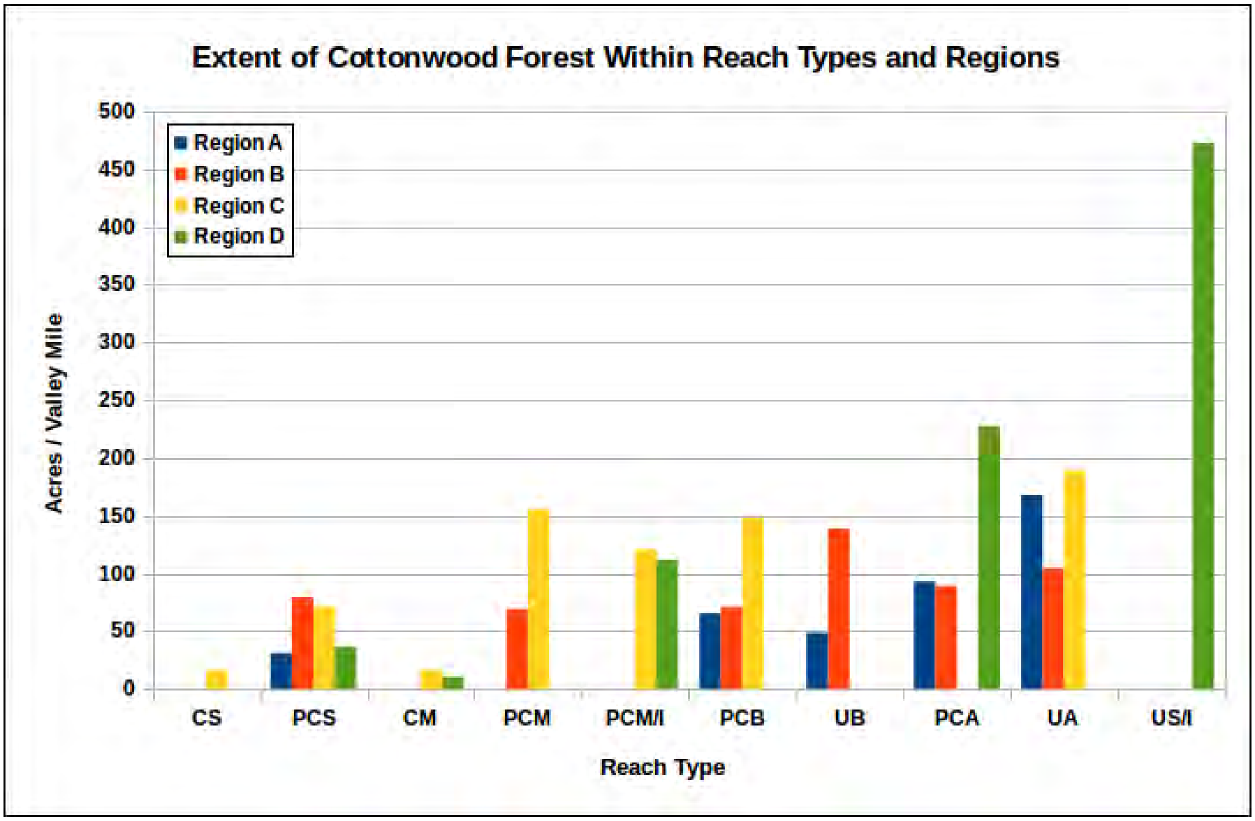


Figure 5-26 **Extent (acres/valley mile) of cottonwood forest (TC+TO) within reach types across regions in 2001.**

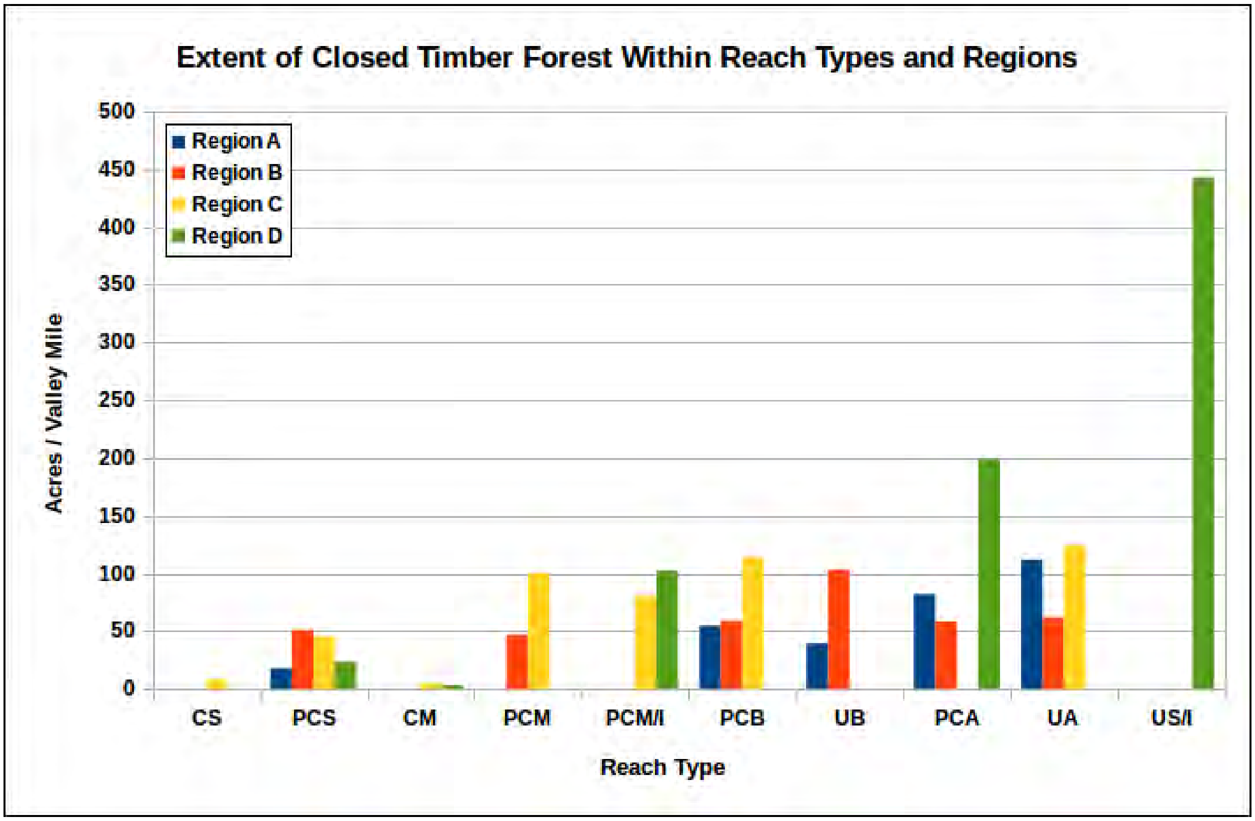


Figure 5-27 Extent (acres/valley mile) of TC forest within reach types across regions in 2001.

Figure 5-28 presents the amounts of Res and AgInf in all reaches in 2011. Reaches PC8 (north of Emigrant), B1 (Billings), and C17 (Miles City) contained the greatest amounts of Res; B1 also contained substantial acreage of AgInf and had the greatest extent of land uses that provide foraging habitat for Cowbirds of all reaches. The reaches in Region B downstream from Huntley (B5) had relatively small amounts of Res, suggesting that the potential impacts of Residential development are concentrated in the upstream reaches of that Region. Most reaches in Region PC had more acreage of Res than AgInf, while most reaches in Regions C and D had more acreage of AgInf than Res. Total acreage of land uses that provide foraging habitat for Cowbirds was generally lowest in reaches in Regions C and D, where most reaches contained <200 acres of these land uses in 2011. This is consistent with results from the avian data; Cowbird abundance at avian sampling sites was generally lowest in reaches of Regions C and D as well (Figure 5-17). However, reaches C9 and C19 had the greatest acreage of AgInf of all reaches besides B1 (Billings), suggesting this land use may provide relatively substantial feeding opportunities for Cowbirds in those reaches.

Figure 5-29 presents the amounts of Res and AgInf in all regions in 2011. Because total acreage of land use within a region may be influenced by a single outlier reach (e.g., acres of Res near Billings in Region B), the median values for all reaches are instead presented to give a more general picture of the impact of land use within an entire region. Reaches in Regions PC and A generally had the greatest amounts of land use providing foraging habitat for Cowbirds in 2011, and most of that acreage was attributed to Res. The influence of Res was small in most reaches of Region C and D, although substantial acreage of AgInf was present in these Regions. Reaches in Region D had the least acreage of land uses providing Cowbird foraging opportunities. Reaches in Region C contained the greatest amounts of Cowbird foraging habitat attributed to AgInf, and most of that acreage was gained between 1950 and 1976 (Figure 5-30). Reaches in Region PC generally contained the largest amounts of Res in 2011; most of the

Residential development in this region occurred between 1976 and 2001, when acreage more than doubled (Figure 5-31). Extent of residential land uses also doubled in Region A during that same time period (Figure 5-31). Region C had the greatest amount of Res in 1950, but has gained relatively little acreage since then, and currently contains substantially less than Regions PC and B. Acreage of Residential development in Region D has remained constant since 1976 (Figure 5-31).

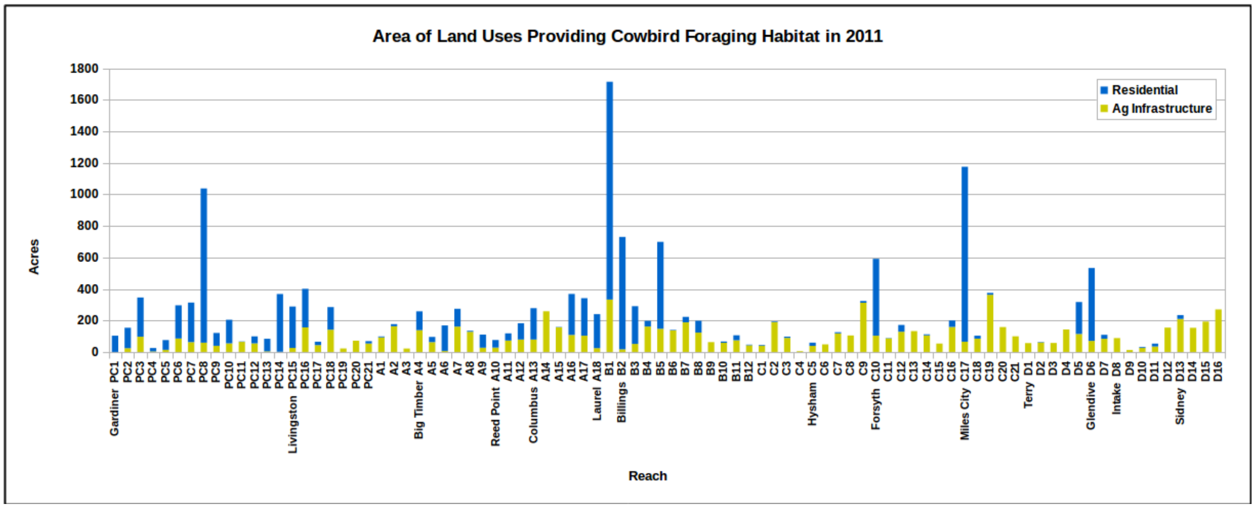


Figure 5-28 **Areas of Residential land use (Ex-urban + Urban) and Agricultural Infrastructure (i.e. feedlots, corrals, etc.) within each reach in 2011. These land uses represent prime foraging habitat for Brown-headed Cowbirds.**

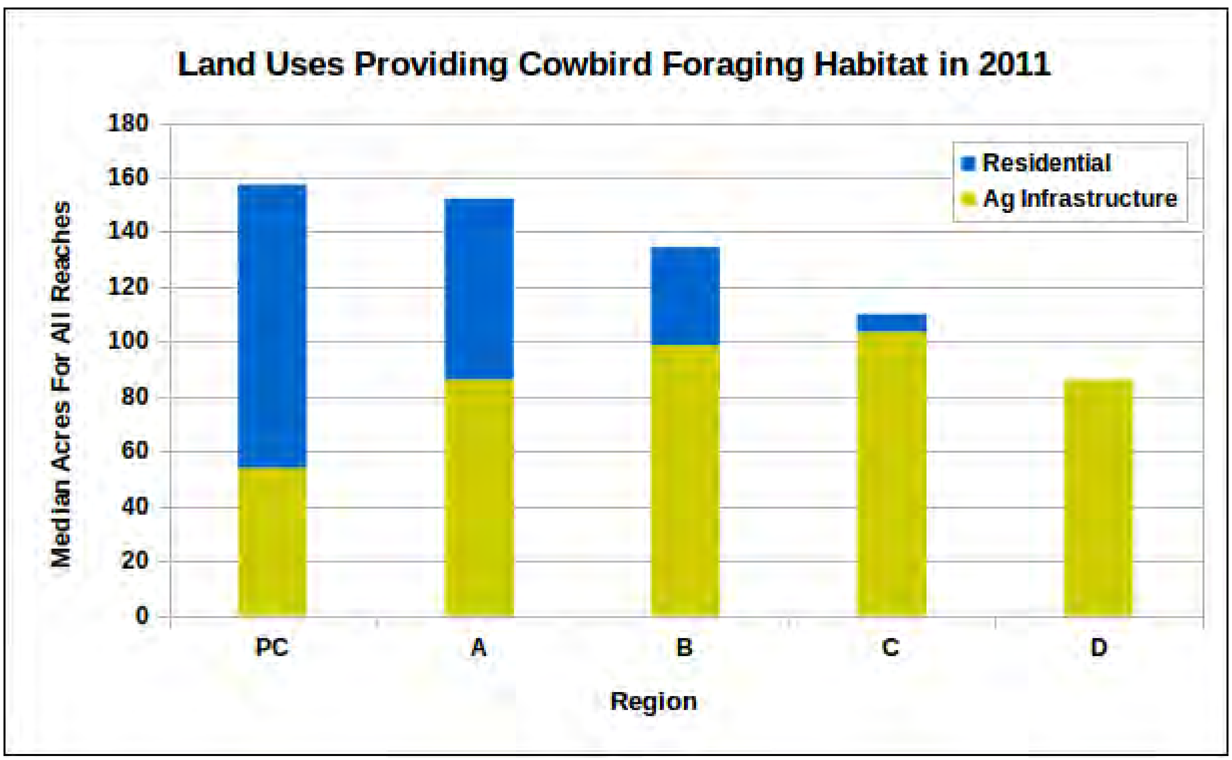


Figure 5-29 **Median acres of Residential land use (Ex-urban+Urban) and Agricultural Infrastructure (i.e., feedlots, corrals) for reaches within each region in 2011. These land uses represent prime foraging habitat for Brown-headed Cowbirds.**

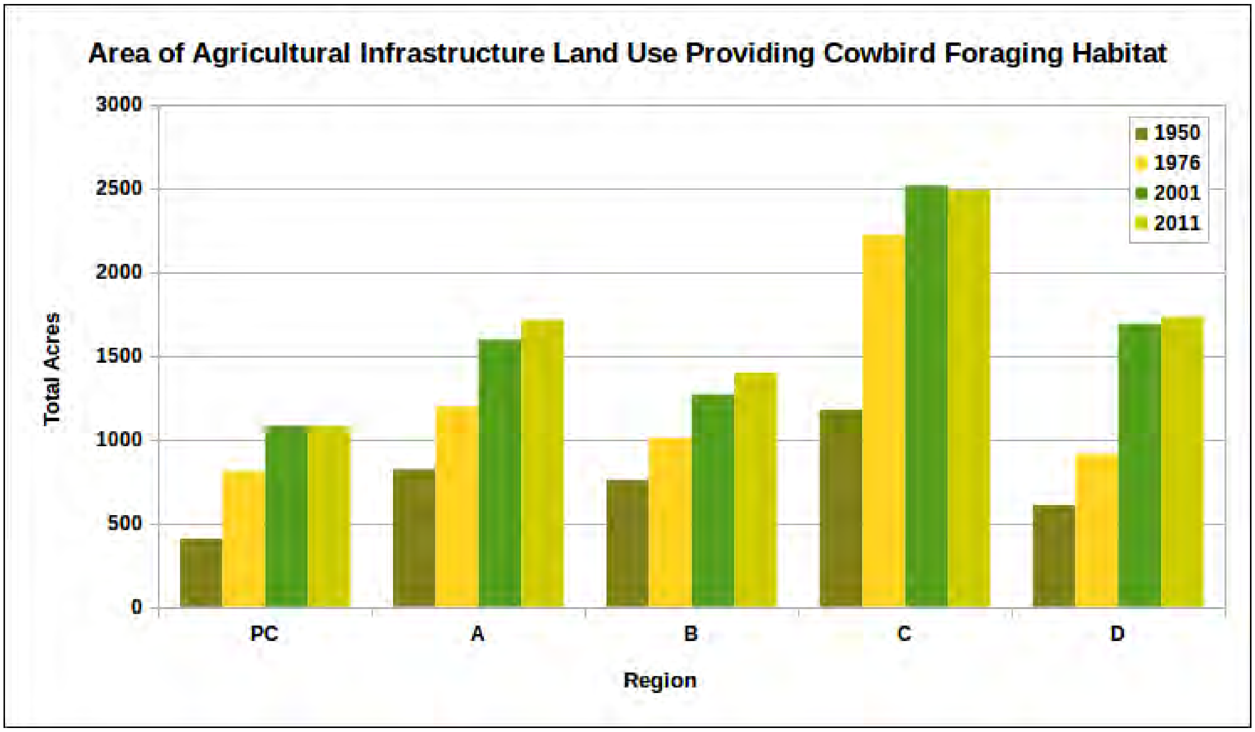


Figure 5-30 Area of Agricultural Infrastructure land use within each region from 1950-2011.

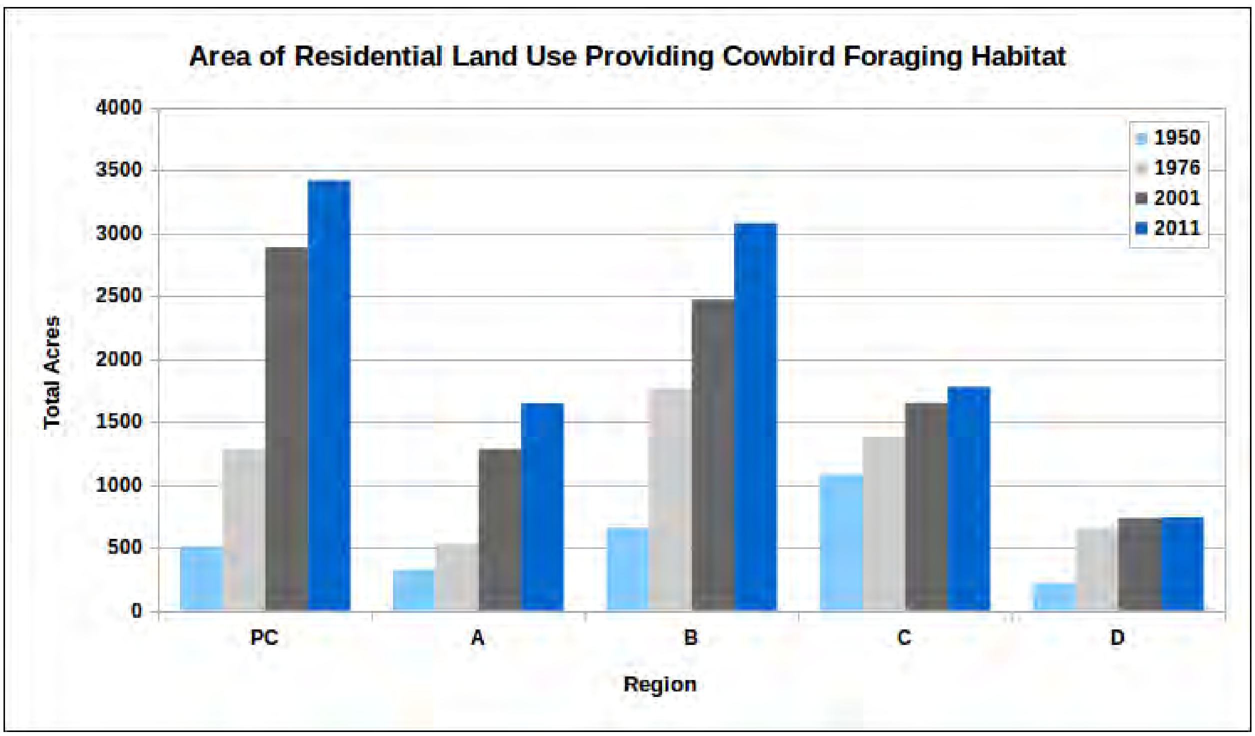


Figure 5-31 Area of Residential land use within each region from 1950-2011.

5.10 Distribution of Cottonwood Forest Potentially Impacted by Cowbird Parasitism

Cowbirds breed in cottonwood forest habitat and forage in surrounding human and livestock dominated landscapes. If necessary, Cowbirds will commute far distances (on average 0.62 miles in western landscapes; see review in Jones, 2014) daily between morning breeding habitat and afternoon foraging sites. When breeding habitat is closer to foraging habitat, Cowbirds spend less energy commuting and have more energy reserves for laying eggs. Consequently, breeding habitat in closer proximity to foraging habitat may experience greater intensity of parasitism. The Level 3 'AgInf' and 'Res' land use categories for 1950, 1976 and 2001 identified in Section 4.10.4.2 were used to project the status of potential habitat degradation due to Cowbird parasitism, and examine how degradation has changed through time. 'AgInf' and 'Res' polygons were each buffered by 1,640 feet and 0.62 miles to represent a surrounding area of Cowbird influence associated with the two types of land uses that provide foraging habitat. The 1,640-foot buffer represents higher parasitism intensity and a greater potential impact of parasitism (i.e., 'highly impacted'), while the 0.62-mile buffer represents an area likely impacted by parasitism, but with a lower level of intensity (i.e., 'impacted'). The buffer area varied based on the size of the polygon being buffered; larger polygons had greater perimeters, and consequently larger buffer areas. This variation in buffer area accurately reflects the larger area of influence that big areas of residential or agricultural infrastructure may have with respect to the amount of foraging habitat provided for Cowbirds. These buffers were then overlaid with polygons representing cottonwood forest from the Riparian Habitat Map (DTM and AGI, 2008) to quantify the extent of forest that is within the influence of these land uses and potentially impacted by Cowbird parasitism, and examine how much influence is attributable to each of the land-use types. 'AgInf' and 'Res' polygons were also merged into one category that was buffered in the same way to represent the total impact of all land uses combined and to quantify the overall extent of potential habitat degradation.

Figure 5-32 through Figure 5-35 describe the percent of cottonwood forest that is potentially impacted by parasitism based on proximity to all Cowbird land uses (AgInf + Res) for reaches in each region in 2001. The last bar in each graph represents the average amount of forest impacted and highly impacted for all reaches in the Region. Only 13 of the 67 reaches along the river had more than 50 percent of cottonwood forest that was greater than 0.62 miles away (i.e., not impacted) from land uses that provide Cowbird foraging habitat. At least one-third of cottonwood forest was potentially impacted by Cowbird parasitism in all but two reaches (C4 and C15).

Most of the reaches in Region A had a high percentage of cottonwood forest that was within 0.62 miles of Cowbird foraging habitat and was likely impacted by parasitism; on average, 90 percent of forest was potentially impacted (Figure 5-32). Much of that forest was actually within 1,640 feet of Cowbird land uses and was potentially highly impacted. Only one reach (A3) had less than 50 percent of cottonwood forest habitat that was potentially impacted by parasitism, while many reaches had 100 percent. Cottonwood habitat in reaches in Region B was also potentially heavily impacted by Cowbird parasitism, particularly in reaches B1 through B6 where almost all of the forest was impacted (Figure 5-33). Reaches of Region C had, on average, less than 75 percent of cottonwood habitat potentially impacted, and less than 30 percent highly impacted. Reach C4 had the lowest percentage of forest potentially impacted (~18 percent) of all reaches along the river. However, all of the cottonwood forest in reaches C17-C19 was potentially impacted by parasitism, with at least 75 percent of that habitat highly impacted (Figure 5-34). Reaches in Region D had on average the lowest percent of forest potentially impacted by parasitism (less than 60 percent), with less than 20 percent of that habitat highly impacted (Figure 5-35). However, reaches D3, D13, and D14 had greater than 80 percent of forest potentially impacted by parasitism. These results are generally consistent with trends in Cowbird abundance observed along the river; reaches in Region A had the highest Cowbird abundance while reaches in Region D had the lowest (Figure 5-17).

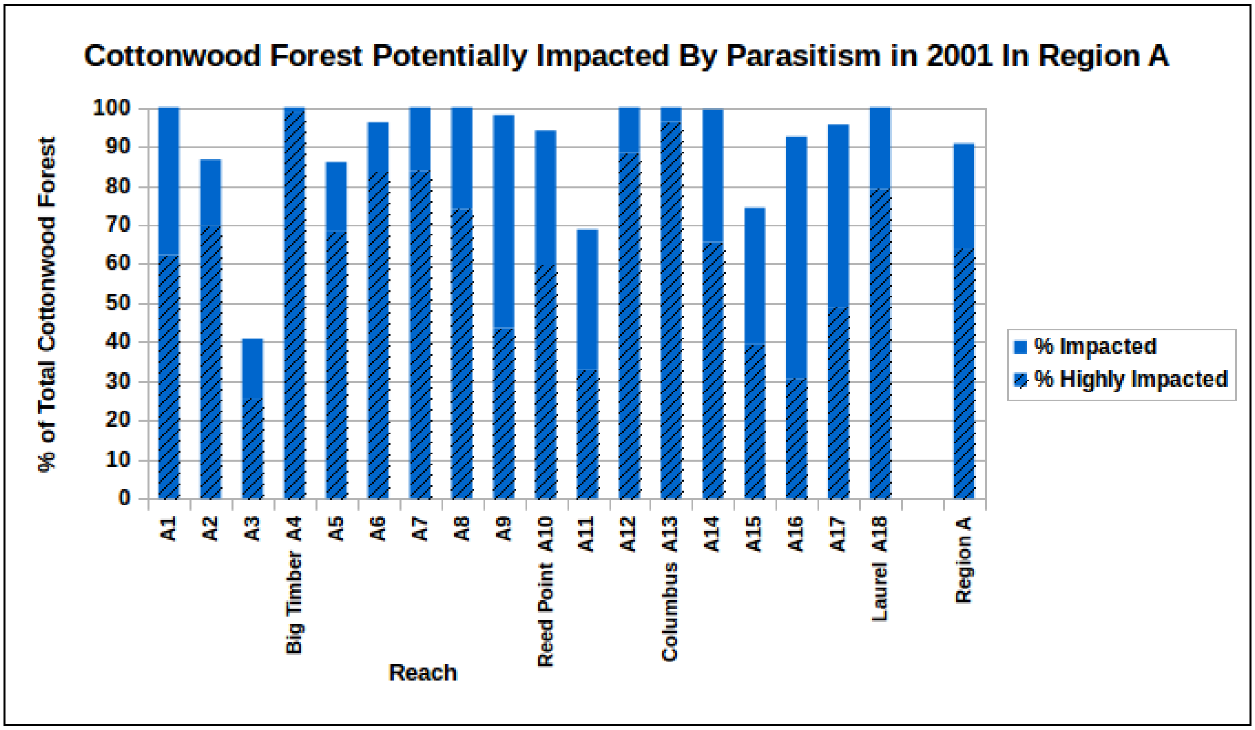


Figure 5-32 **Percent of all cottonwood forest habitat in reaches in Region A that is potentially impacted (i.e., within 0.62 miles of land uses that provide Cowbird foraging habitat) or highly impacted (i.e., within 1640 feet of land uses that provide Cowbird foraging habitat) by Cowbird parasitism in 2001.**

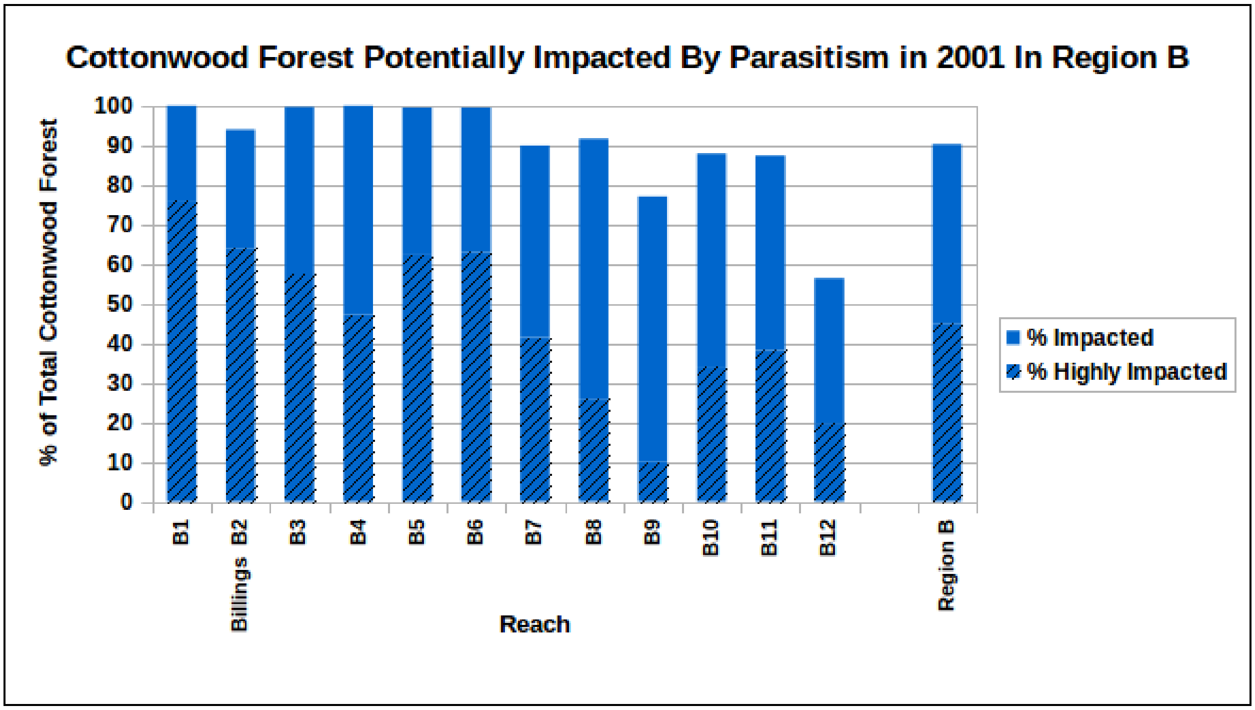


Figure 5-33 **Percent of all cottonwood forest habitat in reaches in Region B that is potentially impacted (i.e., within 0.62 miles of land uses that provide Cowbird foraging habitat) or highly impacted (i.e., within 1,640 feet of land uses that provide Cowbird foraging habitat) by Cowbird parasitism in 2001.**

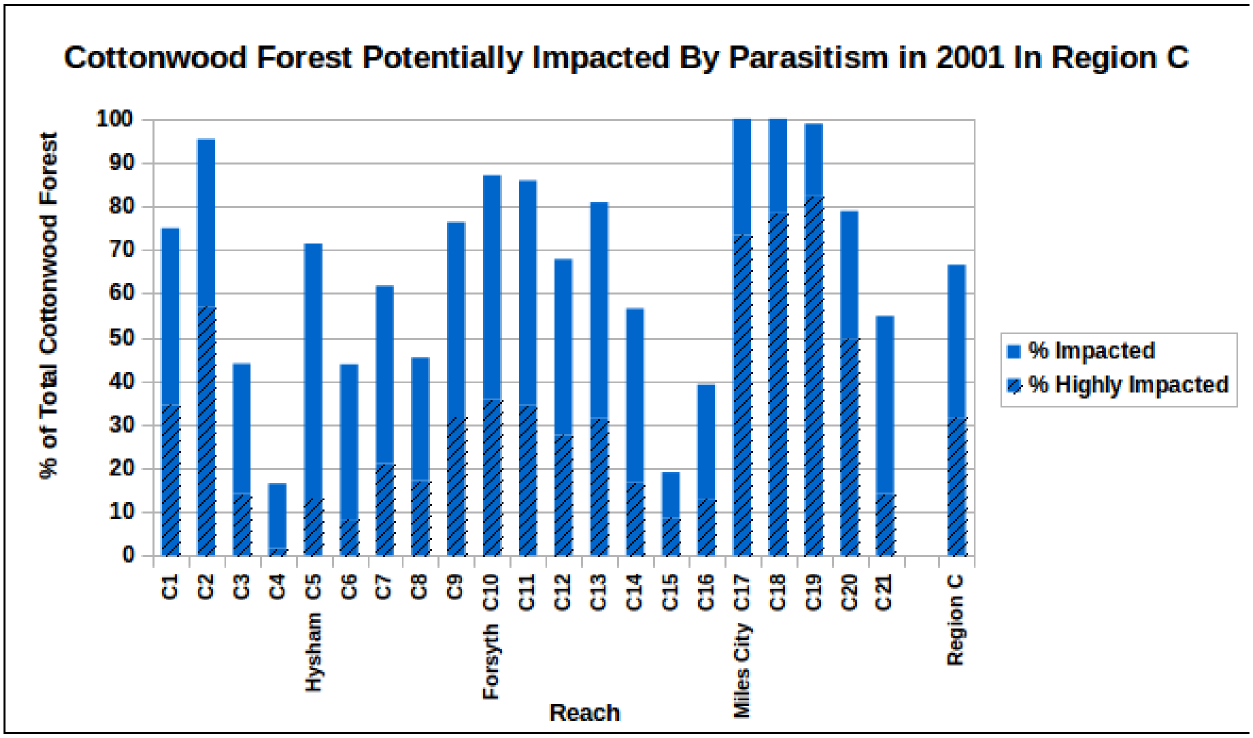


Figure 5-34 **Percent of all cottonwood forest habitat in reaches in Region C that is potentially impacted (i.e., within 0.62 miles of land uses that provide Cowbird foraging habitat) or highly impacted (i.e., within 1,640 feet of land uses that provide Cowbird foraging habitat) by Cowbird parasitism in 2001.**

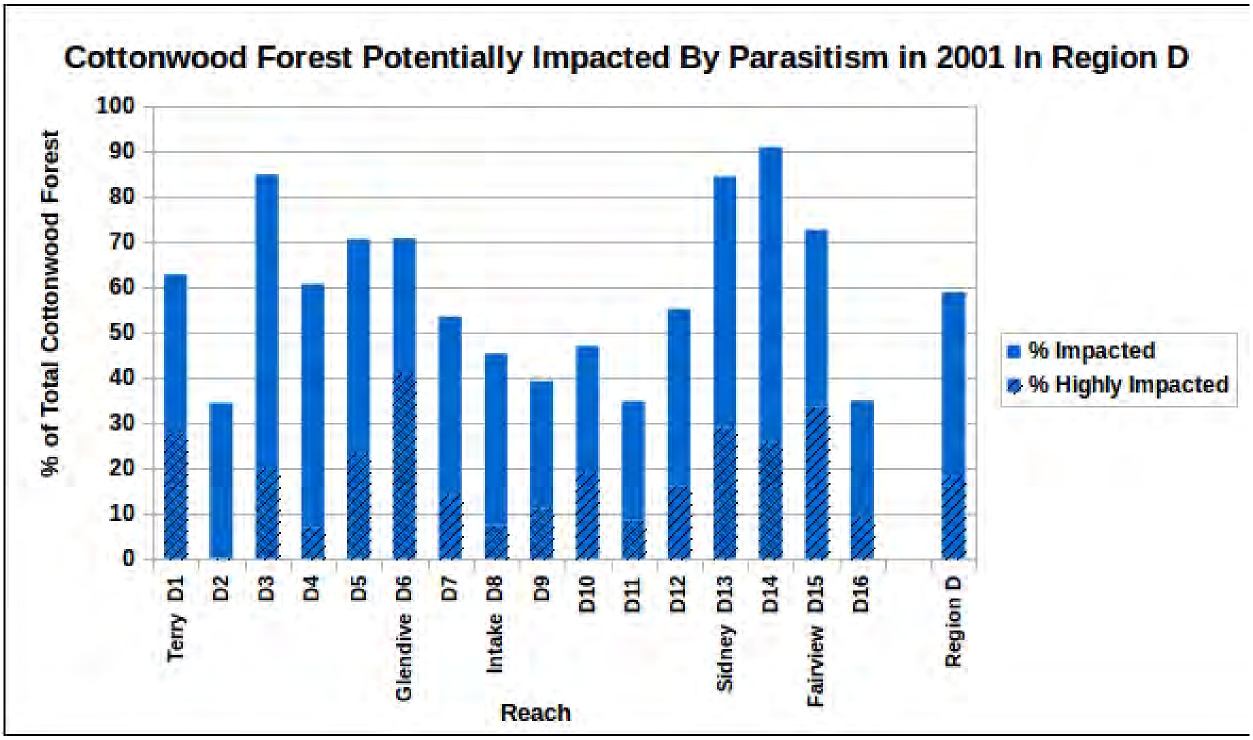


Figure 5-35 **Percent of all cottonwood forest habitat in reaches in Region D that is potentially impacted (i.e., within 0.62 miles of land uses that provide Cowbird foraging habitat) or highly impacted (i.e., within 1,640 feet of land uses that provide Cowbird foraging habitat) by Cowbird parasitism in 2001.**

A much higher percentage of cottonwood forest habitat was potentially impacted by parasitism due to AgInf land use than Res land use (Figure 5-36). However, the extent of each land use type (described in Section 4.10.4.2) was not always proportional to the potential impact of each land use on cottonwood forest habitat. Specifically, in Regions A and B, Res occupied many more acres of land than did AgInf in 2001 (Figure 5-30 and Figure 5-31), but AgInf impacted a much greater percentage of cottonwood forest (Figure 5-36). Furthermore, the percent of forest potentially influenced by AgInf did not necessarily reflect how the extent of AgInf land use changed through time. For example, there was a large increase in the extent of AgInf in Region D between 1976 and 2001 (Figure 5-30), but the percentage of forest potentially impacted by AgInf remained steady (Figure 5-36). Reaches of Region D experienced large net gains of cottonwood forest between 1976 and 2001 that were not observed in the previous time period (DTM and AGI, 2008,Appendix 7); an increase in the extent and influence of AgInf land use from 1976 to 2001 may have been offset by an increase in the total amount of cottonwood forest available in the region. Consequently, the percentage of cottonwood habitat that is potentially impacted by parasitism due to land use reflects more than just changes in land use; the total amount of cottonwood habitat in the floodplain will influence this metric, as well as the density of and location where land use changes occur in a region. Therefore, this type of analyses that incorporates the spatial location and amount of land use with respect to riparian vegetation is useful for considering potential impacts on habitat resources that may not be evident through examination of trends in land use alone.

The influence of AgInf was greatest in Regions A and B, where it was relatively high (>80 percent of forest potentially impacted) across all time periods (Figure 5-36). In all regions of the river, greater than 50 percent of cottonwood forest was potentially impacted by AgInf. The percent of cottonwood forest potentially impacted by Res was highest in Region A and lowest in Region D (Figure 5-36). Almost 50 percent of the cottonwood forest in Region A was potentially impacted by Res in 2001, and this was three times the amount potentially impacted in 1950. In the other regions, the percent of cottonwood forest potentially impacted by Res doubled from 1950 to 2001; however, in Region D the amount in 2001 was still less than 10 percent. The extent of Res land use also increased steadily in each region from 1950 to 2001 (Figure 5-31), and general trends in the amount of Res over time generally reflected changes in the percent of habitat potentially impacted by Res (Figure 5-36).

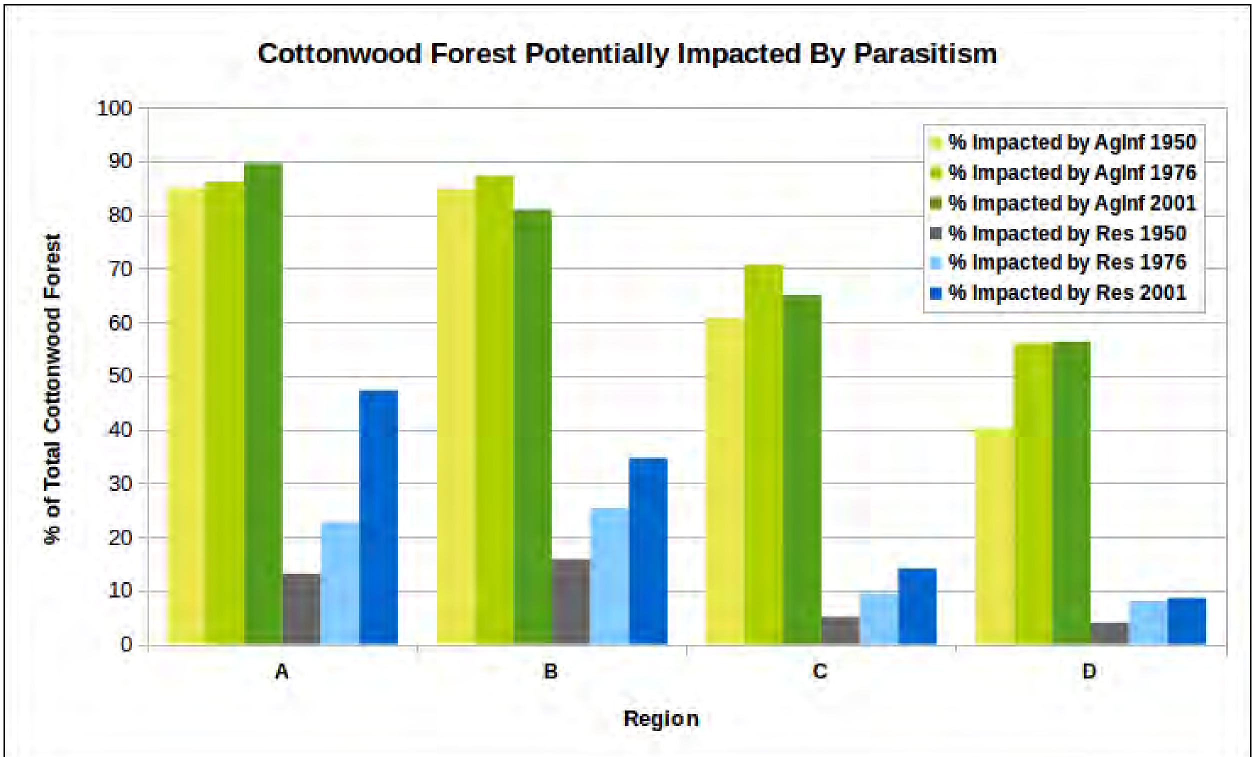


Figure 5-36 **Percent of cottonwood forest habitat potentially impacted by Cowbird parasitism due to Agricultural Infrastructure (AgInf) and Residential land use (Res) from 1950 to 2001 in all regions.**

Figure 5-37 presents the amount (acres/valley mile) of cottonwood forest habitat that was greater than 0.62 miles from AgInf or Res land uses (i.e., habitat with lower risk of cowbird parasitism) for each reach of the river in 2001, as well as change in acreage since 1950. Very little habitat existed upstream from Reach B6 that had low risk of parasitism, while many reaches downstream from B6 had greater than 50 acres of relatively unimpacted habitat per valley mile. Reaches D16 and D11 contained the greatest amounts of relatively unimpacted habitat (approximately 300 and 250 acres/valley mile, respectively). Most of the reaches with greater than 100 acres/valley mile of relatively unimpacted habitat were Anabranching reaches in Regions C and D, likely reflecting the greater amount of forest generally found in these reach types as well as the lower intensity of land use in these regions. The amount of relatively unimpacted habitat declined since 1950 for most reaches of the river; however, reaches C4, C6 and most reaches downstream from D9 experienced substantial gains. On average, reaches in Regions A and B had the lowest amounts of relatively unimpacted habitat (less than 10 acres/valley mile), while reaches in Region D had the greatest (more than 70 acres/valley mile; Figure 5-38). Reaches in both Regions C and D experienced net losses in unimpacted habitat from 1950 to 1976, followed by net gains from 1976 to 2001. This likely reflects changes in amounts of forest habitat that occurred in these regions; reaches in

Region C gained substantial acreage of TO forest during this time, while reaches in Region D gained acreage of TC forest (DTM and AGI, 2008).

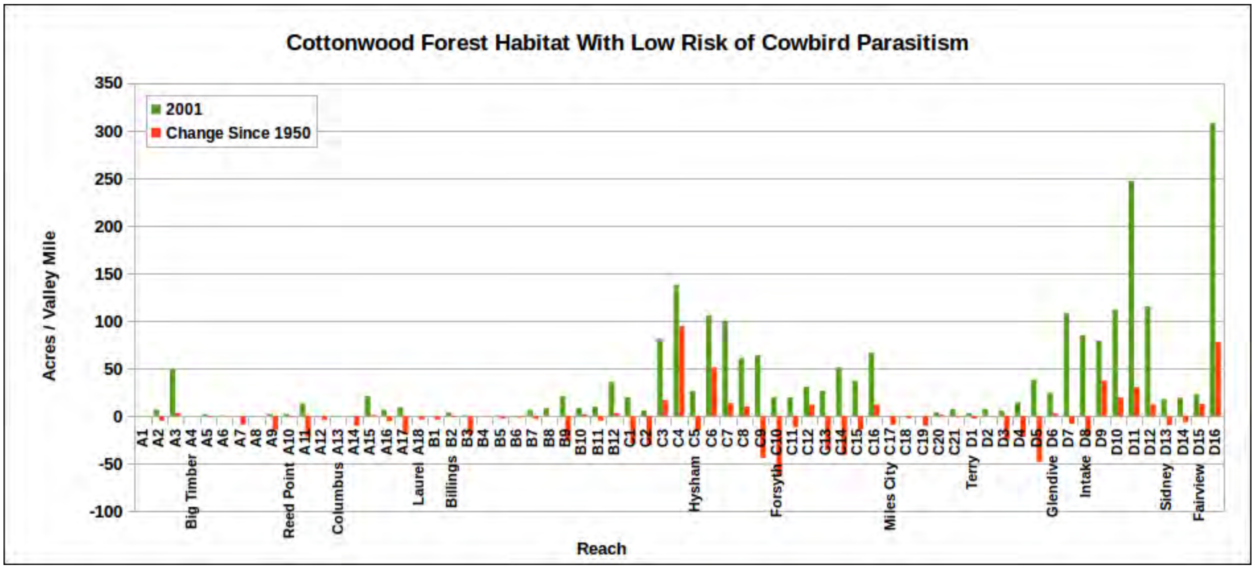


Figure 5-37 **Acreage of cottonwood forest habitat with lowest risk of cowbird parasitism (i.e., greater than 0.62 miles from Residential or Agricultural Infrastructure land uses) for reaches in 2001, and change in acreage since 1950.**

5.11 Extent of Riparian Grassland

Changes in the extent and distribution of riparian grassland are discussed in Appendix 7, and in the Land Use Mapping report (DTM, 2013). Declines in the extent of herbaceous riparian cover represent a loss of habitat for grassland bird species that depend upon this habitat type. More acres of herbaceous land (including grassland) have been converted to higher intensity agricultural land uses since 1950 than any other riparian cover type. In each of Region C and D, over 5,000 acres of non-irrigated herbaceous lands (which reflect lower-intensity land use including riparian grassland) were converted to irrigated agriculture (including cropland and hayfields) from 1950-2001; an additional 5,000 acres were converted in Regions A and B. Many more acres were likely converted before 1950, but it is not possible to quantify these losses.

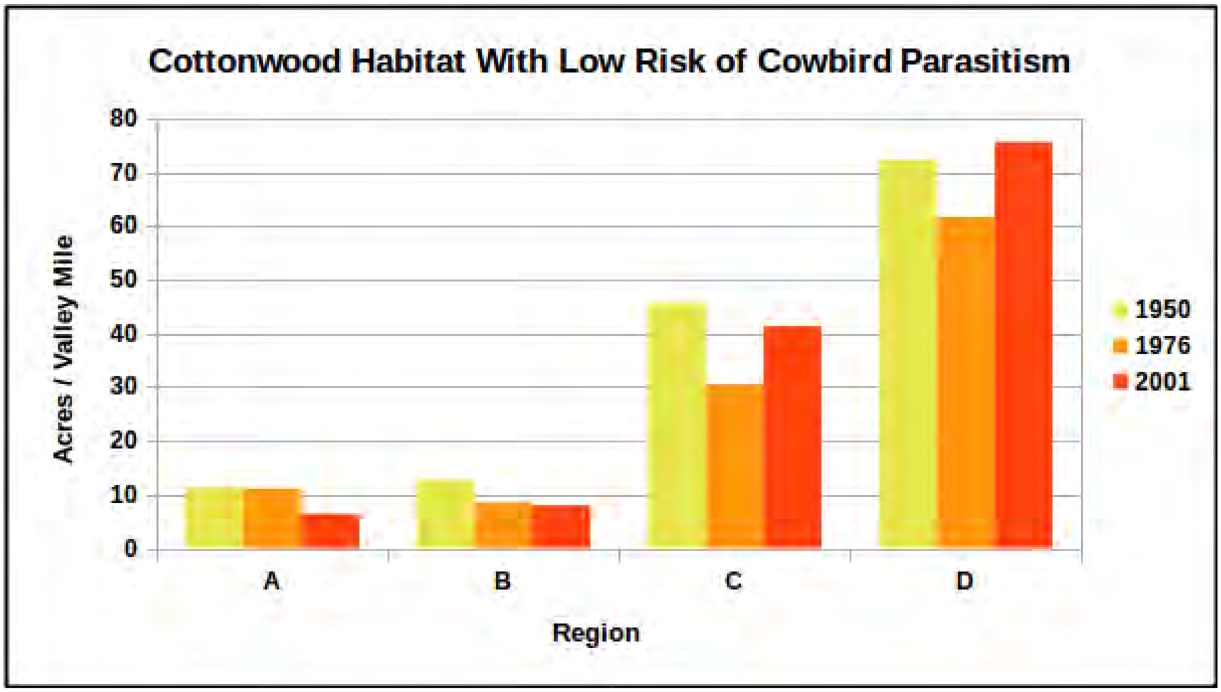


Figure 5-38 Acreage of cottonwood forest habitat with lowest risk of cowbird parasitism (i.e., greater than 0.62 miles from Residential or Agricultural Infrastructure land uses) for all regions in 1950, 1976, and 2001.

5.12 Habitat Heterogeneity within the Riparian Landscape

The braided and anabranching reaches (i.e. the less confined reach types) of the Yellowstone River generally contain more riparian cover and greater complexity of patch types compared with confined reach types (Appendix 7). Results from analyses in the upper reaches of the Yellowstone River support this; braided reaches in that region supported greater extents of different riparian habitat types than did more confined reaches (Hansen et al., 2003).

Analyses describing changes in the extent and distribution of different riparian habitats downstream from Springdale, Montana through time are presented in Appendix 7. In summary, although the total extent of riparian habitat has remained fairly stable from 1950 to 2001, changes in the extent and distribution of specific riparian habitats have occurred. Most notably, there has been a transition to older age classes of woody riparian cover and a loss in acreage of younger habitat types in Regions C and D. Similar changes were observed in Region PC of the river upstream from Springdale during the UYR study. The total area of the various successional stages changed from 1948 to 1999, with substantial declines in acreage of younger habitat types and increases in older habitat types (Hansen et al., 2003). These directional changes in the extent and distribution of habitat types in the floodplain of the Yellowstone River represent a decline in habitat heterogeneity that may negatively impact bird diversity in the riparian zone.

5.13 Extent of Russian olive and Saltcedar

The distribution of Russian olive and saltcedar was evaluated in Appendix 7; see these documents for a thorough evaluation and discussion about these invasive species along the Yellowstone River. In summary, the greatest extent of Russian olive was documented in Region C, while Region B had the greatest concentration. Relatively low densities of Russian olive occurred in Regions A and D. There are no comprehensive studies that quantify the distribution of saltcedar along the entire Yellowstone, but limited data suggest that saltcedar generally occurs as an incidental community type most frequently in Regions C and D. There are no data to quantify how the distribution of Russian olive or saltcedar has changed through time. However, because they are exotic species and did not originally occur in riparian areas of Montana, the current distribution reflects an increase from historic baseline conditions.

5.14 Rates of Floodplain Turnover through Time

Floodplain turnover occurs when riparian cover is converted to open channel, and can be measured as the rate of exchange between channel and riparian cover classes through time (Appendix 7). Turnover represents disturbance within the floodplain, and is a metric of habitat condition for riparian birds because it influences recruitment and successional processes for riparian plant communities. Historic, unaltered conditions likely exhibited a relatively equal exchange of area between channel and riparian cover through time, which sustains a mosaic of habitats and conditions in the floodplain and ensures continual renewal of riparian plant communities.

As discussed in Sections of 4.10.3, rates of floodplain turnover measure habitat condition in many ways, including:

1. Extent of cottonwood forest habitat
2. Extent of structurally complex forest habitat
3. Landscape-level habitat heterogeneity
4. Distribution of invasive plant species
5. Availability of in-channel Least Tern habitat

Discussion of how changes in floodplain turnover rates impact riparian vegetation is presented in Appendix 7. Analyses are also presented in those documents that quantify rates of floodplain turnover. In summary, turnover was quantified for the Yellowstone River from 1950 through 2001. The rate of floodplain turnover from riparian cover to channel in Regions C and D has declined since 1950, particularly in braided and anabranching reaches where floodplain heterogeneity and complexity is greatest. Turnover rates have declined most steeply in those regions since 1976. River reaches in Regions A and B exhibited a more equal exchange between riparian cover classes through time, suggesting more of a balance between gains and losses in those regions.

These changes indicate that the equilibrium in exchange between channel and riparian cover has been altered, with a reduction in the creation of bare sites for cottonwood establishment and a reduction in disturbance that maintains a variety of habitats within the floodplain. Potential consequences for habitat condition include:

- Decline in the overall extent of forest habitat due to a reduction in cottonwood recruitment.
- Decline in availability of structurally complex mid-successional habitats and loss of habitat heterogeneity within the floodplain due to a lack of cottonwood renewal and a transition to older habitats.
- Spread of Russian olive and saltcedar due to a decline in disturbance that creates favorable conditions for the establishment of invasive species, and provides a competitive advantage over native riparian plants.

- Decline in the extent of sand and gravel bar nesting habitats for Least Tern due to a loss of open channel.

- Loss of floodplain complexity that maintains Least Tern nesting and foraging habitat in close proximity to each other.

See Appendix 7 for a discussion of land use drivers of change in rates of riparian turnover.

5.15 Characteristics of Hydrology

Alteration of natural hydrologic processes have been suggested as a main factor in the decline of Least Terns. Analyses quantifying changes to various aspects of hydrology are presented in Appendix 2. Changes to hydrology between 1950 and 2001 for the Yellowstone River indicate that peak flows, summer low flows, and channel forming flows have all decreased since 1950, suggesting a reduction in disturbance and decline in water levels throughout the floodplain. Potential consequences for Least Tern habitat include:

- Decline in the creation of midstream sand and gravel bars used for nesting

- Degradation of existing bars due to the encroachment of vegetation from the lack of flood scour.

- Dewatering of foraging habitats, including side channels and other shallow water areas that sustain fish prey.

- Loss of floodplain complexity that maintains Least Tern nesting and foraging habitat in close proximity to each other.

Likely human influences on changes to hydrology are also discussed in Appendix 2.

5.16 Summary of Changes to Habitat Condition for Species of Concern

The four Montana Species of Concern are impacted by changes to habitat resources in various ways. Below is a summary of impacts for each species.

5.16.1 Black-billed Cuckoo

Black-billed Cuckoo's depend upon relatively large tracts of riparian forest with a dense canopy and understory shrub layer. Cuckoo's are both a forest specialist and an understory specialist species, and are potentially negatively impacted by the **loss of forest habitat** in general, and the **loss of Closed Timber forest** in particular, as well as a **decline in structurally complex forest habitats**. Although data are limited, they have been observed most often in Regions C and D, suggesting that changes in habitat condition in these regions may be most detrimental for this species.

5.16.2 Bobolink

Boblinks are a grassland dependent species that nests in riparian meadows and hayfields. Bobolinks were observed in every region of the Yellowstone River downstream from Springdale. This species is potentially negatively impacted by the **conversion of riparian grassland habitats** to more intensive land uses (e.g., cropland), as well as riparian management activities that include **mowing of meadows and hayfields** during the breeding season (late May to early July). In each of Region C and D, over 5,000 acres of non-irrigated herbaceous lands (which reflect lower-intensity land use including riparian grassland) were converted to irrigated agriculture (including cropland and hayfields) from 1950-2001; an additional 5000 acres were converted in Regions A and B. These large-scale losses of habitat have potentially negatively impacted Bobolink populations breeding along the Yellowstone River.

5.16.3 Red-headed Woodpecker

Red-headed Woodpeckers depend upon riparian deciduous forest with large trees and snags. Across its range, the single most important management issue for this species is the retention of habitat that contains large live and standing dead trees for nesting and foraging (see Jones, 2014 for a complete discussion of habitat relationships). Red-headed Woodpeckers are potentially negatively impacted by the **spread of invasive plant species, particularly Russian olive and saltcedar,** along the Yellowstone River, especially in Regions C and D where they are most frequently observed (Figure 4-2).

5.16.4 Least Tern

Least Tern nesting habitat includes midstream sand and gravel bars relatively free of vegetation, while foraging areas include side channels and other shallow water habitats. Essential breeding habitat includes areas that contain foraging habitat in close proximity to nesting sites. Most breeding sites along the Yellowstone River occur in unconfined or braided sections where channel sinuosity is high and there is greater incidence of bars and islands surrounded by channel (Atkinson and Dood, 2006). Alteration of natural hydrologic processes that cause **changes to in-channel nesting and foraging habitats** has been referenced as a main factor in the decline of this species. Least Terns have been observed only in Regions C and D, suggesting that changes in habitat condition in these regions may be most detrimental for this species.

5.16.5 Veery

Veery's are generally found within higher elevation riparian habitats, and along the Yellowstone River were observed only in Region PC. This species is an understory specialist, a forest specialist, and a Brown-headed Cowbird host, so may be particularly vulnerable to changes in habitat condition occurring along the Yellowstone River. A **loss of forest habitat**, especially a **loss of Closed Timber forest**, as well as a **decline in structurally complex forest habitats** could have detrimental consequences for Veery populations. Furthermore, **land use within the floodplain that provides Cowbird foraging habitat** in close proximity to cottonwood forest may further degrade existing habitat for this species.

6.0 MAJOR CONCLUSIONS IN SUPPORT OF CUMULATIVE EFFECTS ANALYSIS

Below is a summary of the primary findings from the analyses presented in this Appendix that may relate to multiple river components of the CEA.

6.1 Extent of Cottonwood Forest Habitat

The amount of cottonwood forest habitat increased steadily in the downstream direction, with lowest acreage in reaches of Region A and highest in Region D. Most of the top 25 percent of reaches with the greatest amounts of forest habitat were located within Regions C and D. There was twice as much TC in reaches of Region D than in any other region. In general, reaches with the greatest amounts of forest habitat and TC forest were Anabranching reach types (UA or PCA).

Many of the reaches with the greatest amounts of forest habitat experienced gains in cottonwood forest and TC forest acreage and losses in shrub acreage from 1950-2001. This trend was especially evident in Region D where reaches gained approximately 30 acres of forest (particularly TC forest), but lost almost 50 acres of shrub per valley mile. The extent of TC forest has likely increased due to the regeneration and maturation of existing younger stands since 1950. However, the loss of shrub acreage through time suggests a decline in regeneration that could result in a long term loss of forest within these reaches that have historically provided the greatest extent of cottonwood forest, particularly the TC forest habitat type.

Reaches D11 and D16 had substantially more acres/valley mile than all other reaches. Reaches A17, A18, and B3 contained substantially more forest than most other reaches in Regions A and B, suggesting that these reaches provide relatively important areas of forest habitat within those regions.

6.2 Distribution of Structurally Complex Habitats

Structurally complex cottonwood forest habitat types were relatively abundant along the Yellowstone River, and were evenly distributed across regions of the river.

Structurally complex forests habitats are mid-successional forests that are created and maintained by floodplain processes that drive cottonwood succession and renewal. Consequently, metrics representing these floodplain processes, such as riparian turnover, may be the best indicators for potential changes in the extent of structurally complex habitat types.

The rate of floodplain turnover from riparian cover to channel in Regions C and D has declined since 1950, while reaches in Regions A and B exhibited a more equal exchange between riparian cover classes through time. These changes indicate that the availability of structurally complex forest habitat for riparian birds may decline if floodplain turnover rates continue to decline in the future, particularly in Regions C and D.

6.3 Extent of Land Uses that Provide Cowbird Foraging Habitat

Reaches in Regions PC and A had the greatest areal extent of land use providing foraging habitat for Cowbirds in 2011, and most of that acreage was attributed to Residential development. Most of the Residential development in these regions occurred between 1976 and 2001, when acreage more than doubled. Region B also contained a large extent of Residential and Agricultural Infrastructure land uses, but much of that acreage was concentrated in the upstream reaches of the region.

Most of the acreage of land use providing foraging habitat for Cowbirds in Regions C and D was attributable to Agricultural Infrastructure; the areal extent of Residential was small in those regions. Reaches in Region D had the least acreage of all land uses providing Cowbird foraging habitat.

6.4 Distribution of Cottonwood Habitat Potentially Impacted by Parasitism

At least one-third of cottonwood forest was potentially impacted by Cowbird parasitism (i.e. within 0.62 miles of land use) in all but two reaches of the river; more than 50 percent of habitat was potentially impacted in most (54 of 67) reaches.

The percent of cottonwood forest potentially impacted by parasitism was highest in Region A (>90 percent impacted and >60 percent highly impacted) and lowest in Region D (<60 percent impacted and <20 percent highly impacted). These results are generally consistent with trends in Cowbird abundance that were observed along the river; reaches in Region A had the highest Cowbird abundance while reaches in Region D had the lowest.

A much higher percentage of cottonwood forest habitat was potentially impacted by parasitism due to Agricultural Infrastructure than Residential land use. In all regions of the river in 2001, greater than 50 percent of cottonwood forest was potentially impacted by Agricultural Infrastructure; in Regions A and B, more than 80 percent of forest was potentially impacted. The influence of Residential ranged from almost 50 percent (Region A) to less than 10% (Region D). However, the percent of cottonwood forest potentially impacted by Residential at least doubled in all regions from 1950 to 2001.

The areal extent of each land use type was not always proportional to the potential impact of each land use on cottonwood forest habitat. The percentage of cottonwood habitat that is potentially impacted by parasitism reflects more than just land use; the total amount of cottonwood habitat in the floodplain will influence this metric, as well as the density of and location where land use changes occur in a region.

Very little habitat existed upstream from Reach B6 that was relatively unimpacted by parasitism (i.e. greater than 0.62 miles from land use). Reaches in Regions A and B had less than 10 acres/valley mile of relatively unimpacted habitat, while reaches in Region D had more than 70 acres/valley mile.

Most of the reaches with greater than 100 acres/valley mile of relatively unimpacted habitat were Anabranching reaches in Regions C and D, likely reflecting the greater amount of forest generally found in these reach types as well as the lower intensity of land use in these regions.

6.5 Extent of Riparian Grassland

Riparian grassland habitat is lost when herbaceous lands are converted to agricultural crops, because grassland-dependent bird species will not use cropland for nesting or foraging. More acres of herbaceous land (including grassland) have been converted to higher intensity agricultural land uses since 1950 than any other riparian cover type. In each of Region C and D, over 5,000 acres of non-irrigated herbaceous lands were converted to irrigated agriculture from 1950-2001; an additional 5,000 acres were converted in Regions A and B.

The conversion of natural herbaceous lands to irrigated hayfields often represents a degradation of habitat for birds. Although hayfields seemingly provide high-quality riparian habitat where many grassland species breed, they are usually mowed regularly during the breeding season (late May to early July), which destroys nests and often kills adult birds.

6.6 Habitat Heterogeneity within the Riparian Landscape

Different types of habitats within the floodplain provide different types of resources, and species are often associated with particular habitat types. The habitat heterogeneity found within the floodplain of the Yellowstone River provides a variety of resources for birds, and contributes to overall bird diversity within the riparian landscape.

From 1950 to 2001, there was a transition to older age classes of woody riparian cover in Regions C and D, with losses in shrub acreage and gains in TO and TC forest. These changes in the extent and distribution of habitat in the floodplain represent a decline in habitat heterogeneity that may negatively impact bird diversity in the riparian zone.

6.7 Extent of Russian olive and Saltcedar

Cottonwood forest with Russian olive in the understory is often as structurally complex as forest with native shrub, but monotypic stands of Russian olive and saltcedar lack the large trees, snags, and forest canopy provided by native cottonwood forest.

The greatest extent of Russian olive was documented in Region C, while Region B had the greatest concentration. Relatively low densities of Russian olive occurred in Regions A and D. Limited data suggest that saltcedar generally occurs as an incidental community type most frequently in Regions C and D.

Metrics that quantify changes in riparian processes that maintain cottonwood succession suggest that floodplain turnover and recruitment of cottonwood forest has declined since 1950 due to alteration of hydrologic conditions. These changes in hydrology and floodplain disturbance that are detrimental for cottonwood recruitment are often favorable for the expansion of Russian olive and saltcedar.

6.8 Extent and Quality of In-Channel Habitat for Least Tern

Breeding and foraging habitats in reaches with high floodplain complexity in Regions C and D are likely crucial for sustaining populations of Least Terns.

Reductions in peak flows, summer flows, and channel forming flows have occurred since 1950. These alterations likely impact habitat for Least Terns by causing declines in the creation of midstream sand and gravel bars used for nesting, as well as degradation of existing bars due to the encroachment of vegetation from the lack of flood scour. Furthermore, reduced stream flows may result in the dewatering of foraging habitats, including side channels and other shallow water areas that sustain fish prey.

Trends in floodplain turnover since 1950 suggest that the area of open channel in the floodplain has decreased, likely contributing to a loss of open sand and gravel bar nesting habitats. Changes are particularly evident in dynamic reaches of Regions C and D, which are areas that are especially important to Least Terns.

6.9 Summary of Avian Responses

The richness of conservation species (i.e. species experiencing population declines) increased steadily downstream of Springdale, and more than twice as many conservation species were observed on average in Region D than PC. For most SOC and PSOC, greater numbers of sites were occupied in the lower reaches of the river, suggesting cottonwood forest habitat located in Regions C and D is particularly important for many species of conservation concern.

The richness of forest specialist species was greater in areas with more forest cover, and more forest specialist species were observed in TC forest than in TO forest. Reaches that contain a large amount of cottonwood forest, particularly TC forest, may be especially important for forest specialists, particularly those species that are also conservation species.

The distributions of individual PSOC and SOC varied across regions for all species, suggesting some regions may be more important to certain species than other regions.

Cowbird abundance was highest in Regions PC and A, and lowest in Region D. Three times as many Cowbirds were observed on average at sampling sites in Region A compared with Region D.

The richness of Cowbird host species (i.e., those species that are negatively impacted by Cowbird parasitism), particularly species that are also conservation species, was lowest in the upper reaches of the river and increased downstream. These results suggest that fewer species that are impacted by Cowbird parasitism currently occur in the regions where Cowbird abundance is highest. Future changes in land use that result in greater parasitism rates in Regions C and D may be especially detrimental to Cowbird host species that are also species of conservation concern.

Cottonwood forest with Russian olive in the understory is often as structurally complex as forest with native shrub, and there is little evidence that habitat condition is degraded for riparian birds in forest with Russian olive.

Compared with structurally complex native cottonwood habitat, monotypic stands of Russian olive and saltcedar represent a degraded habitat condition for many riparian bird species. Riparian habitats dominated by these invasive species usually support fewer bird species that nest and forage in the canopy strata, while cavity-nesting and bark-gleaning species that depend upon large live and dead trees are consistently absent. Cavity-nesting species constitute >20 percent of the Yellowstone River avian community, including the Red-headed Woodpecker, a Montana SOC.

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Yellowstone River Cumulative Effects Assessment

Technical Appendix 10
Socioeconomics

This appendix contains four reports:

- Yellowstone River Cultural Inventory- 2006
- Socioeconomic Report: Regional Profile of the Yellowstone River Corridor
- Socioeconomic Report: Analysis of Agriculture, Urban/Ex-Urban Development and Transportation Sectors
- Socioeconomic Report: Analysis of Ecosystem Services in the Yellowstone River Corridor and Economic Impacts of Tourism and Yellowtail Dam

Yellowstone River Cultural Inventory—2006

Overall Summary Report

With River-Length Interest Group Analyses

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Sponsored By:
Yellowstone River Conservation District Council

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Research Team and Support Staff

The project was directed by Dr. Susan J. Gilbertz, Montana State University—Billings. She was aided in data collection and data analyses by Cristi Horton, Tarleton State University and Damon Hall, Texas A&M University. Support staff included: Amanda Skinner, Amber Gamsby, Beth Oswald, Nancy Heald, Beth Quiroz, Jolene Burdge, and John Weikel, all of Billings, Montana.

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Yellowstone River Cultural Inventory—2006 Overall Summary

Introduction

The Yellowstone River has a long history of serving human needs. Native Americans named it the Elk River because of its importance as a hunting environment. William Clark explored much of the river in the spring of 1806 and found it teaming with beavers. By 1906, the US Bureau of Reclamation was sponsoring diversion projects that tapped the river as a source of irrigation waters. The river then enabled "twentieth-century progress" and today it supports many nearby agricultural, recreational and industrial activities, as well as many activities on the Missouri River.

Management of the shared resources of the Yellowstone River is complicated work. Federal and state interests compete with one another, and they compete with local and private endeavors. Legal rights to the water are sometimes in conflict with newly defined needs, and, by Montana law, the public is guaranteed access to the river even though 84 percent of the riverbank is privately owned.

Interestingly, in spite of the many services it provides, the Yellowstone River in 2006 remains relatively free-flowing. This fact captures the imaginations of many people who consider its free-flowing character an important link between contemporary life and the unspoiled landscapes of the Great American West. As a provider, as a symbol of progress, as a shared resource, as a management challenge, and as a symbol of our American heritage, the Yellowstone River is important.

The Yellowstone River Cultural Inventory—2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.

There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants' views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river's resources. Special attention is given to the ways

in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

This overall summary provides several overviews of the Yellowstone River Cultural Inventory—2006. The first section provides an explanation of the research approach. It explains how the river was divided into five geographic segments, the recruitment of Native Americans and the efforts to include individuals from four interest groups: agriculturalists, local civic leaders, recreationalists and residentialists, within each of the five geographic segments.

The second section of this overall summary describes the steps taken in analyzing the textual data of the project. Well over 2700 pages of interview texts were generated by this project. The content of the interview texts was distilled by way of analytical steps that would retain geographical and interest group integrity.

The third section includes a brief overview of the key concerns and implications of the evidence gathered for each group: agriculturalists, local civic leaders, recreationalists, residentialists and Native Americans. Detailed river-length analyses for each group are found in later sections of this volume.

Overviews of the geographic segment analyses are found in the fourth section. These overviews describe the major themes of concern among the people of each segment: Missouri River to Powder River, Powder River to Big Horn River, Big Horn River to Laurel, Laurel to Springdale, and Springdale to Gardiner. The details of each segment–specific analysis are found in the companion volumes.

Fifth, this summary identifies the primary implications exposed in the evidence gathered. Attentions, here, are limited to three sets of understandings: 1) desires for the bank stabilization projects and ideas regarding the best methods for addressing erosion; 2) knowledge of the riparian zone and notions regarding its value; and 3) notions about river management as a means of protecting the river as a shared resource.

Finally, the structure of the companion volumes is explained.

The Research Approach

Identification of Geographic Segments: The Yellowstone River is over 670 miles in length. It flows northerly from Yellowstone Lake near the center of Yellowstone National Park in Wyoming. After exiting the park, the river enters Montana and flows through Paradise Valley toward Livingston, Montana, where it turns eastward. It then follows a northeasterly path across Montana to its confluence with the Missouri River in the northwestern corner of North Dakota.

Five geographic segments along the river are delineated for purposes of organizing the inventory. These five segments capture the length of the river after it exits Yellowstone National Park and as it flows through eleven counties in Montana and one county in North Dakota. The geographic delineations are reflective of collaborations with members of the Yellowstone River Conservation District Council and members of the Technical Advisory Committee and the Resources Advisory Committee.

Working from the confluence with the Missouri River towards the west, the first geographic segment is defined as Missouri River to Powder River. This geographic segment includes some of the least populated regions of the entire United States. This segment is dominated by a broad, relatively slow-moving river that serves an expansive farming community whose interests blend with those folks living along the seventeen miles of the Yellowstone River that traverse North Dakota. Here the Yellowstone River is also important as a habitat for paddlefish and Pallid sturgeon. At the confluence with the Missouri River, the size of the channel, significant flow and substantial sediment carried by the Yellowstone River makes its importance obvious to even the most casual of observers. Prairie, Dawson and Richland Counties of Montana are included in this segment, as well as McKenzie County, North Dakota.

The second geographic segment, Powder River to Big Horn River, is delineated to include the inflows of the Big Horn and Tongue Rivers as major tributaries to the Yellowstone River and to include the characteristics of the warm-water fisheries. This segment is delineated to recognize the significant agricultural activities of the area and the historical significance of the high plains cowboy culture. This segment includes Treasure, Rosebud and Custer Counties.

The third geographic segment, Big Horn River to Laurel, essentially includes only Yellowstone County, but it is a complex area. To begin, important out-takes near Laurel divert water to irrigations projects further east. Additionally, it is the one county along the length of the river with a sizable urban population. Billings is known as a regional center for agriculture, business, healthcare and tourism. This area is notable for its loss of agricultural bottomlands to urban development. Irrigation projects are important east of Billings, especially in the communities of Shepherd, Huntley and Worden. These communities and Laurel also serve as bedroom communities to Montana's largest city, Billings. It is in Yellowstone County that the river begins its transition to a warm-water fishery.

The fourth segment, Laurel to Springdale, ends at the northeastern edge of Park County, Montana. The river in this area is fast-moving and it supports coldwater fisheries. While there is little urban development in this segment, there are some rather obvious transformations occurring as agricultural lands near the river are being converted to home sites for retirees and vacationers. The geographic segment includes Sweet Grass, Stillwater, and Carbon Counties.

The last geographic segment is defined as Springdale to the boundary with Yellowstone National Park at Gardiner, Montana and is within the boundaries of Park County. The river leaves Yellowstone National Park and enters Montana at Gardiner. It flows in a northerly direction through Paradise Valley and is fast-moving. It supports a cold-water fishery that is well-known for its fly fishing potential. Near Livingston, Montana the river turns easterly and broadens somewhat thus losing some of its energy. However, severe floods occurred in 1996 and 1997, and local groups have since spent many hours in public debates concerning river management.

Recruitment of Native Americans: Native Americans also have interests in the Yellowstone River. They are active in maintaining the cultural linkages between their histories and the local landscapes. For the purposes of this study a number of Native Americans from the Crow tribe and the Northern Cheyenne tribe were included. Native Americans were recruited by means of professional and personal contacts, either as referrals from state agency personnel, from Resource Advisory Committee members of the Yellowstone River Conservation District Council, or from other project participants.

Recruitment of Geographic Specific Interest Group Participants: The participants represent a volunteer sample of full-time residents of the towns and areas between the confluence of the Yellowstone and Missouri Rivers in North Dakota and the town of Gardiner, Montana at the north entrance to Yellowstone National Park. Participants were recruited from four major interest groups: agriculturalists, local civic leaders, recreationalists, and residentialists living near the river. A database of names, addresses and contact information was constructed for recruitment purposes. Nearly 800 entries were listed in the database, representing a relatively even contribution across the four major interest groups.

Individuals representing agriculture interests, including farmers and ranchers, were identified and recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of the Natural Resources Conservation Service.

Individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and public works managers, were identified and recruited through public records.

Individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity, were identified and recruited from referrals provided by members of the Resource Advisory Committee. Participants were also identified and recruited by contacting various non-governmental organizations such as Ducks Unlimited, Trout Unlimited, the Audubon Society and by contacting local outfitting businesses.

The names of property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank, were obtained through a GIS search of public land ownership records. Twenty acres was used as a screening threshold to separate people who lived along the river corridor but whose incomes were from something other than agricultural practices (residentialists) from those who were predominantly farmers or ranchers (agriculturalists). The names were sorted by county and randomized. Recruitment proceeded from the county lists. Other people living very near the river and whose primary incomes were not generated by agriculture were also recruited. These additional participants may not have had property that technically bordered the river and/or they may have owned more than 20 acres. In all cases, the recruits did not consider agricultural as their main source of income.

Participants were recruited by telephone and individual appointments were scheduled at times and meeting places convenient for them. Many interviews were conducted in the early morning hours and the late evening hours as a means of accommodating the participants' work schedules. A total of 313 people participated in the project, including 86 representatives from agriculture, 68 representatives in local civic roles, 76 representatives of recreational interests, 76 residentialists and seven Native Americans. A relatively equal representation was achieved in each geographic segment for each interest group.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

***Description of Interviews and Collection of Participant Comments**:* A master protocol was designed from questions provided by the US Army Corps of Engineers and approved by the Office of Management and Budget (OMB approval # 0710-0001; see example in the appendix to this volume). Questions were selected that would encourage participants to describe the local environs, their personal observations of changes in the river, their uses of the river and any concerns they may have had about the future of the river as a shared resource. Open-ended questions were used as a means of encouraging participants to speak conversationally.

The questions were adapted to the participants' interest groups. For instance, interviews with agriculturalists began with the question, "How many years have you been in operation here?" while local civic leaders where asked, "How many years have you lived in this community?" Similarly, agriculturalists were asked, "Are there any problems associated with having property this close to the river?" and local civic leaders were asked, "Are there any problems associated with having private or public properties close to the river?" The overriding objective of the approach was to engage the participants in conversations about the river, its importance and their specific concerns.

Participants were promised confidentiality, and open-ended questions were asked as a means of encouraging the residents to talk about the river, the local environs and their personal observations and concerns in their own words. All respondents were interested in talking about their perspectives, and they represented a variety of views of the river, including: farming, ranching, agricultural science, commercial development, recreation, civic infrastructure, environmental activism, historical views and entrepreneurial interests.

With only three exceptions, the interviews were audio-recorded and verbatim transcripts were produced as records of the interviews. In the other three cases, hand-written notes were taken and later typed into an electronic format. The total resulting interview data totaled approximately 2,700 pages of interview text.

Steps of Data Analysis

Segment-Specific Interest Group Analyses: Taking all audio-recordings, transcripts and field notes as the complete data set, the research group first set out to determine the primary values and concerns for each geographic segment-specific interest group.

21 Segment-Specific Interest Group Analyses						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

The team began with the four interest groups from the segment Springdale to Laurel. Team members read individual interview transcripts and determined a core set of values and concerns for the individuals represented. As a team, notes were compared and a combined outline of values and concerns was constructed for each interest group in the geographic segment.

Quotes were then taken from each transcript in the set to illustrate the particular values and concerns. Outlines of the interest group analyses for the Springdale to Laurel segment were then used as aids in constructing the interest group analyses in all other geographic segments. Care was taken to adapt the interest group analyses to highlight if, and when, the core values and concerns were different in each geographic segment. The Native American perspective was addressed as an individual analysis with attention to the specifics of those perspectives. Each of the 21 segment-specific interest group analyses was then illustrated with quotes from interviews.

Segment-Specific Geographic Summaries: A summary of the values and concerns for each geographic segment was constructed using the sets of four geographic-specific interest group analyses. Geographic summaries were written to reflect the concerns that crossed all interests groups of the segment, either as points of agreement or disagreement, and were illustrated with quotes from the four relevant interest group analyses.

5 Segment-Specific Geographic Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

River-Length Interest Group Summaries: River-length interest group summaries were constructed for each of the four primary interest groups. For example, agricultural concerns from the five geographic segments were compared and quotes were taken from the segment-specific interest group reports to illustrate commonalities and differences. Similar reports were constructed for local civic leaders, recreationalists and residentialists.

4 River-Length Interest Group Summaries

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Key Concerns and Implications from Primary Interest Groups

Agriculturalists: There are five issues that seem to be most particular to riverfront agriculturalists. The first issue involves an apparent lack of effort, or success, by authorities and neighbors to eradicate noxious weeds. Salt cedar, leafy spurge, Canadian thistle, Russian olive, and spotted knapweed are all named as problems, and farmers and ranchers are unanimously concerned that their weed problems will only get worse. The second anxiety is related to the federal government's management of the flood plain. Many express fears about the creation of new regulations or restrictions on agricultural flood plain activity. Such regulations could affect the individual's productivity. The third concern is over the security of water rights. Changes in local and state demographic profiles are viewed with trepidation as agriculturalists fear that water adjudications could be affected. Fourth, agriculturalists often discuss the importance of storing water, especially as a means of keeping water for use in Montana. Finally, when taking all the issues into account, agriculturalists worry about the future of their livelihoods. At stake is far more than family incomes. Agriculturalists view the threats as potentially impacting their communities, their heritage, their culture and America's food supply.

It is apparent that the agricultural interest group views the various pressures on their livelihoods as real and threatening. It is also apparent that the agricultural interest group needs to develop new and more robust partnerships with agencies and other interest groups. Finally, it appears the Yellowstone Conservation District Council can play an important role in achieving constructive working relationships with the private agricultural producers that border the Yellowstone River.

Local Civic Leaders: There are several points of discussion that seem to carry great weight for individuals in local civic leadership roles. Conversations with these participants often include discussions about government and the philosophies behind democratic processes. They also discuss the challenges of local citizenries, the best ways to connect with state and federal entities and concerns about flood plain maps and official evaluations of local dikes.

Discussions with local civic leaders offer four implications for the future. First, there is a need to generate and share good information at the local level. Second, there is need to help local officials with the complexities of holistic management, especially new officials. Third, with limited resources and growing demands, it is obvious that not everyone will have everything they want. It seems certain that sharing the resources will only become more difficult. Finally, governance via rules and regulations will require multiple strategies and careful coordination across the various entities and agencies involved.

Recreationalists: Three concerns seem to be at the heart of the recreationalists' perspective when considering the future of the river. First, they are dedicated to the uniqueness of the river, and are advocates of keeping the river free-flowing. Second, they view the public access laws of Montana as essential rights which must be protected against all threats. Third, they attend to water quality issues and are committed to encouraging best practices on the part of agriculture and industry.

Four implications emerge from an analysis of the conversations with recreationalists. The first is that recreational activities add a great deal to Montana's local economies. Many of the changes in Montana's communities are a result of the recreational appeal of the river. Second, recreational interests are linked, often legally, to the missions and purposes of governmental agencies; thus, recreationalists are likely to partner with any agency looking out for the health of the river. The third implication is that recreationalists are willing and ready to collaborate with agriculturalists in order to solve mutual problems. The fourth implication is that recreationalists worry about pollution and other effects of industrial, municipal and residential activities. However, they recognize their loyalties and interests are often ironically splintered, and so they ready themselves to accept the complexities and difficulties of working to address all interests.

Residentialists: Residentialists are deeply committed to maintaining healthy wildlife populations and to high water quality standards. Yet, only a few of them are particularly well versed in explaining how the riparian areas contribute to each of these concerns. Rather, three different issues emerge as important when considering the residentialists' perspectives. First, they are especially protective of their property rights. They value their privacy. While they generally acknowledge the public's right to be on the river, they express varying degrees of understanding for recreationalists who violate the "high water" designations. They mostly oppose recreationalists using their properties as if they are public access sites. Second, when asked if they worry that they might be flooded or that the river might erode the bank away, there is a sizable group of residentialists who agree that over time such possibilities are real but who also explain away these threats by saying, "Not In My Lifetime/Years." These residentialists were identified as NIMLYs. They are residentialists who view the river as mostly benign and who see no real threat to their properties. The third particular concern of residentialists is that they believe unchecked development near the river will eventually either ruin the privacies they have come to enjoy or force the sale of their homes as they will not be able to afford the subsequent increases in property taxes.

Four implications emerge from an analysis of the conversations with residentialists. The first is that residentialists are potentially strong allies when looking for individuals to support practices that will promote the health of the river and the riparian areas. However, at this point some are not well-enough informed to help. A second implication is that further residential development will decrease the informal paths that the public uses to access the river. Pressures will build for more public access sites. A third implication involves seemingly incompatible wishes. They appear to want a free-flowing river and the ability to protect private property. Given that the first wish is to some extent compromised every time the second wish is granted, it seems guidance is needed in the local communities regarding how to avoid further complicating matters with increasing riverfront developments. Finally, given that residentialists articulated so many different opinions and perspectives, it is apparent that every influx of new people and every new generation of adults will need to be educated and assisted in understanding the river, the management strategies, and the constraints of local governments.

Native Americans: There are three sets of concerns specific to Native Americans. They are concerned about pollution in the Yellowstone tributaries, especially as those problems are a function of faulty wastewater treatment facilities on the reservations. They are also concerned about the cultural separations occurring as each generation seems to be not only physically removed from the river, but spiritually removed as well. In some cases, these detachments from the Yellowstone River have caused tribes to relocate cultural practices onto the river's tributaries. The third set of concerns is articulated as vulnerabilities due to economic hardships and political problems that allow for unfortunate natural resource decisions.

Four implications are derived from discussions with Native Americans. The first is that the Yellowstone River should be managed according to holistic principles, those that include the entirety of the basin and its constituencies. Second, tribal communities should be given as much support as possible when dealing with problems that ultimately effect downstream water quality and quantity. Third, oral accounts of the river should be more fully gathered and incorporated into the official records of the river. And fourth, there are many mutually-beneficial opportunities for partnerships between the interests of the Native Americans, other interest groups, and managers.

Exploring Additional Documents Concerning Interest Groups: Detailed analyses of each of the major interests groups overviewed above are provided in this volume as river-length summaries. Readers are encouraged to explore this volume further. The quotes used in each of the river-length summaries are used for illustrative purposes. They are taken from the detailed analysis found in other volumes of this work. For example, a quote identified as have been provided by a *Richland County Agriculturalist* would be found under the Agriculturalists Interest Group Analysis for the segment titled, Missouri River to Powder.

Key Discussions within Geographic Segments

Research data was collected by geographic segment from individuals representing each of the four interest groups, and segment-specific summaries are available for the purpose of describing how the four interest groups perspectives' co-exist within a particular geographic area. For instance, agriculturalists, local civic leaders, recreationalists and residentialists from the segment Missouri River to Powder River are compared and contrasted in the segment-specific summary for that area. The segment-specific summaries attempt to more holistically present the geographic communities by identifying the primary discussions or themes of discussion that are found across the groups from a particular geographic area. Those summaries are available in the companion documents (Parts I-V). Brief overviews of the segment-specific summaries are presented here.

Missouri River to Powder River: A review of the interview data for the segment, Missouri River to Powder River, suggests that people in this area engage in four primary discussions when asked about the Yellowstone River. First, the notion of Eastern Montana is not simply a geographic reference. It is a defining concept that captures the agricultural roots and the cultural values of the people living in the study segment, and the river is an essential element within their notion of Eastern Montana. Second, the river is discussed as a wholesome recreational outlet. However, shifting landownership is noted as an important change in the recreational context. Third, even though agricultural practices are viewed as the mainstay of the local economies, many participants discuss the long-term economic viability of their communities as a concern. Industrial and residential developments along the river's edge are seemingly remote possibilities and are generally discussed with references to flood plain restrictions and the stability of nearby dikes. Finally, discussions of managing the river are limited, but a variety of opinions are offered regarding bank erosion and stabilization techniques.

Powder River to Big Horn River: In the study segment, Powder River to Big Horn River, three conversations emerged across the four interest groups. The first conversation focuses on the "familiar way of life." The conversation exposes a local identity that is tied to agriculture and to traditional forms of recreation, such as hunting and fishing. When asked if the familiar management practices are sufficient in terms of sharing the river's resources, some locals express concerns. The second conversation explicitly acknowledges that the demand for recreational access to the river's resources is in its infancy in terms of representing a problem. The third conversation focuses on controlling the river with rip-rap and dikes.

Big Horn River to Laurel: The study segment Big Horn to Laurel includes data from the people of one large county, Yellowstone County. Three themes dominate conversations with the four interest groups. One theme focuses on the evolving communities of Yellowstone County, most of which are influenced by the economic success and sheer growth of Billings. The second theme focuses on the evolving relationships that the people have with the river. While traditional agricultural activities continue in the county, many people discuss notions related to urban and residential experiences and how the river becomes an asset that improves one's quality of life as an urban dweller. The third theme involves a complex tangle of pressures and demands that require managerial strategies capable of dealing with a future that has arrived.

Laurel to Springdale: In the study segment, Laurel to Springdale, three themes emerge as dominant across the four interest groups. One theme focuses on the changing riverbank profile as more and more residential homes are built on the river's edge. The second theme focuses on the river as a powerful and dynamic physical entity. The third is about the changing social profiles of their communities and how those changes influence user practices.

Springdale to Gardiner: The segment Springdale to Gardiner essentially takes in the river as it flows through Park County. A review of the interview data for Park County suggests that people in this area engage in five primary discussions when asked about the Yellowstone River. First, they seldom speak only of the river, as they are likely to broaden the conversation to a discussion of the changes that are occurring in Paradise Valley. They see their valley as changing rapidly. Second, the floods of 1996 and 1997 left lasting impressions on the people of Park County. Even newcomers are aware of those events and of the devastations visited upon locals. Third, many people in Park County are vocal participants in public deliberations concerning the management of the river. The 1997-2003 Task Force created a legacy that continues to define discussions of the river and its resources. Fourth, then, are the particular topics that continue to generate discussions in the wake of the Task Force. These include debates about rip-rap, setbacks and Mill Creek. Finally, a set of observations emerge as the Park County residents both reflect on the Task Force and move forward. These observations are shaping community members' concerns about the river, the role of governing agencies and local commitments to future public processes.

Exploring Additional Documents Concerning Geographic Segments: Detailed analyses of each of the geographic segments overviewed above are provided in the other volumes of this work. Readers are encouraged to explore those volumes as a means of furthering their understandings of how the concerns of the four interests group together into local conversations about sharing the river.

Each of the other volumes is dedicated to a specific geographic segment of the river (i.e., Missouri River to Powder River) and each includes: 1) an explanatory summary of the primary points of concerns for the particular segment, 2) an outline of the textual materials gathered from agriculturalists for that particular segment, 3) an outline of the textual materials gathered from local civic leaders for that particular segment, 4) an outline of the textual materials gathered from recreationalists for that particular segment, and 5) an outline of the textual materials gathered from residentialists for that particular segment. The quotes used in each of the geographic segment summaries are used for illustrative purposes, and are taken from the detailed analyses that follow those summaries. For example, if a quote used in the summary for Missouri River to Powder was provided by a *Richland County Agriculturalist*, the quote will also be found under the Agriculturalists Interest Group Analysis for that segment.

Primary Implications of the Yellowstone River Cultural Inventory--2006

Of greatest clarity across all groups is this notion: the Yellowstone River is the single, most important natural resource of southern and eastern Montana. Other conclusions can be drawn, but they can easily be challenged by evidence that demonstrates not everyone agrees. Moreover, general conclusions can simplify topics in ways that do not allow for nuances of understandings to be illuminated. Thus, even though the comments offered in this section are based on some overriding observations, they are not meant to serve as summations of how the people feel; rather, they are an attempt to offer resource managers some sense of the challenges that lay ahead.

Bank Stabilization: Along the course of the Yellowstone River, from the confluence with the Missouri River to Gardiner, Montana, rip-rap is a well-known method of bank stabilization. Across all interest groups, it is understood as a generally effective option for protecting property. Objections are raised by some, and alternatives are promoted by a few, but it appears that only one set of concerns keeps the majority of property owners from rip-rapping their riverbanks, the costs associated with rip-rap projects.

Put simply, the costs associated with materials and placements are viewed as prohibitive by many landowners. Stories of owners spending hundreds of thousands of dollars are commonly passed along as examples of why people have not rip-rapped their banks. Enthusiasms are sometimes diminished by knowledge gained from having watched the river “take what it wants,” even when rip-rap was already in place. However, rip-rap is considered a worthy effort even by those who doubt its overall permanence as a solution.

Permitting processes are understood to be time-consuming and frustrating. More than a few property owners simply do not “want the hassle of dealing with so many agencies,” and it is only those owners who hire someone else to deal with the design specifications and permitting details who are not overly offended by such requirements. Participants from all walks of life grasp the notion that pushing the problem onto your neighbor is not acceptable, but many people either implicitly or explicitly suggest that so long as one has enough money to pay for the appropriate “engineering,” such issues can be resolved. While the permitting process is understood by many as a means of protecting neighbor from neighbor, it is seen as an impediment mostly working against the not-so-wealthy land owner.

Recreationalists discuss the need to avoid channelizing the river, but the cumulative effects of bank stabilization efforts are not topics that generate much conversation. Agriculturalists want to keep their productive lands, and residentialists, many of whom ironically value the free-flowing character of the river, want to protect their homes. Given that real estate interests are certain to push for continued development of residential uses near the river, questions concerning cumulative effects are likely to be even more pertinent in the future. Park County serves as the example to the entire valley. After major flooding events in 1996 and 1997, the number of people willing to put resources in to rip-rap projects increased dramatically and that community has since gone through extensive public debates regarding bank stabilization methods and cumulative effects.

As a whole, the people of Park County are well-versed in explaining the arguments for, and against, the further use of rip-rap as a means of controlling the river. Unfortunately, Park County also illustrates that even though community members can become rather sophisticated in their abilities to discuss issues, they probably will not reach a consensus regarding the best courses of action. The prolonged discussions of the Park County Task Force demonstrate that when “best practices” are not the best option for each individual, consensus is probably impossible and voluntary adoptions are perhaps unlikely.

Many property owners accept limits designed to protect neighbor from neighbor. However, they are resentful of rules that appear to privilege the wealthy, require of them a less-than-effective means of protecting their personal property, or are constantly changing. Resources managers should anticipate that as more property owners feel compelled to control the river, either because they can afford to do so as preventative measures, or because they feel immediately threatened, pressures to approve bank stabilization projects will increase. Moreover, because best management practices are likely to change over time, even at the local level, efforts to establish consensus agreements regarding such practices are likely to fail.

Efforts to engender wide-spread voluntary adoption of best management practices might succeed if individuals are convinced their personal interests are very well served, but resource managers must anticipate the objections that will be voiced and must generate the information needed to convince private owners that their interests will be served by the best management practices being advocated at any given time.

Riparian Zone Understandings: Ideas about, and observations of, the riparian areas vary greatly. Surprisingly detailed inventories of animal life are offered by many as, apparently, people often keep journals of their observations. Some people record their observations on a daily basis and some as a matter of taking their annual river trip. Many are committed to “knowing” the particular birds, beavers, and even bears of their area. Residentialists, in particular, pay a great deal of attention to the wildlife and the seasonal migrations of birds and waterfowl. Agriculturalists and recreationalists, too, can offer extensive inventories of river animals. In these ways, the animals of the riparian areas are fairly well accounted.

With regard to the plants of the riparian areas, many people explain that they feel a great affection for the cottonwood tress. Many people are also aware of and concerned about invasive weeds. Agriculturalists and civic leaders seem to be the most informed. They speak of cottonwood trees as bank stabilizers and they identify specific noxious weeds and the strategies for dealing with them. However, knowledge across community members is not uniform, and people commonly complain about land owners who seem to be oblivious to the problems caused by lack of weed management. More than a few are disgusted by land owners who purposefully introduce Russian olive trees onto the riverbanks, and they are disheartened to see stands of weeds on river islands. In general, though, the plants of the riparian areas are seemingly less engaging than the wildlife. It was rare to find an individual with a journal chronicling the plant life of a given stretch of river, suggesting that plants are mostly taken for granted. For instance, only a few individuals express concerns regarding the age of the cottonwood stands.

It is only a few individuals in each geographic area that speak at length of the riparian areas as more than habitat for plant and animal life. For instance, only a few people explain that riparian areas can filter undesirable chemicals and nutrients out of run-off or irrigation discharge waters. Likewise, only a few explain that flood regimes are important to cottonwood tree regeneration. A few people discuss the impacts of grazing animals on riverbanks, but they seldom articulate in any detail the ecological impacts, positive or negative, of sediment transport processes. Least of all, individuals speak of hydrologic and geomorphologic processes as important to the health of the river. Those who have spent a great deal of time near the river are aware that the river is “constantly working,” and they rather vaguely explain that such workings are valuable in that they are natural. They offer few explanations of what those particular “natural” values might be. Attention to water quality is widespread, and many are concerned about the sewage contamination caused by inadequate treatment facilities, such as in Gardiner and on the tributaries.

The above observations suggest that much work is needed in educating the people of the river about the various functions of riparian areas. It seems that good riparian practices are currently, at best, a matter of attention to habitat. Specifically, it would be beneficial to help more people see the connections between wildlife abundance, clean water and healthy riparian functions. If more people were versed in explaining the linkages between wildlife, the physical processes, the plant life and the functions of the riparian areas, it seems many would be willing to protect those functions. As discussed above, voluntary adoption of best management practices must be attached to individuals’ self-interests. When they are convinced a particular practice is linked to their personal interests, vocational or vested, they are more likely to adopt it.

Managing a Shared Resource: The details of management concerns vary greatly across interest groups and across geographical segments; however, there is an obvious majority that regards management as essential to the long-term health of the river and its resources. Virtually everyone agrees that management of the river is complicated work. Their priorities vary according to their personal and vocational interests, but everyone knows they share the river with others and that not everyone will get everything they want when they want it. As tempting as it may have been to overstate their personal needs, it seems generally true that the people of the Yellowstone River promote balanced approaches as the most fair when managing the shared resources of the river.

One specific refrain comes through with great clarity when asked about how authorities should balance the needs of the various user groups. Namely, the people of the Yellowstone River believe in local control. Agriculturalists, local civic leaders, and residentialists all call for local control of the river's resources. They express a great deal of faith in local control as they view it as balanced control. They worry that state and federal authorities are not "in touch" with local needs, and many people, recreationalists included, view state and federal authorities as "slow to respond." Recreationalists are perhaps the most likely group to call on state and federal agencies to defend their interests. Yet, recreationalists are not without sympathies for local interests and are among the first to argue for a clear sense of balance in protecting the river's resources.

Some participants indicated that they could trust local officials not to meddle and not to forget the needs of the local community. It seems people are more willing to trust their neighbors to protect their interests. Perhaps they regard local control as essentially less rigorous. If it is difficult to imagine neighbors attempting to control one another, then might the calls for local control simply be understood as calls for no control.

Fortunately, even a brief review of the comments from local civic leaders convinces the most cynical reader that local leaders spend far too many hours listening to their various constituencies, and far too many hours juggling and sorting the many layers of local, state and federal guidelines, to allow a local focus to exclusively privilege any one group's interests. Local civic leaders are excellent examples. They sometimes feel trapped between local needs and official rules, but they are, indeed, dedicated to balanced approaches. Many locals, from all categories, understand their communities cannot afford detailed analyses of river issues, and they understand that other communities need similar types of information. Local civic leaders explain that good information is critical both in making decisions and in upholding unpopular rulings. They willingly admit that they depend on other entities to supply information, and they stress the need for an entity that can serve as a clearing house.

Thus, while many of the people of the Yellowstone River opt for local control, they want state and federal agencies to provide information and guidance. Members of all interest groups indicate that they would benefit from an organization that would gather, distill, organize and disseminate information that could be understood and put to use at the local level.

Readers are encouraged to further their understandings of the people of the Yellowstone River by reading the river-length interest group summaries and the geographically organized materials found in the companion reports.

Organization of the Companion Reports

River-Length Interest Group Summaries—As noted earlier, comparisons were made across interest group representative from different geographic segments. In this way river-length interest group summaries were written for agriculturalists, local civic leaders, recreationalists and residentialists. As well, a detailed report of the Native American perspectives was constructed from the interview transcripts. Those five river-length interest group summaries are found in the following sections of this (in hand) volume.

Part I: Missouri River to Powder River—This volume includes the geographic summary for Missouri River to Powder River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part II: Powder River to Big Horn River—This volume includes the geographic summary for Powder River to Big Horn River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part III: Big Horn River to Laurel—This volume includes the geographic summary for Big Horn River to Laurel and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part IV: Laurel to Springdale—This volume includes the geographic summary for Laurel to Springdale and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part V: Springdale to Gardiner—This volume includes the geographic summary for Springdale to the boundary with Yellowstone National Park and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Agricultural Interest Group: River-Length Overview

Eighty-six interviews were conducted with individuals representing agricultural interests, including farmers and ranchers. Participants were recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council, and the Montana Office of Natural Resources Conservation Service.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Agriculturalists: Analysis Table

River-Length Concerns Among Agriculturalists
1. Land is Valued for its Productivity 2. Rural Life Valued as a Way of Life 3. Owning Riverfront Land is Risky 4. The Big Neighbor (the State) is Difficult 5. Rip-rap is a Worthy but Temporary Solution
River-Length Diversities Among Agriculturalists
1. Development Impacts Agriculture 2. The Viability of Agriculture is Threatened 3. Recreational Activities Compete with Agriculture
River-Length Specific Concerns Among Agriculturalists
1. Weeds are a Problem and We Need Help 2. Regulating the Flood Plain is Problematic 3. Water Rights May Not Be Secure 4. More Reservoirs Might Help 5. The Future of Agriculture
River-Length Implications of Agriculturalists Analysis
1. The Pressures on Agriculture are Real 2. Partnerships with Agencies and Other Interest Groups are Needed 3. Yellowstone River Conservation District Council has Credibility

Agricultural Interest Group: River-Length Summary

Introduction

A review of the interview data for this river-length summary suggests that agriculturalists share five common sensibilities when discussing the Yellowstone River. First, the Yellowstone River is valued for the productivity it supports on lands bordering the river. The water of the Yellowstone River is, and has been, essential to the agricultural community.

Second, agriculturalists love the rural lifestyle, the river and Montana. They are neighbor-oriented and respectful of others' private property rights. Because of this sentiment, agriculturalists believe that other users, in particular the recreationalists, also need to respect private property rights.

Third, owning and working the land along the river is risky. The cycles and variability of flows complicate their financial security. Stewardship is considered imperative and difficult.

Fourth, all riverfront landowners share one common neighbor, the State—its water, its wildlife and its various publics. Farmers and ranchers are skeptical of the management choices of this seemingly wealthy and powerful neighbor.

Finally, rip-rap is considered a worthy, but temporary solution for flooding. Rip-rap does protect land if done correctly, but agriculturalists know it can be quickly undone by flooding and ice jams. In the past, rip-rap was a "do-it-yourself" project. However, it has become costly and it is difficult to attain the appropriate permits. Rip-rap is known to sometimes divert problems to other properties, a fact that can cause social difficulties among neighbors.

Despite clear commonalities, agriculturalists express dissimilar opinions and beliefs based on their unique situations and geographic locations. There are three important differences across the river segments. First, agriculturalists experience different pressures due to residential and industrial development, and the differences are mostly dependent on the activities in the immediate geographic areas. In two segments, Missouri River to Powder River, and Powder River to Big Horn River, there is little mention of development. In the Bighorn River to Laurel segment, Billings' urban sprawl is a prominent topic of conversation. In the Laurel to Springdale and Springdale to Gardiner segments, second homes and absentee owners are bringing different values to the valley.

The second major difference among agriculturalists involves the different threats that individuals see in terms of their viability as agriculturalists. In the eastern segments there are concerns regarding increasing interests in water conservation. Some agriculturalists are converting from flood irrigation to pivot-head irrigation, and others are concerned about what possible regulations would require them to do. In the western segments, the dominant concerns are related to the reductions in available productive lands as new owners are disinclined to lease acreages for farm or ranch purposes. This transformation is coupled with dramatic increases in land values, property taxes, inheritance taxes and a myriad of daily inconveniences such as increased road traffic.

Third, there are different types and densities of recreational activities across the five segments, each having different effects on agriculturalists and their communities.

Beyond the common concerns and diversities of opinions, there are five issues that seem to be most particular to riverfront agriculturalists. The first issue involves an apparent lack of effort, or success, by authorities and neighbors to eradicate noxious weeds. Salt cedar, leafy spurge, Canadian thistle, Russian olive, and spotted knapweed are all named as problems, and farmers and ranchers are unanimously concerned that their weed problems will only get worse.

The second anxiety is related to the federal government's management of the flood plain. Many express fears about the creation of new regulations or restrictions on agricultural flood plain activity. Such regulations could affect the individual's productivity.

The third concern is over the security of water rights. Changes in local and state demographic profiles are viewed with trepidation as agriculturalists fear that water adjudications could be affected. Fourth, agriculturalists often discuss the importance of storing water, especially as a means of keeping water for use in Montana.

Finally, when taking all the issues into account, agriculturalists worry about the future of their livelihoods. At stake is far more than family incomes. Agriculturalists view the threats as potentially impacting their communities, their heritage, their culture and America's food supply.

Taken as a group, the perspectives and concerns voiced by agriculturalists suggest that particular issues must be taken into account, both in the near future and in on-going resource management strategies. It is apparent that the agricultural interest group views the various pressures to be real and threatening. It is also apparent that the agricultural interest group needs to develop new and more robust partnerships with agencies and other interest groups.

Finally, it appears the Yellowstone Conservation District Council can play an important role in achieving constructive working relationships with the private agricultural producers that border the Yellowstone River.

Common Concerns Among Agriculturalists

The following concerns are common among agriculturalists, regardless of where one meets the individual.

Land is Valued for its Productivity: Agriculturalists view the irrigation waters as essential to the productivity of their lands. They are also sensitive to losing fertile areas near the river.

> That guy, across the river there, he's farming, he's planting corn, and he's just three-quarters of a mile from me. He lives next to the river, he's planting corn there and he's thinking of this river to get water out of it, to raise…[his crop]. And he's looking at it [as] production only. That's what his land is going to sell for, based on production. And my land values are different….My personal values are different….When you lose that production value, you lose a lot of drive, and then personal pride. You know, it's not lazy, but you lose a lot. (*Prairie County Agriculturalist*)

> Recreation is important. But it has nothing whatever in value compared to the high yield land and the farm possibilities on that river. And then the power generation, too; that comes from the river. (*Custer County Agriculturalist*)

> There are a lot of people that are buying land on the Yellowstone now, not so much, say, from Big Timber down, but from Big Timber up. A lot of them are buying the land and they're not doing anything with it. Either irrigating it or not much at all, letting it just go back to wild….It ties up a lot of land that used to be available for leases or for grazing or something like that. And it makes that much more competition for the land that is available to lease. And it drives the price up a lot. Sometimes it doesn't even pay to lease it. (*Stillwater County Agriculturalist*)

> Some of the land we leveled ourselves. We have two scrapers and we leveled quite a bit of the land ourselves. By leveling the land and making the irrigation more efficient, it accomplished two things: the land became more productive and we were able to use much less water. (*Yellowstone County Agriculturalist*)

> I'd say we've lost…about a half a section….I'll bet we've lost seven acres, at least, from that little pretty bottom area down there,…probably six acres. It was only aesthetically valuable; agriculturally it didn't cost anything. (*Park County Agriculturalist*)

Rural Life is Valued as a Way of Life: Agriculturalists embrace a rural life-style. They are neighbor-oriented, enjoy the quietude of rural life and are respectful of the privacy and property of others.

> It's just beautiful. It's like a huge greenhouse, basically. You know everything is green, and everything is clean. You know, we really take pride in this valley. (*McKenzie Country, ND Agriculturalist*)
>
> One thing we have…is an irrigation ditch association, so we're bonded all together on this ditch. And it's for everybody's benefit that things are done well and right. *(Rosebud County Agriculturalist*)
>
> You've got to allow the owner of the land to do what is in his best interest and the land's best interest. And if you start stepping on that, then you're violating their property rights and their personal rights, and that isn't quite what this country was founded on. (*Yellowstone County Agriculturalist*)
>
> I like it here….I never wanted to do anything besides be a farmer or rancher. (*Carbon County Agriculturalist*)
>
> There is a relationship that forms working with the land. You learn to love it, and it becomes part of you. It becomes part of your character. It has some very formative influences on who you are. It becomes part of your soul. I think of the legacy and the heritage. Our kids understand that formative influence on their character. This place defines who they are. (*Park County Agriculturalist*)

Owning Riverfront Land is Risky: Agriculturalists are aware that owning and working the land along the river is risky and that they are not blessed with financial security. Stewardship is considered critical, yet the economies of agriculture do not allow for environmental altruisms:

> I noticed that the river has probably come in 100 feet, and I've lost property down here. I have the river coming in, and it's sort of making another channel. It's taken quite a little property, the erosion. But I haven't got any qualms about that. I know living here that we're going to have to put up with some of that. (*Dawson County Agriculturalist*)
>
> The erosion is a big one. You can't believe the erosion. I will take you right over to it over there. There is a house over here. We rented that piece of ground when I was in high school. That was 80 acres and there is maybe an acre left. That…[happened over] 40 years. (*Treasure County Agriculturalist*)
>
> Agencies say the rip-rapping isn't worth the investment. But once a piece of productive land is gone, there's no revenue from it. It isn't just the revenue the farmer [lost]….[Farming] supports a lot of businesses in the community….It's a hard thing to figure. The land might have been worth $1,500 to $2,000 an acre…but when you figure the production over ten, 15, 20 years, it grosses a lot….And it takes hundreds of years to get it back. (*Yellowstone County Agriculturalist*)

> I never know where my property line is at….The river takes a little every year. In real high water years, it's more aggressive. It takes fertile soil real fast….I'm not whining, I'm resigned….I've resigned myself to this in sadness. (*Stillwater County Agriculturalist*)
>
> Some of the people have told me, 'You are never going to win against the river,' and I think that is probably true. As an agriculturalist, I don't deny that that is going to happen. Mother Nature is cruel, tough and hard. If I didn't do anything because I was afraid my crop would freeze or flood then nothing would get done. You gather up and do the best you can, and you might fail. She might cut you down. (*Park County Agriculturalist*)

The Big Neighbor (the State) is Difficult: Agriculturalists who own property along the river have a politically and financially powerful neighbor, the State of Montana. As compared to other agriculturalists, they must interact with far more agency personnel. The 310 bank stabilization permit process stands as a fitting example of the networks of persons, paperwork, regulations, and reports that must be navigated in order to do what previous generations of agricultural producers simply went out and did. For example, one agriculturalist counted interactions with 31 different agency persons in order to get approval of his bank stabilization permit. No one argued it is likely to get better in the future. Farmers and ranchers are skeptical of the management choices of this seemingly wealthy and powerful neighbor. Even those that participate in local groups, such as the Task Force in Park County are skeptical (see Part V for complete description of Task Force):

> They fooled with the river…[when] they put the jetties in, and that stuff. You'd think now that they fooled with Mother Nature, somebody should be committed to keep it from washing….They should…[see] to it that it don't wash….If [the jetties] were put there, they should have been maintained….I've had it stuck in the back of my mind, but I don't know who a guy would see [to have it looked into]. The Corps of Engineers? (*McKenzie County, ND Agriculturalist*)
>
> I do know that I consider the riverbed not mine, I consider the river not mine and I consider up to the high water mark not mine. Like when the water is running right now in the June rise, everything above that is mine, everything below that is the State's or [it's] Federal or [it's] the people's. (*Custer County Agriculturalist*)
>
> I own this property, and the State owns that river. I understand that and I am perfectly fine with it. I can't go out in that river and mess around, because that is the State's. So, I think the State should have to keep that river off of my property, too. If I can't mess with the river, why can the river mess with me? (*Yellowstone County Agriculturalist*)
>
> I've worried a time or two about some of these regulations that the government has on it to where you can't get some very simple things done in a timely fashion. By the time you wrestle with them, why, the condition has changed, or gotten

> worse, or whatever. That would be one of the complaints:…by the time you deal with all these government agencies, you can get a little bit goofy, you know. And then you get disgusted, and then you get discouraged, and then you quit,…[and] just say, 'The hell with it. They're going to do what they want to do anyway'.…But there's got to be communication. There's absolutely got to be communication. And you've got to have it from the engineer, and the hydrologist, and the old farmer/rancher, and grandma and grandpa, and everybody. And you got to talk about it, and discuss it, and see what you can come up with. That's just that simple. (*Stillwater County Agriculturalist*)

> It's the people's river. So, that is what got me on the Task Force in the first place….If my dog goes over on the neighbor's, and causes difficulty, it is my responsibility. If that is the people's river, it is their responsibility to keep it within the bounds. (*Park County Agriculturalist*)

Rip-rap is a Worthy but Temporary Solution: The historical approach to living with the river was simple, don't build too close to the river. By keeping one's investment out of the flood plain, one minimized loses due to flooding. However, flood plains are used for productive purposes, and agriculturalists suffer real loses when their properties are washed away. Rip-rap is known among agriculturalists as a temporary solution for flooding. It protects land when correctly applied, but it can be quickly undone by flooding and ice jams. Rip-rap can also divert water to your neighbors' land. Rip-rap has become costly, and it is difficult to attain the appropriate permits:

> I am not the expert, but I have lived here, and I have seen the river do some strange things. It may work for a few years if you do it right, but you could get a bad year, and it will wash it all out. (*Dawson County Agriculturalist*)

> In my opinion, most of all the rip-rap projects…have been done wrong. It's because people have not taken the time to assess, 'What am I doing? What do I want this to look like? and What are the true reasons [why] I am doing this?' You know, if you analyze all those things before you go in there,…hopefully you'd come to the realization that you'd give the river some room, so that when it comes its day in June that it needs to go over the banks….It has…[somewhere] to go. You could stack the dirt up 40 feet high and just keep narrowing it up. Well, the river is going to rev up so fast that Jesus Christ himself couldn't stand on the bank and keep the bank from disappearing….I mean, we've just got to pay attention. (*Prairie County Agriculturalist*)

> They rip-rapped the whole thing, and it…[sped] up the river [so] that it created a whole wet land where ever it wasn't rip-rapped you know, and it came out, and that's what the rip-rapping does. You know, before there was any of that, it had spread out a little bit everywhere and it would fill channels and fill sloughs along the way. And I think that filling those sloughs and the channels during high water is what helps to recharge the river in the wintertime. Because the river in the wintertime is lower than I've ever seen it last year. And it just seems like it keeps

> getting lower. And I think a lot of that's due to those sloughs and things not getting filled from flooding. (*Stillwater County Agriculturalist*)
>
> Water finds its own level, as you're well aware, and that's what the Yellowstone will do. If you stop it from meandering [in one] place, it's going to meander someplace else. (*Yellowstone County Agriculturalist*)
>
> Some of it was rip-rapped before we came. I know it is a controversial thing. You rip-rap here, and the water hits it and sends it across the river, and it does more damage to the guy that lives next door. You are sending the problem further down the river. I am slowly learning that…[but when] you see your own land disappearing, it is hard. (*Park County Agriculturalist*)

Diversities of Opinions Among Agriculturalists

Among agriculturalists there are a number of topics that generate diverse opinions. These diversities can occur among immediate agricultural neighbors, but they are more likely to appear as differences along the length of the river.

Development Impacts Agriculture: The rise of professional economies brings new people to the Yellowstone River Valley, many of whom wish to locate their residences near the river. The resulting residential developments are relatively expensive investments that result in rising property values, in rising taxes and an increase in the total number of people that use the river. Some agriculturalists accept that the Yellowstone River valley is no longer hidden. It is no longer a secret to recreationalists, vacationers or second-home buyers. Agriculturalists also worry that these newcomers are simply drawn to the river's beauty and that they lack the necessary respect for the river and its capacities. As well, the newcomers often have little understanding of rural communities, practices, norms and agricultural operations. Almost all agriculturalists noted these different attitudes, values and beliefs that have arrived with the second-home owners, retirees and (often) former urbanites. Almost all are attempting to adjust. The different rates and types of development affect agricultural practices in distinct ways:

> I just like living here. The best thing about this country is there's nobody here….It's just being able to do something without people around you all the time, you know. Like, when you're traveling, or in the cities, [and] you want to turn around but there's always a car coming, there's always someone. You get out on these roads, and go. You got to look, but it's just something not having someone watch you all the time, just being able to be a little more of a free spirit….It's just nice to be able to do what you want. You want to take a leak? You do whatever you want to do. (*McKenzie County, ND Agriculturalist*)
>
> Our community is kind of dying. The high school has 30 students. The town is turning into a retirement community. There is nothing to keep the youth here. It is a typical Eastern Montana town. Hunting is getting to be a big deal. We are

> getting a lot of non-agriculture people buying for hunting. It is hard to compete when you are trying to make the land pay. (*Treasure County Agriculturalist*)
>
> Down around Columbus, you start getting into row crops, and corn, and beets, and into a lot more expensive land—a lot more productive land….We've got to protect some of that. Urban sprawl is taking that out. (*Yellowstone County Agriculturalist*)
>
> It's changing rapidly….I was talking today to a man selling his ranch who has two offers on it right now. And I think that a lot of people don't realize how quickly it's changing….I think Montana needs to decide, do they want tourists?…Montanans need to sit down and decide the future of Montana, [and] plan it. What do they want it to be? Want it to be this? How do you keep it this way, or make it this way?...It's going the other way….[Montanan's have] got to be the author of the future. They've got the opportunity, now, because it hasn't been ruined like many places in America….Seize this opportunity, and do it together, work in a cooperative way, and work out the future. Well, that's a lot to say,…[and] hard to do. (*Sweet Grass County Agriculturalist*)
>
> There used to be 65 or more different ranches in this valley. Now there are probably 15, and the population along the river here has increased dramatically. (*Park County Agriculturalist*)

The Viability of Agriculture is Threatened: There are various threats to the viability of agriculture that appear to be immediate:

> In ten years, I foresee that irrigation will be different. There's going to be a lot more conservation as far as water. You're going to see a lot more pivots. I don't think you'll see this [flood] irrigation system like we have here. I really don't….If everybody had a pivot, and it worked, there would be no drains at all and there'd be very little water coming. I mean, there'd be a third of the water coming down that big canal. (*Richland County Agriculturalist*)
>
> We are third and fourth generation. We are farmers and we are stewards of the land. We don't really want to give that up….People from other places come in and the land here is cheaper and a lot of places are getting bought up. People come to hobby farm, not to invest. It drives the prices up. The second, third and fourth generations are in jeopardy. It is financial. (*Rosebud County Agriculturalist*)
>
> The prime agricultural land that's down along the Yellowstone…should be prioritized for protection. (*Yellowstone County Agriculturalist*)
>
> I hate to see the way it's going up, not just up here, but when you get down to Billings, and it seems like Billings just keeps creeping west farther and farther, taking valuable farm land and really putting some people out of business just

> because of zoning. And, all of the sudden, they were in agriculture trying to grow crops and they're having to pay taxes and you know they are a lot higher than they used to be, and they just can't afford it. (*Stillwater County Agriculturalist*)

> We've become a minority anymore it seems, and it's pretty tough. We don't have near the money that these other organizations can put together, and some of these battles get kind of tough. I know that when that Task Force deal was going, there were things said….They said, 'Well, the ranchers are on the way out—deal with it'….I guess we're not ready to hear that. (*Park County Agriculturalist*)

Recreational Activities Compete with Agriculture: New populations use and value the river differently than agriculturalists. These groups shift the cultural significance and meaning of the Yellowstone River away from historic production values. This evolution of the river's cultural meaning seemingly competes with agricultural values. Furthermore, various environmental and watershed organizations are seemingly successful in exercising political power. These organizations seem to promote non-production-oriented relationships with the river. The members of these organizations appear to invest financial resources and personal time in proactive efforts that influence policy decisions.

One agriculturalist noted the lack of participation by his peers and was shocked that "real estate people" were the ones participating in public forums and planning boards. Across the geographic segments of this study, agriculturalists offer somewhat divergent concerns regarding the degree to which recreational interests are considered competitive interests:

> Occasionally, you'll see boats. That's always kind of a highlight when you're down there hanging out, to see a boat or a raft go by. You wave; they wave back. (*Prairie County Agriculturalist*)

> I get a little pleasure watching people hunt and fish and enjoy themselves. [Maybe] get a deer or a big fish, or a big agate. It's kind of neat. We enjoy campers, too, because we'll go down there and pester them. Make them feed us. (*Custer County Agriculturalist*)

> You can go to a Montana farmer and rancher, not to the New York boys or the Californians that have bought [land], but go to a Montana farmer or rancher, and you ask permission to go hunting or fishing, and nine times out of ten you're going to get that authorization. (*Yellowstone County Agriculturalist*)

> Recreation is coming on faster and faster; every year there…[are] more boats. In fact, I wonder sometimes if it's going to get to where it has so many boats in some places that they'll have restrictions for motors, and it'll be just float boats. I think maybe in the future, something might happen like that, just because of the impact and the noise. I don't know if it will, but I look for something like that maybe to happen. (*Stillwater County Agriculturalist*)

> We are almost a bedroom community to Bozeman. And, as fishing becomes more popular, we'll see 20, 30 boats go past here in a day at least. That's a lot. And fishing is [meant to help people] get away from crowds….[They] don't want to play bumper boats. (*Park County Agriculturalist*)

Specific Concerns Among Agriculturalists

The concerns identified here are, more or less, specific to this interest group. In most cases, the issues are linked directly to the vested interests of these individuals as agriculturalists.

Weeds Are a Problem and We Need Help: Invasive weed management needs to be a shared responsibility, involving upstream and downstream neighbors, as well as private and public entities. It must be given more priority as a problem:

> This salt cedar, or Tamarisk, or whatever it is….You lose your willows when that stuff comes up. It's not a vegetation that's edible for wildlife or anything, so you're going to lose in every respect….And that's what's going to be some of our biggest problems in the next few years. (*Dawson County Agriculturalist*)

> The salt cedar and stuff like that—I'm sure that I'm not the first one that's mentioned salt cedar. It's a big problem. It hasn't been, but it is now. You've got the Canadian thistle; you've got the knapweed. You've got everything coming down the river….It's getting down here and it's coming down the river. (*Rosebud County Agriculturalist*)

> The County came out here, and they told us all these things we needed to do [about the weeds,]…or they can come out and spray it and charge me money. I told them, 'You go up to the head of the Yellowstone River and you kill all the knapweed and spurge down to me, and then I will kill mine, and then you can go on down there. Until then, there's nothing we can do about it.' I can…show you every place that river has ever overflowed—it just spreads them weeds, and that is exactly where the knapweed and spurge is. (*Yellowstone County Agriculturalist*)

> I have to tell you, the first 20 years I spent a lot of time spraying but you never seem to get ahead. So the sheep we're putting in now will be eating the spurge. Frankly, the spurge beetles we put out in some parts of the ranch have gotten rid of 95 percent of the spurge; in other parts of the ranch, I can't tell that they've made any difference. And I'm sure it's just a difference in habitat. The island right across this channel right here, we can look at it when we get done, but this time of year there would just be a field of yellow with all the spurge. And we've put some beetles over there, and it got rid of 90 percent of it. I don't quite understand why it worked there and it doesn't other places. But bio controls make a huge difference. Not only that, they're really cheap. (*Sweet Grass County Agriculturalist*)

> Weed control becomes an issue…because when the floods come, we get the weed seeds [coming from the National Park]. Even fishermen who use the river on a regular basis are bringing weeds along with them from wherever they have been. I would like to see the fishermen that park on the islands for lunch go pull weeds and share in the responsibility. (*Park County Agriculturalist*)

Regulating the Flood Plain is Problematic: Agriculturalists express a number of worries over governmental regulations related to the flood plain:

> I've heard 'corridor,'…and I don't know what the actual measurements would be. I've heard they want to establish a corridor five miles from the river in each direction where everything's protected. What a bunch of crap that is! That's what worries people. If they did that, they'd have control of this entire place, and you wouldn't be able to do anything. You hear of these Heritage River deals, where they come along and see a house that you can see from the river, 'Well, you've got to take it down.' They can really shut you down. I think that's what a lot of…[environmentalists] want. And, the really radical ones, they don't care if I'm here or not. They couldn't care less about me, or anybody like me. They'd like to see us gone, actually. They'd like to see a buffalo range, and me in a sustainable village doing something that the government mandates that I do. (*Dawson County Agriculturalist*)

> When you…mention a river corridor, I think there's going to be a 'dam' police here. That's my honest opinion….I mean, if they put an interstate through here, well, the first thing they'd do is they'd get to put a highway patrolman here. I don't want you to think I'm an outlaw or anything, but that's what I think of. (*Prairie County Agriculturalist*)

> As I understand it, they want to take land from the landowners along the river and make this river corridor. Let's say they have a corridor of a quarter-of-a-mile wide. That would take a good share of our productive land. I object to that. That's how we make our living. Then let's say the river continues in its wild, untamed fashion and it washes into that corridor….They'll want another quarter-of-a-mile. (*Yellowstone County Agriculturalist*)

> [Concerning public access,]…the courts took our riverbank without compensation. (*Stillwater County Agriculturalist*)

> I think the majority of the people would like to see more legislation or regulation along the river flood plain area. And I think that in this study the state conducted…they put a hell of a lot of land in the floodway and the flood plain. It encompassed a huge area, and I think that their numbers were jaded. They used a method of finding elevations, which I think was sort of arbitrary. I don't think it was scientific and accurate. I mean, we should be underneath the Yellowstone according to their maps, [but] we've never had water flowing through here. (*Park County Agriculturalist*)

Water Rights May Not Be Secure: As communities grow and change, water needs also change. New demands on the water resources suggest that the water rights of agriculturalists may not be secure:

> It's used for barge traffic...[but] why should Montana lose [its] water when it's Montana's water to start with? There should be more control left to the states to control their own water. (*Dawson County Agriculturalist*)

> With the water and the amount of people that there is anymore, we're more in jeopardy of losing our water rights, so we need to keep our water rights….A lot of your downstream people come up with some idea [that] this water is theirs, too. They pay taxes. They're a citizen of the U.S. We need to keep all of it here that we can, for development and agriculture and those types of things in Montana. (*Rosebud County Agriculturalist*)

> Sure, they want our water. They need it for commerce downstream. And now we have the environmental sector,…the tree-huggers from back east, and the Fish and Game has gotten involved….And it's almost a sacred word, 'Don't touch our Yellowstone.' Well, wait a minute here. God put that water here for it to be used. (*Yellowstone County Agriculturalist*)

> Being an Ag individual,…of course I'd want agriculture to have a priority. But I do know from when I was on a Conservation District, that drinking water comes first, then Ag water, which kind of makes sense, too. (*Stillwater County Agriculturalist*)

> I think it's important to be able to continue to use the water from the Yellowstone. Our livelihood depends on our water rights from the Yellowstone River. That's a pretty important issue to me. Then I think keeping the wide-open spaces is important. Because without cropland, we'd be out of business here….Instead of mowing hay, we'd be mowing lawns. (*Park County Agriculturalist*)

More Reservoirs Might Help: Many agriculturalists bring up the idea of more water storage, especially as it could be done with reservoirs. While they seem to be generally in favor of the idea, many are certain such plans would not come to fruition and at least a few are not certain reservoirs would be especially helpful:

> Down around Scotts Bluff and Mitchell…they irrigate out of reservoirs, but they were out of water. (*Richland County Agriculturalist*)

> I think just keeping water back, like that Yellowtail Dam is the best….We've talked about putting in reservoirs…upstream to hold back some of this water….It's a good idea, everybody likes it, but it's who's going to stand the expense to put it in? We feel that it should be the Corps of Engineers, because they seem to have pretty much the say-so….I can't think of anybody who would

object, because we [would] have recreation on that reservoir—fishing, boating. (*Dawson County Agriculturalist*)

We have had a lot of flooding, but not in the last few years. It's been pretty good. Depends on how they operate that Yellowtail Dam….If they wait and release water when this Yellowstone is high,…it floods….Last time they did it, they flooded everything. They waited until June, which is our high water time anyway. And they opened that thing up. We lost a lot of crop. Water…sat out there for two weeks; not only that, but it changed the whole channel of this river completely….They never should have done it….They probably have caused more erosion than all the farmers could cause in the next 100 years. (*Rosebud County Agriculturalist*)

[In order to have a lot more water] you'd have to build a dam up in…Paradise Valley or somewhere up in there. And that is such a beautiful area, you'd hate to see that lost….I'd have a lot of misgivings in this day and time. At one time, I was real strong in favor of it. I think it is important for future generations. You know, I suppose that's as important as the land we irrigate now, [but] we already can overproduce what we sell. So, it's hard to say. (*Custer County Agriculturalist*)

I think it is too bad we can't divert it somehow, the high water, and put it to use. Once it leaves this state, it is gone. I think we could develop more agriculture if we had some diversion. I'm not sure how'd you do it. Maybe it would take a dam and that would be pretty hard to do anymore. (*Yellowstone County Agriculturalist*)

I think there will always be plenty of water in the Yellowstone until late in the fall. There will be some shortages that show up in the fall, for irrigation mainly. The river gets so low then that people have to pump and that is expensive. I don't think they will ever put a dam on the Yellowstone. I think there is too much public pressure. The only thing is, if they could divert some of the high water, and use it when the river is low. I don't know anybody that is in favor of a dam. (*Yellowstone County Agriculturalist*)

The dam is a way to control the water, but I personally don't want to see a dam on it, especially if it's up above me. If they're going to build one, then build her on down the way. Hopefully this place would remain an area that would benefit the wildlife, and we can get along without setting right on the river's bank, you know; we can live without doing that. (*Stillwater County Agriculturalist*)

I think there could be some small dams and things like that to slow the run-off, and maybe support some of the streams a little better. You know, the smaller streams. And I think that would help control a lot of it. (*Sweet Grass County Agriculturalist*)

> I think there are some things that could be done, not particularly to the Yellowstone, but to the tributaries of the Yellowstone to conserve water so less water would need to be taken out of the Yellowstone. We have several streams on us, [and] if we were allowed to dam up the stream to build up a reservoir,…there would be less water drawn from the Yellowstone….Most of [our] water would be [drawn from] the reservoirs [that] would fill up during run-off time. (*Park County Agriculturalist*)

> We need some off-stream storage. We need to preserve some of this water. There's times when this river runs [very high]. And the climate is changing; we know that. And the run-off is coming a lot quicker than it used to. It used to be the river held up until August. As it is [now,] it starts to go way down in the first of May, June and July. (*Park County Agriculturalist*)

The Future of Agriculture: The agricultural way of life is more and more difficult to sustain. Impacts are felt from increasing residential and industrial development, rising property taxes, falling and instable commodity prices, increasing costs of equipment and fuel, and the rise of the recreational tourism, to name a few:

> I've already told my son that he'll be going to college and that I'll be the last generation farmer. I won't put him through that. It's too tough, way too tough. I mean, you already see the decline of farmers. It's sad….I mean, unless something changes,…you can't make it. You just can't. It's a struggle….We'll rent out.…Some days, I wish that I wasn't here but there's that dedication thing in there. (*Richland County Agriculturalist*)

> I think it's all going to be corporate-owned and tenant-farmed, that's what I think is going to happen. Because there is a lot of money out there, but it's not in agriculture. And these people coming in, buying this land, are not buying it with money they made in agriculture, unless they sold a place in California and bought some cheap land in Eastern Montana. It's an investment; it's not going to work to buy it and pay for it and stuff. (*Rosebud County Agriculturalist*)

> The biggest problem that I think is going to be faced on the Yellowstone is ignorance of the natural process, and bad practices. They blame everything on the farmer and rancher. Well, there aren't many left….Those guys [still farming] are getting old, and they're selling off. (*Yellowstone County Agriculturalist*)

> Land prices are going up all the time. It is tempting for people to sell….You can't buy the land and make it produce enough to make payments. That is changed in my lifetime. (*Sweet Grass County Agriculturalist*)

> We've looked at our inputs, such as fertilizer and fuel going up a third or more in one year. That's a pretty big hit for a small business. We don't have anyone to pass that along to. Our prices are pretty much set. We sell at what the market

> offers us. And in a business where the margins are pretty slim, it makes a big impact. I don't know how long Ag will be viable. (*Park County Agriculturalist*)

Implications of Agriculturalists' Perspectives

Taken as a group, the perspectives and concerns voiced by agriculturalists suggest that particular issues must be taken into account if resource management strategies are to be successful.

The Pressures on Agriculture are Real: Agriculturalists along the Yellowstone River face a challenging climate, changing social and political landscapes and a myriad of economic difficulties. They depend on the river for irrigation, but many agriculturalists are concerned that when they attend public meetings they feel horribly underrepresented. One participant was upset when applying for a rip-rap permit because he had to attend a series of public meetings. He expressed his frustration this way:

> I don't want to be a public person. All I wanted to do is ranch and do my thing. I had no idea I would become a public figure. (*Park County Agriculturalist*).

There is a heritage among agriculturalists that promotes a spirit of independence, a commitment to individual rights and a desire to minimize regulations. This heritage is rooted in a historical context that more or less demanded such values. In particular, none of the homesteaders would have been successful if they had not embodied at least some of this spirit. Today, however, some agriculturalists recognize that those who wish to be self-reliant may, ironically, jeopardize that wish simply by exercising it. If agricultural interests are detached from recreational, municipal, and residential interests, by virtue of standing apart they may become victims of their self-reliance. A handful of agriculturalists have resigned themselves to this irony and are attempting to understand the common interests that are exposed at managerial forums.

Numerous agriculturalists noted that it is essential that agriculture's interests be represented in the public forums and decision-making bodies. To remain an active member of any citizen group is always challenging. Providing for one's family and actively maintaining a farm or ranch are full-time responsibilities making those agriculturalists who recognize the importance of involvement, and who are willing to be involved, invaluable to the community as a whole. The uncertainties of commodity prices, the rise of land prices, the accompanying increases in property taxes and the increasing costs of operation may not, in the long run, determine agriculture's viability. Rather, it may be a function of whether or not agriculturalists are actively and constructively involved in public managerial forums.

Partnerships with Agencies and Other Interest Groups are Needed: Large-scale agricultural operations along the Yellowstone River are advantageous to many constituencies beyond the agricultural community. A hayfield better supports riparian functions than a housing development. Recreational users prefer pastoral scenes, and residentialists regard the rural landscapes as the heart of the appeal when deciding to live near the river. As well, agriculturalists have local and historical expertise from which resource managers can benefit. It seems, then, that a number of partnerships between agriculturalists and other constituencies would be forthcoming. Unfortunately, a great deal of mistrust exists among agriculturalists with regard to these other entities. These mistrusts must be addressed, both from the outside and from within the agricultural community if the interests of agriculturalists are to be protected.

It takes very few negative encounters between agriculturalists and agency personnel to severely damage the credibility of an entire governmental agency. Moreover, broadly held negative attitudes result when agriculturalists share the stories of this negative encounters. It matters little whether or not the agriculturalist telling the story was directly involved. Agency employees should make themselves aware of historic troubles, and they should assume that many agriculturalists distrust government. Every interaction is an opportunity to build a lasting relationship, but it may be that negative feelings are already at the base of that relationship. Also, agriculturalists' describe their approaches as based in common sense and economic feasibility. Yet, their comments suggest that agency personnel are not always successful in making technical information valuable. Information packets and presentations are often laden with jargon and sometimes seem completely irrelevant. When government-endorsed practices are costly, time intensive, and/or seemingly irrelevant, the likelihood of adoption is slim.

It is important that agriculturalists also attempt to remedy relationships with agency personnel. This is especially critical if agriculturalists hope to find agency support for programs and policies that contribute to the viability of the agricultural sector while protecting the broader resources. Agriculturalists should demonstrate their commitments to stewardship. They should look for and voluntarily adopt practices that protect the river's resources. By doing so, agriculturalists will build a positive base for partnering with the various agencies. The goal should be to establish mutual understandings of the biological resources, the economic realities, and the pragmatic limitations of managing and sharing the river.

In some areas, riverfront properties are becoming quite valuable. The ranches and farms of the river create sublime backdrops that entice many people to purchase land on the river. The enormous profitability of selling property for developmental purposes is in stark contrast to the virtual non-profitability of producing livestock or crops. Many agriculturalists are resigned to the idea that their retirements depend on the eventual selling of their properties. They only hope that they will not need to sell it all. For most, the anticipation of a handsome profit is little comfort for the cruel irony of their situation. Namely, riverfront agriculturalists survive only so long as they are willing to subsidize the sublime.

In some areas, developmental activities have advanced to the point that environmental and recreational groups now decry those activities. They appear to be ready to assist in the preservation of agricultural activities. Yet, little progress has been made in building partnerships. From the agriculturalist's perspective, the prospect of saving the farm for environmental or recreational groups is no more appealing than saving the farm for the pleasure of the residentialist across the way. Furthermore, if saving agricultural lands means that the agriculturalist must forfeit the opportunity for a secure retirement the plan may as well be nonexistent for all of the support it will garner. A successful partnership between agriculture, recreation and environmental groups will need to be based on innovative programs that allow agriculturalists to maintain their lifestyles and that allow them to participate in and benefit from, the preserved value. Those who wish to preserve the sublime must not ask agriculturalists to subsidize the view, and agriculturalists should recognize that a guaranteed future is unlikely. Recreationalists may be willing to support creative programs that ensure against the riverbank being cluttered with houses, but the carpenters and plumbers who fish the river wonder, too, how they will afford retirement.

Yellowstone River Conservation District Council has Credibility: Agriculturalists express a growing need for educational resources, and they refer to the Yellowstone River Conservation District Council as a source with a great deal of credibility. The Council is positioned to act an informational source, a translator, a liaison and a sponsor of research activities.

A key effort would be to promote and further develop a river-length invasive weed management plan. Agriculturalists and many residentialists identified this as a high priority, especially in terms of leafy spurge and spotted knapweed. When upstream neighbors do not manage weeds, because of ignorance, disinterest or absence, the downstream landowner suffers. Many agriculturalists willingly put in time, effort and money into managing their weeds, and they have come to know which strategies are working and which are not. The Council could function as the clearinghouse for advice, innovations and best practices. It could identify impediments to full compliance and develop strategies for targeting negligent landowners. Simply providing a list of local advisors might be helpful. Unfortunately, many agriculturalists noted that areas of State land, especially islands, and Federal lands, such as Yellowstone National Park, are not managed for weed abatement. If the Council could function to demand better management of weed control on those lands, individual property owners might be more willing to engage in the prescribed best practices.

The Council should disseminate information about bank stabilization methods, permitting processes and flooding. Convention and convenience have convinced many agriculturalists that large and bulky rip-rap is the only means of effective bank stabilization. Alternative methods, such as weirs and bank sloping, have worked in some areas but are known to a very few people. Many agriculturalists view the permitting processes as an impediment only. It clearly prohibits the traditional do-it-yourself approach, and it seemingly introduces unreasonable costs. A few landowners discussed the need for better understandings among agriculturalists of the benefits of flooding. One agriculturalist wondered whether or not there were ways to encourage the benefits of flooding while preventing major damage. These discussions suggest the need for the Council to make a concerted effort to address concerns about the cumulative effects of bank stabilization projects and best management practices for living with a free-flowing river.

Agriculturalists expressed a need for better informational guides for newcomers and recreationalists. For newcomers to an area, they suggest such resources should include information about river safety, access points, high water demarcations, private property rights, local manners, and customs, flooding potentials and weed control responsibilities. They see a need for recreational maps to include information about access points, private property holdings, local conventions, codes and laws. The maps provided by Montana Afloat and in the BLM Floater Guide are good models but they are either incomplete or not widely distributed. The Council could publish a series of information guides that address the river as a whole and that include community-specific information. If communities or groups have already developed guides, the Council could assist in updating, refining and disseminating the information provided.

Finally, because the viability of agriculture and the management of the Yellowstone River are intertwined, the Council, among its many research agendas, should continue to sponsor activities that are meaningful to the agricultural community. Beyond research project that will help agriculturalists understand the physical processes of the river, the Council could investigate and provide guidance for understanding tax shields, open space programs, Farm Bill legislation, and water quality trading programs, and recreational revenue streams that have minimal impact on traditional agricultural activities. Agriculturalists trust the Council to understand their interests, and they trust the Council to promote innovative approaches that have a common sense base. It is worth noting that the Council stands apart from the greatest concerned voiced by agriculturalists:

> There are too many people [who] are too far away from having a little dirt under their fingers from working the soil, and they just don’t understand exactly what all of this is. (*Yellowstone County Agriculturalist*)

Local Civic Leaders: A River-Length Overview

Sixty-eight interviews were conducted with individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and water/wastewater treatment managers. Participants were identified through public records. In a few instances, individuals were identified as local leaders even though those communities have no formal local government.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Local Civic Leaders: Analysis Table

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Local Civic Leaders: A River-Length Analysis

Introduction

The local civic leaders interviewed for this project were a diverse group of individuals, and many of them could have served as excellent representatives for the other interest groups, meaning they often also had vested interests in agriculture, recreation and/or residential concerns.

Even though local civic leaders sometimes have particular personal interests, and even though they represented twelve different counties, a number of municipalities and a numerous unincorporated communities, a number of commonalities emerged from this group. Namely, these local leaders view the river as a shared resource that provides broad benefits to their communities. As well, they are more comfortable making decisions when they feel well informed, in particular because they struggle to balance the various needs that are presented locally. They especially value the river a source of drinking water, but they are aware that the river presents dangers. Finally, they express sympathies for both agricultural and recreational interest groups.

In other ways, they expressed a diversity of opinions, both within and across geographic segments. Diverging opinions are found when looking at comments concerning private and public rights, local economies, managing for the future, and problems associated with noxious weeds.

There are particular points of discussion that seem to carry great weight for these individuals as they work to fulfill official duties. Conversations often turn to philosophies about governing, the challenges of local citizenries, the best ways to connect with state and federal entities and concerns about flood plain maps and official evaluations of local dikes.

Finally, discussions with local civic leaders offer four implications for the future. First, there is a need to generate and share good information at the local level. Second, there is need to help local officials with the complexities of holistic management, especially new officials. Third, with limited resources and growing demands, it is obvious that not everyone will have everything they want. Finally, governance via rules and regulations will require multiple strategies and careful coordination across the various entities and agencies involved.

The following sections explain the commonalities, the diversities, the particular points of concern and some of the implications of their comments.

Common Concerns Among Local Civic Leaders

The following concerns are common among local civic leaders, regardless of where one meets the individual.

The River is a Resource for the Community as a Whole: Among local civic leaders there is an expressed commitment to the river as a shared resource, to which various groups have rights, and from which their communities prosper:

> The Yellowstone was very influential with settlers being in the area initially. Some large cattle and sheep ranches [were established]. Then the railroad went from the western border to the eastern border of Montana. I would say the Yellowstone might be the single most important entity for establishing Glendive, and [it is still] the reason [Glendive] is here today. A lot of small communities have dried up and gone away. Glendive continues to be a lifeline in Eastern Montana because of the river. (*Dawson County Public Official*)

> From our standpoint as commissioners, the [river provides] economic benefits for the local area….[It] provides irrigation for the farmers….It brings…the hunting and fishing people…[and it serves] our own recreational uses. (*Rosebud County Public Official*)

> If you follow the valleys down, you'll find that throughout Eastern Montana…the vast majority of the economy is within the boundaries of that river.…And it's not a whole lot of land….[And] the water that the City of Billings takes from the river,…there would be no growth potential if they couldn't do that. (*Yellowstone County Local Civic Leader*)

> More than anything else, I think…we live in a society that creates a lot of pressure and tension. People work 24/7, almost just to try and make ends meet, and they need a way to get away. Right down here [at our park,]…all summer long, you will see people there come in just to get away and replenish the soul. I just feel as along as you set reasonable policies I think you can let people have access to even your smaller tributary areas that feed the Yellowstone. (*Stillwater County Local Civic Leader*)

> As anywhere, [we have] a very complex stew of interests. I think the County Commission that has a lot of power that they are reluctant to use because [they are] balancing interests. I think you've got some fairly enlightened folks on the County Commission. I think that they're only now gaining enough confidence as a commission to take steps to protect the river. (*Park County Local Civic Leader*)

Good Information Helps: It is evident that local civic leaders consider good information important, both in making decisions and in helping others in their communities understand the decisions that are made:

> Erosion is constant….The problem is, if [we address erosion] here, we're affecting everything downstream. They have learned that…small changes on this river cause major changes downstream….We have a bridge out here that [the river] flowed straight through the piers. It now flows [parallel] to the bridge. Minor changes have had major effects on that river….You can't control this river….One year, this guy lost 600 feet of agriculture land. (*Dawson County Public Official*)
>
> We can always use examples of strategies that have proven to be successful in an area that is not that different from the area where we live. An example is the National Main Street Program….Miles City can look at a database of communities that have made these changes, and what the challenges were, and how they overcame those challenges. [The Yellowstone River Conservation District Council] could give us some models as to how we can manage the bottomland of the Yellowstone. How do we zone the area around the river so it is preserved for the kinds of activities that are most important to us, like Ag and recreation, [with] security against flooding, and [protection for] wildlife and fishery habitat?…[We need] some set of priorities that the [local community] can then start working on incrementally. (*Custer County Public Official*)
>
> Once I explained…'Hey this fishery is the best thing that could happen to you….You're downstream of the need to have 2000 CFS in the [Big Horn River] for the fishery. So, don't cuss at those trout, because that's the best thing you could have. Now you've got the fishery people on your side….They don't care that much whether you're taking the water as long as it gets past Two Leggings [drainage]—the end of the blue ribbon stretch is in there.' And once they figure that out, they liked that idea. (*Yellowstone County Local Civic Leader*)
>
> I think the flood plain is…expansive along the Yellowstone….We've got maps that would show that, and it's all elevation relative to high water mark that occurs over so many years back. I think we probably depend heavily on the State for that information, so we would have maps. (*Stillwater County Local Civic Leader*)
>
> Our old maps are terrible to use and the new maps, with elevations and overlays on aerial photos, are so wonderful to use. What little we have been able to use them has been very helpful….[The maps] have to be accepted by the commissioners, and then they go to DNRC,…then to FEMA, and then they have to review and put them on a rate map to drive the flood insurance. Some of the meetings that are scheduled for approval are [scheduled] for 2008….It has gotten political. They have talked about moving the flood plain and it is a big financial burden on those people. (*Park County Local Civic Leader*)

Local Needs are Various and Must be Balanced: Local leaders and officials are aware of the various needs of their communities' members. They also explain that, often not everyone will be fully accommodated and that they must attempt to balance a variety of local demands:

> In our community, where everybody knows everybody, they know someone that has access somewhere. If they don't, there are public access sites. I have never heard of anybody complaining that they were denied access to the river. (*Dawson County Public Official*)
>
> Rather than a flat 500-feet setback, there's usually an identifiable meander channel where the river wiggles back and forth over time. And that could be the no-build zone.…[The no-build zone] would depend on the topography. We have some steep hills coming up to the river's edge, and there is no meander channel….[We could be] flexible…based on some criteria. (*Custer County Public Official*)
>
> There is a critical balance….It would be ticklish….Those who are really sensitive to the water [rights] would have some immediate red flags….It is a critical balance that we have right now….It is a real touchy balance. (*Yellowstone County Local Civic Leader*)
>
> Irrigation in this county is a huge deal. From the county's perspective, we are trying to construct facilities that are safe for the river, in terms of fish habitat, etc., but [also] trying to protect the agriculture users. They are a huge part of this community. Some people say they don't care about Ag, they care about the 'viability of the river.' Once you get past the base minimum standards, those are local decisions. I think a locality can choose to be more protective.…I understand that can be messy, but I can't think of anything that isn't [messy] when you are doing grassroots planning. You can't exist in a vacuum and say that it has no effect on anyone else. You can't say that with the Yellowstone. You can't have this over-arching 'We know what is best for you.' (*Sweet Grass County Local Civic Leader*)
>
> It takes some persuasion and education in terms of the public. The public is so used to thinking of the river as being something you need protection from and I think we need to understand that it is a dynamic resource, and we need to learn to live with that dynamism in a way that doesn't degrade the river in terms of fish productivity,…aesthetics,…natural functions…[or] seasonal changes. (*Park County Local Civic Leader*)

The River Provides Water But Can Threaten Health and Safety: Local civic leaders are especially aware of the importance of water for human health needs, but they also regard the river environs as areas that potentially pose risks to the safety of their local citizenry:

It's difficult to save people from themselves, so I think that one of the most important things a governmental entity has to do is persuade rather than demand. And I think that's where the involvement in the decision making process is critical….You have to be open and receptive to public comment—you have to be empathetic without necessarily having to agree. And I think in the instances when we don't agree, you have to convey [that you are] understanding without necessarily being in agreement….The Corps, in the past, has not been as sensitive as they might have been in terms of conveying to the public that they are listening, not necessarily agreeing….[With] set-backs, you're trying to save people from themselves—it's a very hard sell. (*Park County Local Civic Leader)*

We draw millions of gallons of water out of the river daily. It is our lifeline for the city….We are probably one of the only communities that take water directly out of the river, and we don't worry about getting sick. (*Dawson County Public Official*)

There's disagreement among hydrologists [about] whether that [1918 flood] was the 100-year flood or the 500-year flood. If it was the 100-year flood, we're due for it again. I have a picture of the [1918] owner in a boat on the front porch [of my house] so that really pretty much took care of everything in town. Everything was flooded. (*Rosebud County Local Civic Leader*)

[Billings takes] about 24 million gallons a day, peaking at over 50 million in the summer and down to about 15 to 16 million in the winter….We aren't even a pipsqueak compared to irrigators….We return 75 percent of it to the river [and] another 10 to 15 percent is returning to the aquifer. Ok, so we've evapotranspirated 15 percent, but we've gained great things from that. (*Yellowstone County Local Civic Leader*)

The river is not safe [for human consumption] as it is. We remove all the fine particles, all the bacteria, and the viruses that are harmful….We improve its potability in the sense of its aesthetic quality to users. It's clear; it has a good quality taste….People find it pleasant….There's lots of water that's safe drinking water but not potable. The [Yellowstone River] is a good quality source. It's a bicarbonate water. We're pretty far up the watershed. There's only a minimal amount of interference from man, but enough that it wouldn't be safe for anybody to drink as it comes down the river. (*Yellowstone County Local Civic Leader*)

One of our obligations is to keep the roads and bridges open, and that would be for emergency services primarily but also for…school buses. (*Stillwater County Local Civic Leader*)

What shakes out first is public health and safety. I would say you are balancing those other factors. Beyond public health and safety, I wouldn't give a number to any of the others. I am not suggesting that if an irrigation project required rip-rap [that you shouldn't do it].…You look at the pros and cons in any kind of planning

> [and] I think you are looking at a potential for impacts and how they can be mitigated, rather than a choice of either/or. It is a balancing act. (*Sweet Grass County Local Civic Leader*)

> With respect to the river, I am not panicked about the river in the next ten years. I feel pretty good about where we are going with the Corps of Engineer's works and that they will come up with some measures that will prevent big floods. I have also lived around rivers enough to know that sometimes a river will just jump. Unless you have 14-foot flood retaining walls, there may come a time,…despite the best efforts,…[when the river] will jump. That is somewhat incumbent on living by a river. I certainly realize it is something that we may have to go through. (*Park County Local Civic Leader*)

Sympathies for Agriculture and Recreation: In general, even though many local officials view agriculture as economically important and a foundation of their communities, they also view recreational activities as important. They appear to have sympathies for both:

> It is the 'too' country—too dry, too wet, too windy, too cold, too hot. It is always too much of something. We never have an average year. We have averages on the Internet that will tell you, 'Wow, that is a pretty nice average temperature,' but you will never see that temperature. I guess it is an extreme country. It has a lot of extremes. (*Prairie County Public Official*)

> The river is very wide at this end because it's the end of the river. That's just what it is. I mean, it's over a mile wide down here…if you went all the way across. (*McKenzie County, ND Public Official*)

> This is an agricultural valley. There are many crops grown here [like] grains, and sugar beets; sugar beets are a prominent crop. When you get away from the river valley, it goes to cattle….If there was not the river, we would not have irrigation; if there was not irrigation, we would not have sugar beets, spring wheat, winter wheat, [or] any of the crops that…[are] in abundance along the river valley. (*Treasure County Public Official*)

> I know a lot of people who will go down and do recreation on the river. A lot of people fish on the river….It gives people an opportunity to get away from the everyday stress and just go sit at the river banks without having to drive a long distance. (*Richland County Public Official*)

> The river helps make a nice community, with the trees and stuff. That is probably why I moved to Miles City. I was real hesitant to come until I got here and saw what they had to offer. I fished on it for a number of years. I know that, without the Yellowstone and the Tongue coming from the other direction, the recreation would be very sparse. (*Custer County Local Civic Leader*)

I know what the most important aspect[s] now…[are] agriculture [and] irrigation. But, I think the tourist attraction of [the river] as a natural, scenic resource will become more important over time….[Recreation] should have equal importance to agriculture. It is a tremendously diverse riparian ecosystem along the river. It has historical and cultural significance. It is beautiful. So, people will pay to come and use it, to see it, or they will consider lifestyle changes that involve the fact there is an undammed river nearby that they can appreciate and see. (*Yellowstone County Local Civic Leader*)

I don't think agriculture should have priority on the river. I think at best…[agriculture] should…be on par with recreation. Agriculture, you know, feels they have a right to the river, and no matter how hot the water gets, or how low it gets, they figure they got the right to what's left and to hell with the fish, to hell with everybody else, to hell with the whole living system around it. And I don't agree with that….You'll see it later this year, as the heat continues….It will stress everything along the river,…from deer to muskrats. (*Yellowstone County Local Civic Leader*)

[We] try to protect the people that have been here with their agriculture. You know, irrigation ditches. Things that have been there will be there. And [we] try to make sure that nothing infringes on that. (*Carbon County Local Civic Leader*)

I think even the people that live in Billings and [in] Yellowstone County to the east consider us their playground, which is fine. If I lived over there, I'd want to come over here, too. (*Stillwater County Local Civic Leader*)

When I was a kid, agriculture, and particularly livestock, was far and away what everybody was engaged in. They were all working farms and ranches. Recreation was interesting, but it was way down there [in terms of economic importance]. Now everybody that has any land out there has either sold it or is waiting to sell it. [There is] hardly any livestock….A lot of ranches exist in name, and maybe in area, but they are purchased by absentee owners or part-timers, and they don't have any interest in livestock. It has been a whole different slant on the vegetative and ecological part….The farm ground is worth so much…they can't afford to not sell. (*Park County Local Civic Leader*)

It is easy to describe because people have a picture of what Yellowstone Park is even if they have never been there. I describe it as an extension of Yellowstone [Park]. You attach things like the fishing culture, the hiking, the outdoor mountain recreation. I don't think anyone gets a sense until they have been there. (*Park County Local Civic Leader*)

Diversities of Opinions Among Local Civic Leaders

Among local civic leaders there are a number of topics that generate diverse opinions. These diversities can occur among immediate neighbors, but they can also appear as differences along the length of the river.

Valuing Private Property Rights and Public Rights: It is generally understood among local leaders and officials that they must deal with the tensions generated between private property rights and public rights. Each will express a commitment to not over-reaching on behalf of the public, but within and across geographic segments these individuals place varying emphases on private rights:

> As far as a residential house, if the guy wants to build it there, ok, it's his land. Build it. But I don't think he should be allowed to say, 'I'm going to armor the riverbank'....[And], like I said, nobody does that around here, because it floods. But, I know that further up the river that's done all the time, and [on the] lower river too. You go down below Bismarck, North Dakota [and] there are a lot of big homes built right on the river. And they're all rock and everything….It's beautiful. But let's say something happens, and it washes…[those] people away. Then, to me, too bad. I mean, that's the way we should look at it. (*McKenzie County, ND Public Official*)

> The people that come off the ranch, and have had a great deal of latitude in terms of what they can do on the ranch…learn first-hand the statutes that control the city zoning and planning decisions….[Some of them] go ballistic or feel some real indignity….Part of the attitude is rooted in the economic scarcity [that] people who have lived here for generations [endured]….The good times come around so seldom and [people think] 'Let's make hay while the sun shines.' (*Custer County Public Official*)

> You know, the Constitution of the United States, with its Bill of Rights, as well as the Montana Constitution, absolutely lists as an inalienable right your right to property, both personal and real. And you should be able to develop that to the highest and best use. The biggest problem that we get into then is the responsibility of the property owner….It was absolutely wrong for people to develop their copper at the expense of everybody else's environment. That was wrong. It is wrong today for somebody to build a house that is inappropriate and…destroys other people's values. So the balance between our right to own a piece of property, and to develop that piece of property as we see fit, either for our own aesthetic value or market value,…between all of those bundles of rights and the responsibility of a good citizen, as a neighbor…that's where, I guess, government and rules and regulations and so on come in….What is responsible in my opinion may different from your opinion….Refereeing the property rights [is important, but,]…without a question, we're going to defend private property rights….People should be able to hone that property and invest and make money

> in it, or sell it, or whatever. But there is a responsibility that goes with that ownership. (*Yellowstone County Local Civic Leader*)
>
> Oh, yeah, sure we can [have management]. You know, private property rights are hard to…step on,…but there's sometimes when, maybe, you have to do something, or [you have to] mitigate,…or hope, or give them a carrot, or whatever. (*Carbon County Local Civic Leader*)
>
> If you get flooded out and lose your home, why would you rebuild there? Because it only happens every 100 years? Can you get insurance? No. I do think that if you are going to take the risk, *you* should do it....As long as you handle your sewage properly, and you know that you can't get insurance, and the Feds aren't going to have to bail you out, if you want to do it and it isn't hurting anybody else, you can do it and take the risk. That is what our country is built on—…people that were risk takers….Your home is your castle. You should be able to do that. (*Stillwater County Local Civic Leader*)
>
> Public safety has to be number one. Number two is probably…protection of property rights….I would put a high premium on property rights. (*Sweet Grass County Local Civic Leader*)
>
> There's a culture of property rights and courts and so I think that the County Commission is certainly faced with a difficult balancing act in making decisions regarding things like set-backs. (*Park County Local Civic Leader*)
>
> It's a real tussle sometimes between property rights and community values and who owns community resources. The river, like it or not, is fundamentally and primarily a community resource with very private sector edges, and that dynamic is not going to go away. The problems there and the conflicts are only going to intensify….I saw a really different dynamic when I worked in Colorado….They don't have the stream access law that we do….At least [in Montana]…there's a little bit more power held by the public than there would be in other places. The problem is how do you mobilize the public support for valuing the public aspects of this resource. I think there's not that realization that things could be different. And people have always lived within this environment in terms of river ownership, the public ownership of river rights, not understanding that it's not the common situation, it's very exceptional. (*Park County Local Civic Leader*)

Local Economies and the Future: Perhaps the greatest diversity of thought that is traced to the geographic segments is in terms of the local civic leaders' thoughts regarding the economic futures of their communities:

> I think the main goal of this area would be [to] keep the river usage as it was, as we've been using it. I think it should remain for the agricultural part, you know, the irrigation part. I think the recreational part has been used for years and years, and I think it should remain that way. I don't want to see controls put on the river

by any government department….I don't want to see them trying to change the river…for something frivolous. I mean, if it was something that was going to destroy a water intake system, I think that's something that's legitimate….[It] should be protected, because it effects a lot of people, like in a city….Other than that, I hope people come and enjoy the river,…[that they] realize when it's private property to visit with the owners of the land, and try to be…good stewards. (*McKenzie County, ND Public Official*)

I think that the energy thing is our biggest asset….The environmentalists and the…people [in power] need to get together and have a program where we have a safe removal of the coalbed methane. That is a big controversy, and they can't be bull-headed because it is a big asset to our community….Eastern Montana has ten percent of the coal reserve. And we have got to develop it, but we have to be environmentally friendly, within reason, and that is all I can ever see that really can help Glendive grow. (*Dawson County Public Official*)

People are becoming older [and there are] more retirees. I think this would be a fair statement. We've already seen [this happen in] the community of Hysham. (*Treasure County Public Official*)

As a city council member [in Forsyth], one of my concerns is to encourage different businesses that would hold our kids, where they could go to [college] and come back and have something to work for. Right now, there's nothing. (*Rosebud County Public Official*)

There's quite a bit of money spent by hunters in town here. You always see them in town at noon. They stay overnight at the motels, they stop in at the Friendly Corner, down here and buy stuff. Quite a bit of money gets spent here because of them. (*Treasure County Public Official*)

Priorities have been lopsided towards the environmentalists and communities have not been considered….I think [the] conservationists,…[who] are already doing things as far as the land [goes],…get penalized and shut out because it doesn't quite suit some environmentalists…[who] don't have a clue what it's like out here. (*Custer County Public Official*)

A lot of people from this area see the river as a recreational resource….Sometimes that can take precedence over a real good logical use of the river. (*Custer County Public Official*)

Those who are interested in the future of this urban area should be interested in the calling cards to the area, one of which is the river. If you allow a few to own it, you've lost that calling card. Would it suffice for the ecosystem if it were a park? Absolutely it would, because it's a huge area. Riverfront Park is a pretty good example. It needs a lot more extensions. You can go to many cities, Boise is a good example…and fair amounts of Missoula's Clark Fork are in public

> ownership….Their urban area is right on top of it….The Yellowstone is a beautiful possibility for an open wildlife corridor. (*Yellowstone County Local Civic Leader*)

> I think we're going to see a lot of change because we have endless amounts of subdivisions going in. That brings a lot of problems with it. And they're wonderful people. We have doctors, and veterinarians, and all kinds of people living out in the hills here. They just want to be left alone, but they're going to get terribly bored after a couple of years. And we just wait for that, so we can put them to work as a volunteer. They're really wonderful people. (*Stillwater County Local Civic Leader*)

> It's very special to have this river here, and, of course, we want to protect it. We want to make sure that any housing developments follow the DEQ rules, [especially] septics should be placed according to DEQ. I guess I don't believe in setbacks. I think the property owners have the right to be as close to the river as they want, without damaging the river. If they do not damage the river, I think it's their property line. (*Stillwater County Local Civic Leader*)

> People come out to Montana and they are enthralled by the views and the attitudes of the people and…they settle in here and they want to have it all, but by some of their actions they are responsible for destroying the things that they admire….They want their big castle back in the trees, or up on a ridge, or right next to the river. They have destroyed what made it beautiful….The wide open spaces aren't wide open anymore. (*Park County Local Civic Leader*)

> It's changing….There…[are] a lot more houses than there used to be….It is just a reflection of the whole transition from an agricultural based economy…to a tourist and recreation area. (*Park County Local Civic Leader*)

> We have CEOs from big companies…that fly in with their jets and helicopters. They will spend a day, or a few days, and then they are out of here. The rest of the year, we are taking care of it. We worry about weeds and roads…[while] they have one little ranch manager whose authority is limited to keeping people out….We don't want to be a rich man's Disneyland. They come, they go….We are trying to maintain something and still be progressive. (*Park County Local Civic Leader*)

> The land prices are high, at least agricultural lands. It's being influenced by recreational ranch buyers. (*Park County Local Civic Leader*)

Managing for the Future: Local civic leaders are fairly consistent in arguing that local control is better than Federal, or even State, control. Yet, the call for local control is generally outmatched by comments that acknowledge Federal and State standards as the primary means for protecting communities from unnecessary expenses and for protecting the future of the river's resources. A great deal of emphasis is placed on the need to accept the river as a dynamic and changing entity that requires respect if one intends to manage for the future. Comments suggest that at least some officials attempt to anticipate problems before they are unmanageable and that they attempt to work with groups to help them understand future implications of personal actions:

> There are already rules by FEMA that say you have to buy flood plain insurance, which means you have to abide by their rules. Enforcement of [the rules] is something important that you have to do. Pierre, South Dakota is a great example in that they let a subdivision build in a flood plain, [and later it] cost…millions of dollars to buy out 300 homes. In Billings, they just kicked some people off the flood plain. It is for the saving of dollars and lives. (*Dawson County Public Official*)

> Anybody that lives along the river has to have problems with bank erosion. Five years ago, there used to be one of the best cornfields in the whole area, upstream about five miles….[Then the] river took one of its classic loops way off to the other side,…[and] it went right through the middle of that cornfield. It took out 40 acres of that field and abandoned 120 acres where it had run before. And [now] if you look at that abandoned section, occasionally in high water [the river] will move through there, but there are young trees in there, and there's shrubs and bushes….So, as the river moves, it both creates and destroys, as it has always done….I happen to be a fan of wild rivers. I hate to see people lose their homes, and I have a certain amount of sympathy for a home that has been standing for 100 years,…but the river changes….I think a person should be able to protect their property, but I am absolutely opposed to new construction in the flood plain. That's an accident waiting to happen….That is eminently foolish. (*Rosebud County Public Official*)

> What's the cumulative effect [of development] on the underground aquifers?...I don't think it is as big an impact as people are trying to make it to be….I think we have plenty of water. It snows like heck every time, and we [have] water coming down the Yellowstone….And if you read in Genesis, God set the whole thing up to where the river comes down, [and] evaporates, and the salt sea is almost a purifier….Now, that's a pretty good ventilation system that He developed. And that's here in Montana. Now we are running through some droughts, and you can get into global warming….But what I see in Montana is, we've got lots of water. We are not going to run out of water unless there is this global shift that changes things. (*Yellowstone County Local Civic Leader*)

> People will tell you they need the access, but that's usually too late because they realize that their access is being blocked. I think [it helps] bringing in somebody that has some experience in another place…[and make judgments] based on maybe projected population…and characteristics of the river….You might need some outside help. (*Yellowstone County Local Civic Leader*)

Keep the Feds out of it. It should be done on a local basis. The people that have the most clout in the county are the county commissioners. They are local people. For the most part, they know what has happened. They are accessible. They are common sense individuals. They should really have the final say on it. Community planners…[are] part of it….[It's] like designing a sewer system. You could get a local guy [to] do it for $100,000. No, you have to get engineers and all the other stuff, and pretty soon, it is two million. (*Stillwater County Local Civic Leader*)

It is meander-land, and nobody can own that….There were river changes in that '98 flood, and, of course, some islands were created, and it washed down banks….Some people lost acres and acres of land….I know of one group who ended up with an island, and they claim it's theirs, because the river ran right through their property and created an island….Nobody pays taxes on it….For example, if this is a lake, and the water comes up in high water years to cover most of [the land], you wouldn't think that would reduce your taxes, [and] it doesn't. Or, if it goes down, and you can farm this for a while, you still don't pay taxes on it. But, you can't claim it either;…its no-man's land….[It] used to be that the Corps of Engineers could come in and just change things at will, and that caused its own set of problems, here and there. I don't like the idea of changing the direction of the river….It has its own set of problems that come with it. It might help this guy who lost some acreage to reroute the water away, but it ultimately, someplace else, will cause a problem….I think rivers should meander wherever they naturally go. (*Sweet Grass County Local Civic Leader*)

I think that preserving the agricultural aspect of the community is really important and a lot of it can be done through education. I don't think it is a win-lose situation….I think, for the most part, ranchers are pretty responsible. I think that they can do things better, but that is more of an educational process than intent to harm the resource. (*Sweet Grass County Local Civic Leader*)

I think the city will continue to struggle with subdivisions, whether they should or shouldn't be allowed. We only have one zoning district outside of the city limits and it is voluntary. We are going to put our land into a zoning district and in this district you can't carve off less than 160 acres. By voluntary, I mean when they created that district that carved out anyone that didn't want to be part. County or city can come in and say we are going to zone. Outside of the city limits, Sweet Grass County is un-zoned except for that one area. I think in ten years there may be more zoning, either private, although there has been more discussion if there would be interest in county zoning for a certain distance. I am not advocating or suggesting it is a bad or good idea. I am just saying that these are being discussed. I don't know that I know what I think of it yet. (*Sweet Grass County Local Civic Leader*)

The most important thing is to be proactive and not assume that problems will solve themselves. The only thing that happens with that passage of time is the two

> sides of the issues become more concrete in their positions and less willing to look at the common elements of interest. So, if I were to talk to someone in a county that's maybe 20 years behind where we are in terms of growth,…[I'd say] start from the perspective of trying to determine what values are generally held in common by the whole community. Work with those commonalities and keep the focus on the commonalities….It won't [necessarily] prevent the polarization, but it will certainly keep people focused on avenues to solutions that recognize commonalities. (*Park County Local Civic Leader*)

Help is Needed with Noxious Weeds: Almost without exception local leaders note noxious weeds and invasive plants as problems near the river. However, there are great differences of opinion regarding whether or not the current efforts to control these plants are effective and regarding who is responsible for the problem:

> The noxious weed program [is] absolutely [important]. We have a multi-county [effort] working on the salt cedar…and leafy spurge. We actually have some spotted knapweed on the river, particularly on the north side of it, now, that is of great concern to us. (*Prairie County Public Official*)

> Salt cedar—that's a big issue, and a pile of money gets spent on it. There's some knapweed, but, you know,…they were brought it in for honey bees. I was just reading about it the other day. They brought it in up around Idaho and it took a long time to get started, but once it got growing…[it didn't stop]. (*Treasure County Public Official*)

> The only other issue that's the big one is the noxious weeds….There's just about every horrible weed you can find on the Yellowstone….I don't know how it got started, but it definitely goes down the river. If you just go on the riverbanks and look, that salt cedar is just about everywhere now. We can't hardly go anywhere without seeing leafy spurge and…it's a very competitive plant. It'll take a field over….You can't just kill…knapweed and spurge….I can only imagine if we don't get a handle on that how that will look in ten years….Salt cedar is an issue we used to only talk about around Sidney. Now…it's all over the Big Horn. (*Yellowstone County Local Civic Leader*)

> Small tract owners….We have people who bought their 40 acres and don't have a clue what to do with it because they've lived in town all their life. So, what do we end up with? A whole bunch of weeds. Don't allow anybody on it, 'This is mine. Let's not graze it, let's not do anything with it so the fireman will have something to look after.' That's really real out here. They don't allow any grazing or anything to use that tall grass that's out there, waiting to burn. That's hard for me. We need to harvest things if we expect them to grow. I've watched an awful lot of pastures [and,] when they're managed right, you get good strands of grass and a good ecosystem. And if you don't manage it, you've got a mess. And we have subdivisions that are a mess, although we've had a really active weed department, and they finally realized that there are other ways of controlling these weeds,

> biological, do little with livestock, spray the perimeters so we don't spread it over the neighbors. If somebody is highly allergic, or their value system says I don't want anything to do with pesticides, far be it for us to suggest to use it. Let's give them a few bugs and they're tickled to death. We've got a real diversified sort of a weed management system, or we don't call it weed management; it's plant management. (*Stillwater County Local Civic Leader*)

> The Governor has proposed spending a sack load of money on new public access. What is typically not in those acquisition dollars is maintenance dollars. And Fish, Wildlife and Parks has always been short of maintenance dollars. It's easy for them to get Federal money or grant money to buy land, but they don't take care of the weeds, they don't take care of the trees, they don't take care of the whole ecosystem, if you want to talk about that….I continually say that the tree-huggers, or whatever you want to call them, don't give enough credit to private landowners…They'd like to see the whole valley owned by the government, but the government can't take care of what they've got. (*Park County Local Civic Leader*)

Specific Concerns Among Local Civic Leaders

The concerns identified here are, more or less, specific to this interest group. In most cases, the issues are linked directly to the role of local leader.

Philosophies about Government: Not surprisingly, local leaders engage in thoughtful discussions concerning the role of governing agencies in managing river resources. While the specifics of "good government" can vary quite a lot, it is obvious that many local leaders believe that rules and regulations are necessary and that "good government" is possible. Their efforts are varied and earnest. The most obvious distinction is geographic—the communities in the eastern-most reaches of the river are much less convinced that rules and regulations are necessary, whereas those in the western-most reaches are almost unanimously convinced:

> I've had a lot of people say, 'We'd better have some rules and regulations along this river….Aren't you afraid that people are going to start building right on the river bank?' Well, no. That river itself will take care of that problem. I've lived here all my life, and ice chunks and water will destroy a house very fast.…You'd have to construct a sort of levy around your house because it just floods every so often. (*McKenzie County, ND Public Official*)

> The next [Miles City] Mayor's Task Force is a quality-of-life task force. [The group will consider how we] can provide amenities that leverage some of our best natural assets. The trees are something that we have an abundance of, [and] we are looking at becoming a 'Tree City.' We have these rivers and the levee….These could be scenic walking, biking and horse paths. [Right now] we have ATVs and four-wheel vehicles that are ripping around….It will be an uphill battle to ask, 'Why are you abusing this resource?' If we don't do it ourselves

then I fully expect other people to come in and say, 'We built this dike and the activity is going to stop.' The city council and the mayor's office have been dominated by people that have grown up here and have a maverick spirit…[but,] if we are going to ever be attractive to people from out-of-town, we need to start treating those resources with a little more respect. (*Custer County Public Official*)

Bad policy…makes people angry. And the one thing that we found out is that you don't force things down people's throats. You sit and work with them and you work on a solution to get it done. That is what creates the balance….We sit down and work it out….This is really a feather in Commissioner Reno's cap. We are going to actually have a grand opening…for a boat ramp access to a big island down on Pompey's Pillar. And that has been a site where there have been [both] trespassers and legal access to the river off a county right-of-way for the last 150 years. It is a great spot [for access]. (*Yellowstone County Local Civic Leader*)

[When] you have people who are talking emotionally, [you can] get caught up in the emotion, rather than the facts. That's why it's important that you have people who can present the facts….Make the decision that's for the betterment of the community. A lot of times, if you get caught up in the emotional decisions,…you walk away and say, 'What did I just do?' (*Yellowstone County Local Civic Leader*)

I want people to get along so that, in the end, we have a free-flowing Yellowstone River that behaves itself—if that's possible. But I really believe in people respecting others' thoughts, and not doing things just because the law is on their side, or [because] they can [afford] a lawyer. They can threaten people and get away with it….There isn't a problem that can't be solved if we work on it and reach a little consensus, but some people are so ticked-off that they won't come to the table. They know that they won't be treated properly….There's enough of these high rolling dudes in the country that they intimidate folks….Meanwhile, the river runs. I'm going to start a new soap opera series and call it *As the Still Water Ripples*. I tell you, we could keep that thing running for years. (*Stillwater County Local Civic Leader*)

Oh, yeah, sure we can [have management]. You know, private property rights are hard to…step on,…but there's sometimes when, maybe, you have to do something, or [you have to] mitigate,…or hope, or give them a carrot, or whatever. (*Carbon County Local Civic Leader*)

You do the best you can. People have the right to live where they want to live. I think there is a growing awareness that [rules sometimes] change. It is tough to deal with, but just making the people…more aware of the problems that we all face, and having them taking some responsibility…[will] help make that change positive instead of negative. (*Park County Local Civic Leader*)

> [We might want to assume] people are rational actors, that they process things and they act in rational ways. Well, they don't always. A lot of times people will act in ways that are not only not maximizing their profit, but…they act contrary to those ways because…[their] biases and heuristics and rules of thumb…systematically, and very predictably, distort their perception….[For instance,] someone buys property right on the river for the accessibility of fishing….Then he puts a bunch of rip-rap down there to save his property….[The rip-rap] is damaging the resource in very predictable ways and diminishing his property values….[If] he'd built back, say 150 feet, [he would have] maintained the productivity of the river along that reach. So I think that's the heuristic that's based on ignorance of how the resource works, how the system works. So, to that extent, education is helpful, but you also need persuasion in terms of the credibility of the argument. (*Park County Local Civic Leader*)

The Challenges of Local Citizenries: Local civic official discuss a wide variety of experiences in dealing with their neighbors. Sharing is apparently much more difficult when the limits of the resources are within sight. Comments regarding interactions with the local citizenry reveal that the communities of the upper reaches of the river find the task of sharing a contentious process:

> In our community, where everybody knows everybody, they know someone that has access somewhere. If they don't, there are public access sites. I have never heard of anybody complaining that they were denied access to the river. (*Dawson County Local Civic Leader)*

> Landowners are getting extremely reluctant to allow people from the federal government to come in and inventory anything on their places....Landowners do not want more intervention on how they manage their property. As we move forward, we need to make sure that the inventory isn't used as a starting point for a change in management practices along the river. It is fine to suggest [new ways] and to tell people why it is important to do those things, but in my opinion it is not appropriate to force them to do these things….Our role is to help people understand the changes, not to dictate that they will change. I think it is appropriate to have control of things…[but] these federal mandates tend to get scary because, at the federal level, they are very gifted at the one-size-fits-all style of regulation. (*Custer County Public Official*)

> People have to realize that there are two sides to every story, maybe one good, one bad, but there's two sides. I learned a long time ago when I was working that I had to listen to both sides, and then maybe my side really wasn't right, but maybe the other person was right. And so you learn that…you're always going to have pessimists in whatever you do, but I think…people [need to] understand what you're trying to do…[and] keep them involved. Don't do it behind their back, because you'll lose everything. (*Yellowstone County Local Civic Leader*)

> The good old Yellowstone is a cantankerous old thing. That river is wonderful, but it's also wonderful to watch it. It's going to go wherever it wants to go. I'm kind of torn…because we have people [who] defy us to do any rip-rapping, or to save a public structure, or anything like that. We're not supposed to do that, I guess. That's what I'm hearing. But, darn it, you've got a two million dollar bridge sitting there, and the thing's washing out, you better do something. We can't shut all the traffic off….This bridge down here was in jeopardy. So, they brought in a lot of rock and fixed it. It's fine. We had it protected.…We've [also] had some subdividers that have gone on their own and put in some Mickey Mouse things, jetties. But it really didn't upset the river a whole lot; it's got a mind of its own. (*Stillwater County Local Civic Leader*)

> Montana is interesting to me in that it goes beyond public information and public comment to public decision-making. Folks don't just expect to know what is going on or have access, or be able to make comments, they expect to be seated at the table with the ability to put their hand in the air and cast a vote. I appreciate the interest that people have. It can present challenges if a lot of people feel like there has to be a consensus before a decision can be made. That can be difficult. (*Park County Local Civic Leader*)

> Some of these people don't take no for an answer. Now, developers come and bring a staff of lawyers, hydrologists, engineers….They will come to the planning board meetings with their attorneys. They will set up their own sound systems so they can record everything. This is a kind of intimidation where they will sue you if you don't do something they want, 'We are recording every word that you are saying.' They have a whole entourage of people working for them, and you are one person, trying to do the best for the county, and you have to face their staff. That is how they are now….They will hire their own stenographers for meetings. They will go to the commissioners meetings when it is their turn to decide something. They intimidate….First, they will try and schmooze you. They will put on a luncheon. If that doesn't work, they will get tighter and angry. Then come the lawyers. (*Park County Local Civic Leader*)

> To some extent,…irreconcilable situations occur when ideologies start from a position…and therefore [the person] only admits the evidence that applies to that position. I think that's the danger. (*Park County Local Civic Leader*)

Connecting Local Government with State and Federal Entities: Ideas about how the local entities should work with State and Federal entities are numerous, but it is clear that local leaders want to be engaged and they desire greater coordination of efforts:

> How the flood plain[s] themselves are delineated is just based on seat-of-the-pants [guesswork], basically….As you travel the interstate, you can see people are within 50 feet of the bank of the Yellowstone. They can't get close enough if it was up to them. Yeah, I do have a problem with that….From the planning board perspective,…in general, I guess I agree with setbacks….[But,] just case by case.

Someone has to make that judgment [as] part of generalizing to a rule,…[but] the river…varies every quarter [of a] mile….No one could agree on how to word [the rule]. (*Richland County Public Official*)

Our other problem is that they are understaffed. With this economy, enforcement [of regulations] is not an option….In order to do the enforcement you have to have the tools. It has to work from the top down. You have to have a county attorney that is willing to prosecute. (*Dawson County Public Official*)

I think we like to be left alone….Don't come in and try to take it away from us. I have heard some stories from up at Billings where they come in and actually run farmers off the riverbank….The regulations said he could not be on the riverbank even though it was his private land. He could not dump his rocks down there because he was messing up the river. (*Prairie County Public Official*)

You don't want the troublesome fight….For example, [when] the Hysham water ditch system [needed to have some work done],…they had a tough time getting permission for that. (*Treasure County Public Official*)

Right now, my major concern is the infrastructure. Like so many entities across this country, and in this state, the infrastructure, as far as the delivery of water, is very old….The lines were [last] repaired in the '40s or the '50s, or even early '60s….Forsyth has no industrial base, so the availability of funds is always a burden on the individual taxpayer, that means small business people and homeowners in this community….State statute mandates that the water system is self-supporting. So, you can't pay for it out of a gift,…[or] from the general fund. It has to create its own revenues. That didn't seem so bad when that statute was first put in place in the early '50s. But, with the rising cost of this and that, how is it going to support itself [except by] a continual rise in water rates and sewer rates? That really frosts me. It just does. I think government has certain responsibilities, and to me that would be one: provide basic services to the public. (*Rosebud County Public Official*)

The question is, should there be coordination? And who's responsible for doing that? You can have a Federal program, you can have a State program, you can do all that, [but] those only work if people want them to work. It has to come from the people. You cannot mandate that stuff….If this report ends up saying that there are a lot of issues and that there is no consensus, well, we already know that.…There needs to be time to process and think about something and not make snap decisions. (*Rosebud County Public Official*)

Now, we are very fortunate in Montana that those major rivers supply a tremendous amount of water….The State of Montana…owns the water. And the thing that bothers me most…is the Federal government and the Corps of Engineers and their control over our water. They [can] demand water…downstream…[to] float barges in the Mississippi….That is always bothersome to us. (*Yellowstone County Local Civic Leader*)

You have the Fish, Wildlife and Parks with the mission of access….Then you have…the road department that tells the private owner that, if you give me a right-a-way, we will fence it and keep the public off your property….Down by Duck Creek…you have a river,…a private property owner and…you have a bridge. [The area by the river] is all within the high water mark so [the public] can [be] down there…[but] to get down there, people do what? They drive down,…violating this guy's right….because the State said, 'If you give me my road right-a-way through here, I'll fence it.' So [the State ran the] fence…up to the bridge [and] the public can't get from this public right-a-way to this public right-a-way without climbing over the fence. [So] they cut the fence….There are solutions:…pedestrian gates through there, and better enforcement by Fish, Wildlife and Parks. They often will open an area up but they count on the Sheriff's Department or somebody else to put out the bonfires and the keggers….[This] is a State issue….They sign those agreements for 'highway uses only'.…Quite honestly,…you need to provide adequate access where you can because [the river] is a public resource. (*Yellowstone County Local Civic Leader*)

I would like to see nice fishing…accesses developed that Montana Fish, Wildlife and Parks might have to spend some money to preserve the appreciation of the river. And good parking….They need to step up and get some good spots, and they're going to have to pay for them. (*Stillwater County Local Civic Leader*)

[Our former] planner….noticed the local people don't like the local people telling them what the regulations are, but if it comes from the state or the federal government they are fine with that. They don't want a local official bossing them. They feel [the local official] could be more biased than a state or federal agency….We get it constantly….If I can say, 'I have to administer [this way]…it's from FEMA and I don't have a choice'…then they say, 'Oh, okay.' (*Park County Local Civic Leader)*

The state and federal government input needs to be sensitive to the local commercial economic needs…[and] the concerns of residents, especially on the east side of town that are currently at risk of either flood damage or having to leave their homes. And one of the options in that 205 study is a buy-out….I think that those kind of options certainly need to be discussed in a way the community is comfortable with….We've seen cases in which there were decisions made at the federal and state level that appears to be made at the city level. The city government takes a lot of heat for things that have actually occurred in a different level of decision making….I think it needs to be a process by which there's not just a public meeting, it needs to be a neighborhood by neighborhood communication [process]….Convey [information about the risks] in a way that's understandable and a way that allows participation…both directions, from the residents to the governmental agency, and vice versa. I think that all too often the

> government agency does the research and makes a decision on their own, and then conveys their decision to the public. There doesn't seem to be a lot of opportunity for public participation in terms of understanding. (*Park County Local Civic Leader)*

Flood Plains and Official Designations: It is a common call among local leaders that flood plain maps are essential to their communities and to the economies of local families and businesses. Some express concerns over timeliness and credibility of the available maps, but all seem committed to using "good maps." Similar sentiments are expressed when discussing official determinations regarding the dikes that protect their towns. As a group, they desire maps and evaluations in which they can place their confidences. Those from communities considering setback requirements acknowledge the difficulties in developing local support for such changes:

> When the Corps built the flood dike, they built it to the current standards, and it is not [now] acceptable as a 100-year flood dike….To raise the dike it would be ten or 12 million dollars….To buy out the property, and demolish everything, and return everything back to the Yellowstone Basin, would be 18 million. You are talking to a community that doesn't have the money. (*Dawson County Public Official*)

> We have been working on [flood plans], off and on, for 12 years….It got pretty hectic because that one time we had a lot of rain, and we had a flood situation, and they wanted insurance. You can't buy flood insurance in this town until we have it tied up with [a] flood plan. And we started working on it….The only thing is, if you are in the flood plain, you have [to meet] certain specifications…in order to get flood insurance. I cannot buy flood insurance for my house,…but anybody can buy insurance…if you have a flood plain plan. Nobody can buy insurance if you don't. But…you can enforce specifications on people if they do build in the flood plain. And some of them are pretty…[strict]—where it is not very feasible to build in the flood plain. (*Prairie County Public Official*)

> I believe the dike is stable. I haven't heard a lot of negative on it….It does cause a lot of people to pay high insurance. There is a moratorium, or restrictions, on building in some areas. A pretty big chunk of town is affected by that—everything north of the railroad tracks. (*Custer County Public Official*)

> I have an idea: if we ever have a real wet winter, all…[of a] sudden we will find the weaknesses in [the levee,]…[and that] will become an issue. But we haven't had enough runoff or water to say it's been a problem. There was a period of three or four years when there was quite a bit of ice buildup and ice jams….My husband was working out at the packing plant at the time and one night he really got scared. He heard the ice breaking up and there was ice coming on shore....If there is one of those winters where there is a deep snow pack and then we have a lot of snow—the two combined—then it could be interesting. (*Custer County Public Official*)

> Do you want me to come in and tell you what you can do with your 160 acres? And what if that is where you put all our resources…and your plan ultimately was to…pay for your retirement? Then along comes the government and says now we are going to make this a riparian area. This is a green space and you can't develop that. I have just wiped out your assets. The government has to be careful that controls don't go overboard…[and] start infringing on private development rights. (*Yellowstone County Local Civic Leader*)

> Flood plains are sacred. We just cannot break in flood plains like we used to. There are some things…[that the] law requires: you have to have a three-foot differential, the land where you're going to build your house has to be at least three feet above where the water table is. Well, if that's based on a dry year, and you build your house and then you have average years again, or normal years, you might have a problem. The law doesn't account for that. (*Stillwater County Local Civic Leader*)

> It is hard to change regulations. That is a hard thing to do. We talk about rewriting the regulations, but that is a scary thing. People go ballistic. Not because of logical reasoning, it is because they don't want anymore regulations from the government. It ends up in the same kind of fight. (*Park County Local Civic Leader*)

Implications of Local Civic Leaders' Perspectives

Taken as a group, the perspectives and concerns voiced by local civic leaders suggest that very particular issues must be accounted for, both in the near future and in on-going resource management strategies.

There is a Need to Generate and Share Good Information: It is noted above that local leaders desire information that is locally credible, and they express a desire to have information from other places evaluated and presented in ways that are useful to their specific context:

> A couple of weeks ago we were looking at maps on this growth plan. They have these GIS maps, and they are not even…close, especially around Glendive. It doesn't even show what it is [already in Glendive]. (*Dawson County Public Official*)

> You look at the flood issues in other states, and…[how they allow] development right up to the water['s] edge—is there something to be learned? Should we protect the riparian area? Should we be considering a setback as a tool?…The Red River Valley in North Dakota floods frequently and they go right back in and build again….I hate having…[regulations], but you have to. If each county is different, how is that managing the overall river? I see a broader scope of application, either through the council [the Yellowstone River Conservation

District Council] or state law, that would allow us [control and still] not get backed into the one-size-fits-all type of regulations. (*Custer County Public Official*)

Analyze the information you have from everyone…and identify the best ones—best practices. That is how you come up with one….[But be honest during the process]….You have everybody, and they are nodding their heads, and then someone says, 'No, you can't do that. It is against this blah, blah, blah.' Well, you just shot that [idea] down and you just wasted three hours! Lay your cards on the table and be honest about it, for God's sake. (*Yellowstone County Local Civic Leader*)

We should be able to develop [information] that would serve all of our counties….To say, here's some of the pros…[and] here's some of the bad ideas we came up with….To make sure every county follows the same sets of rules that we make for everybody. And sometimes maybe one set of rules don't fit everybody, but education would work….If you could think ahead….Education is the biggest thing when trying to educate people to…think out of the box. (*Yellowstone County Local Civic Leader*)

The increase in population pressure never stops….We need to find a way to protect the river assets because there is getting to be more and more and more of us. And we all want a piece of the river for our own private purposes and…you can't do that. I think we need to do some planning on the river before you destroy what you love….By taking a look and starting to appreciate…what a tremendous resource the river is….You have to look at use options and priority settings and water rights. And I think you have to work together with agriculture, recreation and industry. I don't like to see the either/or options being thrown around. No one ever benefits by that. I guess that is what I mean about planning. (*Yellowstone County Local Civic Leader*)

I would like to see a lot better mapping on the Yellowstone River. Most of our maps are 1982 FEMA maps. Some of the Yellowstone has had some updating, and…that is helpful, but there needs to be some better mapping and better understanding of activities in the flood plain, and how to best undertake those, both from a safety issue and also trying to protect the resource. (*Sweet Grass County Local Civic Leader*)

Sometimes the information that comes from public agencies, governmental agencies, is suspect. At least that's the perception. And I think that there is also a perception that the best practices benefit the public at large, but they may not benefit me personally from an economic standpoint. And I think that's where the persuasion comes in, demonstrating how those incentives really work on a personal level….People know what they know, and how do you get through that. (*Park County Local Civic Leader*)

> I would like to see some better science on the effects of hard armoring and rip-rap on the…fish production…[and] habitat areas [such as those created in] flood stage….We've lost a lot of that. (*Park County Local Civic Leader*)

There is a Need to Help Local Officials with Complexities: Local leaders, especially elected local officials, are often thrown into situations that are quite complex. The first few years in office can be stressful and some are not shy about asking for help. They admit to running on instinct and common wisdoms, but they often make an explicit appeal for help:

> My gut tells me,…if they look at the entire river, they get a better feel for what [upstream] changes can do [downstream]. I have heard stories about how, all of the sudden, the channel changes, taking away a bank upstream, and, all of the sudden a farmer has lost 100-feet of his field. I have also heard stories about someone rip-rapping their bank, and pretty soon, you have another adverse effect downstream. The natural course of the river has been altered. (*Dawson County Public Official*)

> By the time you realize that [the community is changing], then you've got a mess on your hands, and that's really too late. The agriculture guys don't want land-use planning, and they don't want to be told they can't farm the flood plain because that's the best ground, that's their easiest access to water. And for years the irrigation method of choice was flood irrigation, which is the most wasteful, but it is the least expensive. It's far easier to take the water out of the ditch and run it through the…pipe and send it down the rows, than it would be to buy pivots. (*Rosebud County Public Official*)

> What is lacking for me in my job is [information about] the state-of-the-art. What is going on in Delaware or Kansas? What is going on in Gallatin County relative to these issues?...If only somebody will bring to me the current trends. I was amazed when Gallatin County…put in a mechanism where voters voted to tax themselves to buy view sheds. [They didn't] want lights on top of Bozeman Mountain so, rather than zone it, [they] are going to buy it. When that was explained, it made me wish I knew some of the current best practices. (*Yellowstone County Local Civic Leader*)

> There needs to be better mapping and more compilation of the flood plain. With the flooding of '96 and '97, there is more information that wasn't there in 1982. More of a site-specific analysis….From the planning perspective,…[we need] a better understanding of the hydrology, ecology, the geomorphology,…the safety features, irrigation facilities, bridges and abutments, a better understanding of the river and how the river changes, and the kind of things you need to anticipate. (*Sweet Grass County Local Civic Leader*)

> I think that [the Yellowstone River Conservation District Council] has a lot of opportunity. The thing that they have to avoid is looking like they're a

> gorilla….[Avoid] breeding defensive reactions….Work at a community level and genuinely engaged people. It sounds like such a simple thing, but it's all too rare that an agency genuinely appears to show concern for folks….Encourage people to define goals and force some rationality that wouldn't otherwise be there….Offer guidance in terms of what works mechanically and what works within the framework of the river as a river. (*Park County Local Civic Leader*)

With Limited Resources Everybody Will Not Get Everything They Want: It is both implied and explicit that the resources of the river are limited, while demands are growing. More local officials have a clear notion that decisions about sharing the resources will only become more difficult:

> When you have good flow on the rivers, you do not have any problems with who gets to use the water because there is lots of water. Then, all of a sudden, when it gets a little short, the fish need water, and the wildlife need water, and the people need water, and the farmers need water, and there is not enough to go around. In most cases, and I tend to think more and more all the time, agriculture is going to be on the short end of the stick….Oh, yes, we see that up west already…because there is less and less political clout…[as] we have…[fewer and fewer] people in agriculture. That is just the way it goes. (*Prairie County Public Official*)

> Those land-use planning…ordinances, or flood plain ordinances, or DEQ, or whatever the ordinance may be, people forget that it's not just because somebody wants to keep you out of some place. And it's not a situation of, 'Well, I've got lots of money, so if my house is washed away, it's my loss and don't worry about it.' It doesn't have anything to do with that. It has to do with loss of life….And, if that gets washed downstream, it messes everything up, and scatters all that material in the river where it doesn't need to go. (*Rosebud County Public Official*)

> Water rights are very important….One of our subdivisions has junior water rights….[and a few years ago, during] the second year of the drought,…Fish, Wildlife and Parks…said, 'You no longer can pull water out of the Yellowstone River…because you guys have junior water rights'….We asked, 'Where we were going to get water [for the subdivision]?' and they said, 'The City of Billings.' Where is the City of Billings getting it? The same river. But, the City of Billings had senior water rights. (*Yellowstone County Local Civic Leader*)

> Because of the in-stream needs of the fishery, and because of the way that the water laws are set up to reserve water rights, before the Big Horn comes in, in order to develop new irrigation systems, you've got to have a water right and that water is going to be junior to the needs of the fishery. Once you get past the Big Horn, and it reverses, then you can develop senior to the fisheries. (*Yellowstone County Local Civic Leader*)

> We'll grow at a rate of two or three percent a year. Maybe a little bit more because some of that becomes geometric after a time….[The growth will affect

> the river] indirectly only….As [our] infrastructure improves, and things grow, this county will just have more visitors, more tourists, and more people from surrounding areas coming to visit and play on the river. (*Stillwater County Local Civic Leader*)

> To some degree, the Corps has been maybe too quick to grant the permits for hard armoring without…necessarily educating land owners that there are alternatives. And I'd like to see that. There are certainly a lot of soft armoring techniques that are quite feasible and, in the long run, have lower maintenance [costs]. I think a lot of landowners, if they were aware of those options, might choose those [soft] options….I think we need to look at alternatives. (*Park County Local Civic Leader*)

> It isn't that we have to change it or protect it to death. We need to maintain it and respect it. I hate to say it, but the usage is going to have to be limited. You can't just send 200 boats a day down that river. There has to come a point, like with the Smith River, it will have to be limited or on a permit basis….You will have to be a resident, and they will give out so many non-resident permits….I don't know what the answer is, but we have to do something to change or we can forget it. (*Park County Local Civic Leader*)

Governance and Regulations Will Require Multiple Strategies and Coordination: It is clear from speaking with local officials that they desire help with coordinating the efforts of the many agencies and entities that have interests in the river. Adding more "interests" is not desirable, but they do desire assistance in managing the multiplicities of their local situations:

> The Army Corps holds the key to a lot of future development in Glendive. You might have noticed a dike that was built in Glendive back in the '50s to prevent high water and flooding on that side of the river….Unfortunately,…[the Corps says we are] vulnerable to flooding and high water…. Because of our problem with the dike, and the 100-year flood plain, they are allowing no building, no additions, no anything, on the west side of the river….It is handicapping Glendive. For the community of Glendive, solving our flood plain issue is our number one priority. (*Dawson County Public Official*)

> I don't think those are things that we have any control over. A lot of this is going to be Corps of Engineers, Lower Yellowstone Irrigation, Fish and Game. It is not going to be our problem….We just don't deal much with the river, unless it is a road issue. The only dealing we have had with the river is this boat ramp and, there we dealt with Fish, Wildlife and Parks. (*Richland County Public Official*)

> The new people want to hunt from the rocking chair on the porch as opposed to the long-standing residents that aren't afraid to get out and hunt. It is not just them and the cannon; it is the house, and the well, the septic, and all the traffic in the riparian areas….Local people hunt and fish and then they leave that [river] area to

go to their house. [The] people coming in want to have their house in there. (*Custer County Public Official*)

With regard to development, the State ties your hands in some regards. And the worst regard…is that water issues don't need to be addressed under subdivision….We had a subdivision here and it barely has enough water for itself because it is outside of the City of Laurel. If a sub-divider comes in and says he will build a subdivision right here, and the next one comes in and builds here, at what point can we say, 'You can't do this because then [the people in the first subdivision] don't have water'? We can't do that because the State won't allow it….The link to the Yellowstone River is [that] they will eventually say, 'Please annex this and get us water'.…We let a subdivision build in that same type of situation…[but] we did require them to put in ponds to recharge the ground for the subdivision below them. (*Yellowstone County Local Civic Leader*)

I am an advocate of local control. I think it should be a local thing….They know that community best. They understand the needs of the community and the different constraints. It should be a ground up focus. I don't think you can say it is 100 percent local. If you are dealing with a river like the Yellowstone, you are dealing with something that affects other states and areas.…Local control should be primary, but not the only consideration. (*Sweet Grass County Local Civic Leader*)

I wish they would be more responsive when there was an emergency. We've had some rip-rap that's been washed out in two spots by the Grey Bear Fishing Access. We would like to have got it repaired before flood season. And we still haven't heard back on our permits….[The river] just washed out two pieces probably: one was probably about 15 feet long and the other one was probably 20 feet long. But there's a good chance with high water now it will probably all be gone….So it's one of those deals where we could have got to it right away when we found out it was…and part of that is our problem for not really looking at it close enough until we started thinking about high water. (*Sweet Grass County Local Civic Leader*)

You try to protect [the river] as much as you can through setbacks and trying to maintain water quality, making sure it is used right….It is not just the river itself, but all the animals and the birds that depend on [the river] and its watershed…[including] all of the streams. There are a tremendous amount of streams that enter it. (*Park County Local Civic Leader*)

I'm really hoping we get something in the way of creative solutions, something beyond the floodwall. I think the floodwall was the reactive solution to the situation—it's sort of a 1950s solution. And we know better now; we know more about rivers…[and] I don't think the existing levy gives much in the way of real flood protection. I think we're going to have to have some kind of engineering solution….In a perfect world, [the solution will] involve some kind of service

> step-back, designated floodway, and flood plain area, versus trying to build a structure that would require a fair amount of maintenance on the City's part, and [that would] also be fairly destructive of the resources we have in terms of recreation…trails [and] amenities along the river. (*Park County Local Civic Leader*)

As clear as these overall implications seem to be, it is worth noting that that various geographic segments are defined by particular situations and challenges. As one speaks to leaders from the various areas, it is obvious that the pressures to share the river are different in degree and form:

> I've never had a call from somebody saying, 'What's the status of the Yellowstone River?'…It's there, it will always be there. I'm not that worried about it. (*McKenzie County, ND Public Official*)

> We have to make sure [future generations] have access and have the opportunity to enjoy the same things that previous generations have had with the river….It's going to get tougher because demand is in its infancy. As the pressure gets more…there will be more issues. Right now, it's in the beginning stage. (*Rosebud County Public Official*)

> Bureaucracy is a tool that you can either use to your advantage or disadvantage. The fellow that [complains] probably doesn't realize the benefit he's getting from these layers of bureaucracy. (*Yellowstone County Local Civic Leader*)

> Two things come to mind right now. Although I believe in personal property rights,…I believe, too, that…not everybody is going to get everything they want. It just has to be that way. (*Stillwater County Public Official*)

> [In this] culture,…nobody sweetens their tea. It's the attitudes. It is a very self-reliant culture,…[an] everybody-takes-care-of-their-own type of culture. The view of government out here is not just suspicious. It is flat-out distrust. If government is involved, something is wrong….In other communities they at least give you a chance to screw up. Here they assume you already have and they haven't found out about it. (*Park County Local Official*)

Even though the differences and the similarities among local civic leaders are numerous, it is clear that they are a dedicated group and that, as individuals, they are nearly limitless in their desires to help the local communities. Each local leader, in one way or another, seemed just as sincere and dedicated as this Park County public official:

> Maybe I would like to do something else. But…the thought goes through my mind, 'If I don't do this, who would?' There isn't anybody else….Other people [are now] working and learning…and thank God. (*Park County Local Civic Leader*)

Recreational Interest Group: River-Length Overview

Interviews were conducted with 76 individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity. Many of the recreationalists participants were recruited from referrals provided by members of the Resource Advisory Committee of the Yellowstone River Conservation District Council. Participants were also identified and recruited by contacting various organizations such as Ducks Unlimited, Walleyes Unlimited and by contacting local outfitting businesses.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Recreationalists: Analysis Table

Recreationalists: Analysis Table
River-Length Concerns Among Recreationalists
1. The Yellowstone River Reprieve 2. Respect for the River's Ecology and Its Natural Processes 3. Respect for Other Recreationalists and for Private Rights 4. Access is Difficult and the River is Getting Crowded
River-Length Diversities Among Recreationalists
1. Impacts of Rip-rap 2. Impacts of Development
River-Length Specific Concerns Among Recreationalists
1. Montana Must Maintain the River's Uniqueness and Free-Flowing Character 2. Montana Must Maintain Strong Public Access Laws 3. Water Quality Concerns
River-Length Implications of Recreationalists Analysis
1. Recreationalists Add to Montana's Economies 2. Recreationalist Interests are Linked to Governmental Agencies 3. Recreational Interests are Linked to Agriculture 4. Recreational Interests are Linked to Industry

Recreational Interest Group: River-Length Summary

Introduction

A review of the interview data for this river-length summary suggests that the recreationalists of the Yellowstone River share in four common sensibilities. First, the Yellowstone River is revered for its ability to provide the user with a refuge from the stresses of everyday life. They agree that river recreation helps individuals regain their sense of well-being. Second, recreationalists have the desire to maintain and improve the ecological health of the river. They are inclined to view erosion as a natural process that may not need to be controlled. Third, they have a strong desire to see that others respect the river's resources, the other users and the residents who live along the river. Fourth, recreationalists highly value having access to the river, even though many of them do not reside near the river. However, they worry that the river is getting crowded and that access across private lands is becoming more difficult to attain.

There are two topics about which recreationalists are not in consensus. The first is that recreationalists disagree about whether or not rip-rap causes negative impacts. Some feel rip-rap should not be used because of its detrimental impacts on river ecology. Others feel that rip-rap can be designed and implemented correctly and is appropriate under some circumstances. The second set of differing perspectives is found when examining perspectives regarding the impacts of development. In the eastern segments, recreationalists anticipate an increase in housing development, but they are not concerned about negative impacts. In contrast, recreationalists from the western segments are likely to endorse measures to curb the growth.

Three concerns seem to be at the heart of the recreationalists' perspective when considering the future of the river. First, they are dedicated to the uniqueness of the river, and are advocates of keeping the river free-flowing. Second, they view the public access laws of Montana as essential rights which must be protected against all threats. Third, they attend to water quality issues and are committed to encouraging best practices on the part of agriculture and industry.

Four implications emerge from an analysis of the conversations with recreationalists. The first is that recreational activities add a great deal to Montana's local economies. Many of the changes in Montana's communities are a result of the recreational appeal of the river. Second, recreational interests are linked, often legally, to the missions and purposes of governmental agencies; thus, recreationalists are likely to partner with any agency looking out for the health of the river. The third implication is that recreationalists are willing and ready to collaborate with agriculturalists in order to solve mutual problems. The fourth implication is that recreationalists worry about pollution and other effects of industrial, municipal and residential activities. However, they recognize their loyalties and interests are often ironically splintered, and so they ready themselves to accept the complexities and difficulties of working to address all interests.

Common Concerns Among Recreationalists

The following concerns are common among recreationalists, regardless of where one meets the individual.

The Yellowstone River Reprieve: The Yellowstone River is a highly valued as a refuge. It provides the solitude needed for regenerative contemplation, and it provides exhilarating physical and social venues that countermand the stresses of everyday life. It provides spectacular beauty, abundant wildlife, varying recreational possibilities and a seemingly limitless medium of change:

> It's a very beautiful river. You can start in the western side of the state, and it is very mountainous and beautiful, [and] when you come here, it is more calming and soothing. It is more restful….The sunsets here are gorgeous. A friend of mine took a picture that is just breathtaking….It shows the hillsides reflecting on the water. It's just gorgeous….It's so fun to go exploring on. You can find anything, from recently dead animals, to skeletons, to fossils. So, it is always a pleasure to be out there. (*Richland County Recreationalist*)

> I'm in one of those jobs where, if you start to get bent out of shape, you need to walk away from it. It's my mental health that keeps me coming back to that river. (*Richland County Recreationalist*)

> I spend a surprising amount of time just down by the river doing not much. My wife makes me pick asparagus while I'm down there. The other thing is the sense of solitude there. (*Treasure County Recreationalist*)

> It's a seasonal elixir for my obsessive compulsive disorder. I have two things that I might consider to be OCD: one is pheasant hunting and the other is river rafting. (*Treasure County Recreationalist*)

> We're avid touring kayakers. We love to go on the river kayaking and watch the wildlife, the deer, the birds, the eagles, hawks, beaver, lots of beaver….It puts you in touch with nature and the cycles of nature….It's just amazing what diversity you see along the river….It's a pretty special place. (*Yellowstone County Recreationalist*)

> When you go down [to the river] you might see somebody else. But you could be down there all day, or all morning, and probably not see somebody else. I have an eight to five job, where I answer the phone 100 times a day and solve everybody's problems, and when I go out duck hunting or fishing or hiking, the only problem is, 'Should we stop here for lunch or over there?' (*Yellowstone County Recreationalist*)

> You get on this river and she will carve out a new experience every year. (*Stillwater County Recreationalist*)

> Even though you're flowing down a river valley that is pretty-much paralleled the entire way by a major interstate highway and a railroad,…it still provides an experience of solitude. The natural environment. That's what I try to convey, too, when I'm using the river commercially. I try to convey that experience to my clients. It's not just about going out and catching a bunch of fish, or whatever. It's seeing the eagle's nest, or seeing the eagles, or seeing the other wildlife, or just experiencing the outdoors and having conversations about the uses of the river, or [conversations about] the historical significance of the river as you float along. Those kinds of things. (*Stillwater County Recreationalist*)

> You're dealing with a raw force of nature.…This river,…it won't tell its secrets….You turn those rocks over.…You find those nymphs.…You watch the river year round….You put it all together and after three or four years of study, the river might just give you a trout or two…but…by then it becomes not a matter of catching fish. It becomes a matter of you're…one with the river….It has a different character around every bend….It acts different in the spring than it does in late summer. It's different in the winter. It's an incredibly complex ecosystem, that if one person in their lifetime can figure out a little bit of it, it's quite an accomplishment and that's what transcends the actual fishing. (*Park County Recreationalist*)

> The Yellowstone [River] is my cathedral. That's my church; that's my spirituality….It's where I charge my batteries. It's my connection to the natural world. (*Park County Recreationalist*)

There are some differences in the recreational uses depending on where along the nearly 700 miles of river one visits. In the east, recreation involves big game hunting, waterfowl hunting, fishing, and agate picking. In the western segments, fly fishing, river rafting, bird watching, and hiking dominate the recreational activities. Yet, all recreationalists agree that the river offers a great variety of possibilities:

> We are a hidden secret right now, but that ain't gonna last. I fish on it. I hunt on it. I have a jet boat that I play in the river with. Sometimes you go and float the river and relax. (*Richland County Recreationalist*)

> Focusing just on Treasure County, what I like about the river is that it provides a haven, a safe haven for waterfowl, which in turn provides this tremendous population base which we can harvest, and hunt, and recreate. (*Treasure County Recreationalist*)

> The river is a multi-use river. It's used for agriculture, it's used for recreation, it's used for generating energy….There's agate hunting, fishing, bird

> watching,…kayaking,…water for cities, and towns. I guess that's about it….Oh, [and] mushroom picking. (*Yellowstone County Recreationalist*)

> Back east, they grow all of them in hatcheries. One of the greatest things is the Yellowstone has all wild fish. A lot of places, they don't get this. It is like going to a game reserve and shooting birds, versus getting your dog out and going hunting. There is no fascination with a refuge. (*Sweet Grass County Recreationalist*)

> Not just the fishing, people come just to float, to walk by it. We have a bench down there by the river, they come down and sit and just look at the river. (*Park County Recreationalist*)

Respect for the River's Ecology and Its Natural Processes: Recreationalists have a strong desire to maintain and improve the ecological health of the river. They are passionate about maintaining the abundance of the fish, game, and wildlife. They often connect the health of the ecological resources to the health of riparian zone, but they do not always agree that the resources are being protected:

> I am concerned…that the Fish and Game [is not attentive to] how fragile the river [and] the fisheries are. They have always said the fish would take care of themselves. (*Dawson County Recreationalist*)

> As far as fishing goes, the Fish and Game has done a good job of managing the fishery. They don't do a hell of a lot. When I say managing, I mean restricting how much is taken out. They have limited the paddlefish to 1,000 per year. At one time, they were taking over 3,000 fish a year from Intake. The population was in a downward spiral at that point. We were concerned about that. (*Dawson County Recreationalist*)

> My number one [priority] would be [to] keep the river natural and clean. Then it's going to take care of itself. The vegetation is going to grow. The fish are going to reproduce. There's going to be good water for all the cities and farm ground. So I think the main issue is keeping the water in as natural a state as possible, not like a dam. A dam puts pretty clear water out because the silt is on the other side of the lake. As much as you can, keep it natural the way it is, and keep it from getting polluted. (*Treasure County Recreationalist*)

> Well, I guess Aldo Leopold probably said it the best, 'The flood plain belongs to the river.' (*Yellowstone County Recreationalist*)

> The tributaries, the backwaters, the swamp, the sloughs: Nobody has rights to those, as far as I am concerned….Those are sensitive areas. Riparian areas shouldn't be treaded-up….[Those are] nesting habitat. (*Carbon County Recreationalist*)

> The cutthroat population is headed in a not very positive direction. They have talked about listing the cutthroat [as endangered]. I am not sure if that is necessary, yet, but I would think it will be at some point. I would like to stem the tide before they have to be listed. (*Park County Recreationalist*)

The desire to protect and improve the health of the ecological resources is coupled with an understanding that the physical processes associated with a free-flowing river are sometimes essential to those goals. For instance, recreationalists generally view erosion as natural function that need not, necessarily, be controlled:

> [The course of the river] is always…changing….[It] could change drastically from one year to the next. Every year, it's a change. (*Richland County Recreationalist*)

> I prefer it not to be stabilized because I think we need that flood plain to be utilized by the river. It's there for a purpose; even though floods impact a lot of people, it has a lot of benefits too. It recharges the soil. It spreads out water so that floods aren't as severe downstream. So, the more we stabilize our banks, the more we armor them, the more intense the flooding will be downstream. So, that needs to be managed. There must be a master plan for managing bank stabilization. (*Custer County Recreationalist*)

> That is [the river's] own renewal. Yeah, it does eat away at the bank, but that's the nature of that. Again, nature is the operative word; it's natural. I guess I don't see a benefit to try to control something that is that big and powerful. (*Treasure County Recreationalist*)

> Sometimes it's heartbreaking to see [erosion]….But, on the other hand, it's a wild river and it's expressing itself in such a way that it makes it what it is. It's a living entity that gobbles up one bank one year and might turn around and gobble up the other bank the next year. That's what's uncontrollable and that's what makes it wild and adventurous for those of us who like to get on that sort of thing. (*Yellowstone County Recreationalist*)

> [The Yellowstone River] is a meandering river. And you look all over the face of this globe, and see rivers that are in the stage of development that the Yellowstone is, and you'll see that the Yellowstone is doing what it's always done. (*Yellowstone County Recreationalist*)

> I don't see that the erosion itself is a huge problem, unless you are a farmer that is losing ground, which is big. I don't think there is much fighting [erosion]. I think rip-rap is a mistake. I think rip-rap is almost an arrogant way that man tries to control a force much bigger than himself. (*Sweet Grass County Recreationalist*)

> We have a little erosion every year…There always will be some erosion inevitably. (*Park County Recreationalist*)

Respect for Other Recreationalists and for Private Rights: Many recreationalists express concerns about the habits of others. They are frustrated by the apparent lack of respect that some users exhibit toward the resources and toward other users:

> If you are going down there, you are using somebody's property. Whether it is state, federal, or privately-owned lands, you need to respect it. What you take in, you take out. Leave it the way you want it when you go down there….Mostly, the trash that's along banks and stuff…[is from] people throwing bottles and beer cans in the water, [and from] not taking care of the plastic bags and the rings from the six-packs….The birds get wrapped up in those, and then that's not pretty. I've seen some animals that were laying there with [plastic] wrapped around them….Take your trash out. Pick it up, take it home, put it in the garbage can. It's easy. (*Richland County Recreationalist*)

> [Just] like everybody, out of 100 hunters, one of them is going to do something stupid, and that's the one they remember and makes a bad name for everybody else…It's up to the rest of us to police them and to keep them in line, which we do pretty well, but people are people. Not everybody has the same value system that we do. They just don't care; they're here for months in their life and they're gone. They don't have to live with the repercussions. (*Rosebud County Recreationalist*)

> [There was] a place that had wonderful waterfowl recreation….Now…there are so many kids going in there shooting the ducks….They've absolutely just ruined it to the point where I'm not sure if any of us will go back anymore because there's just so much pressure on it….With waterfowl you can't pressure things too much or pretty soon they'll just go away….I think the only way you could do it is to try to educate [people]. (*Yellowstone County Recreationalist*)

> An unspoken [rule is,] if we're out there floating, and somebody's fishing, we try to go on around them. We cut them slack, and not whoop and holler, and jump in the river. We wave at each other as we're going by….It's been that way here for a long time….We're usually all pretty courteous. (*Sweet Grass County Recreationalist*)

> Lot of landowners have a problem with [stream access laws] and it's because some of the public is thoughtless and abuse…the river and therefore are abusing the landowner who abuts the river, and that's a little flaw in human nature that's pretty much a constant. (*Park County Recreationalist*)

Access is Difficult and the River is Getting Crowded: Historically, recreationalists have enjoyed access to the river via public access points and via personal arrangements with private property owners. However, recreationalists are aware that fewer and fewer private land owners allow recreationalists to cross their properties. To some recreationalists this shift is an affront to local values. To others, it is more simply illustrates the need to improve public access in areas where the distances between access points is extensive, where recreational uses are increasing, and where more private landowners are denying or privatizing access:

> I hate the ideology of, 'I want to buy my piece of the last best place and then lock it up and keep everybody else away.' I can't see that. Access…[has] to be a key thing. One thing about our rivers in Montana…[that is] different than a lot of other states [is that] the State owns the water—the people…[own it]. (*Richland County Recreationalist*)

> One of the concerns around here is access for people to just go fishing. Not necessarily everyone is going to float a boat. (*Dawson County Recreationalist*)

> Harder access—access is much harder as it is everywhere. (*Rosebud County Recreationalist*)

> If you're going to float the length of [the river], you don't know where you can stop, where it's legal to stop. You're not sure where you might get off to get re-supplied or to have people meet you. There needs to be maps. There are some sections where the access is really poor. (*Yellowstone County Recreationalist*)

> Access is a big deal on the Yellowstone. There are sections of this river that you can't get on without camping overnight. Access can be 20-some or 30 miles between access points. With jet boats, it is not a problem; they can just zip, zip. Nothing against the jet boaters, but that upper area is so much more eroded due to jet boat traffic. (*Stillwater County Recreationalist*)

> [Ranchers] have sold…the hunting and fishing rights to corporations or private concerns and so only those people can hunt and fish on their property….It's harder for my husband now to find a place to hunt. (*Park County Recreationalist*)

Recreationalists also name a number of threats to the quality of the recreational experience. This anxiety comes from human changes in landscape scenery, overcrowding and changes in the quality of resources.

> More people, more and more boats every year. Five years ago, if you went on the river, you might see one or two people. Now, it's not uncommon to run into five or six different boats. (*Dawson County Recreationalist*)

> We have been doing it a long time and the traffic anymore….They have big, fancy boats, jet boats….There was one that came by us last year that was as big as a school bus. I thought we were going to sink. It is not rustic anymore. They…[aren't] hunting. (*Custer County Recreationalist*)

> I think another problem with people building so close to the river is that aesthetically it's not very pleasing….From what I understand, they're going to put in some riverside trails….Hopefully [those trails] will keep the areas pristine and

> wild.…It ought to be just like the rims, [with] easements that set aside that [area]….Don't allow people to [build] right up to the river. (*Yellowstone County Recreationalist*)
>
> Everybody wants a little piece of land on the river, and then they build right on the river, which kind of sucks….You go up by Livingston, and you see the houses. I mean, house, after house, after house, after house, built right on the river. (*Sweet Grass County Recreationalist*)
>
> The real-estate developers…know it's wide open….There…are no constraints on developers and I think that's holding a knife to the heart of the Yellowstone….There's no plan. The county planning commission is populated by real estate developers….I see a very deep connection to the river of all of the people here, but nothing that says, 'Wait a minute this is a real gem and let's keep this at least like it is, without further degradation.' (*Park County Recreationalist*)

The increase in recreational users is also seen by some as reason for public attention and careful management. They link recreational activities to the health of the local economies:

> I think recreation is very, very close to [generating the same economic inputs as] agriculture….I buy a pickup truck and a trailer. I buy thousands and thousands of dollars of decoys. I buy a lot of fuel. We buy breakfast. We [spend] lease money. We have shotguns, shells,…licenses. When I have guests coming in from all over Montana to hunt with us, we go out to dinner. (*Treasure County Recreationalist*)
>
> Tourism is I believe the second biggest industry in Montana….Tourism relates to the beauty of that river out there and the fish in it. And people come here and spend their money going fishing and hiking and camping. (*Park County Recreationalist*)

Diversities of Opinions Among Recreationalists

Among recreationalists there are a number of topics that generate diverse opinions. These diversities can occur among recreationalists from across the various segments, from within the same town, or from friends sitting at the same table.

Impacts of Rip-rap: Recreationalists disagree about whether or not bank stabilization techniques negatively impact the recreational resources, specifically the fisheries. Some feel rip-rap should not be used because of its detrimental impacts on river ecology. They are concerned that as more and more banks are rip-rapped, the water moves faster causing problems in the fisheries. Others argue rip-rap can be used correctly and is appropriate if the river is threatening personal properties:

> If it is destroying somebody's livelihood, acres of some farmland, probably it should be controlled. But, where it is just a natural state, I don't think so. It's

really hard to say because I don't own land down by the river. So, to me it's not a problem. But, to people who own land along the river, I am sure it is. (*Richland County Recreationalist*)

You'll see a lot of places along the bank where they're putting rip-rap and taking big chunks of concrete or rocks and throwing them along the bank to keep it from eroding. That's fine with me, I guess. How else you could you protect it? I don't know what they could do. (*Dawson County Recreationalist*)

I kind of like the idea instead of armoring the banks, use barbs or jetties to try to move the velocity of the stream….You got to take into account the nature of the force you are dealing with, the water. Some techniques are just going to be less impacting, dealing with that hydraulic force, and they are going to be more effective. (*Custer County Recreationalist*)

Landowners put rip-rap or whatever….You just cause the problem to shift somewhere else. I think if you are fortunate to own land on the Yellowstone then you ought to take what it gives you. (*Rosebud County Recreationalist*)

[As] a hydrologist, I studied river mechanics and fluidal geomorphology and from that perspective, the channelization really changes the character of the river. [Channelization] creates…an artificial river system, really. Often times the so-called channel protection work that's done in one place, causes impacts immediately down the stream. The river is not allowed to meander and shift as a mature river like the Yellowstone wants to do. It can cause unnatural artificial areas of degradation and aggradation, or deposition, or erosion of stream materials, or loss of streamside vegetation. We're losing the cottonwood trees and much of the riverine environment is changing as a result of man's uses and developments. (*Yellowstone County Recreationalist*)

There's a guy between Laurel and Billings…that…put big rock jetties out into the river to stop the washing. I don't think it's impeded anything. In fact, sometimes some of that stuff gives the fish more cover, more places to go and hide. (*Yellowstone County Recreationalist*)

I always figured rip-rap made habitat for the fish….They say it's [only for] the big fish, but you can have two people with the same study, one for one group and one for the other, and you will never have the same answer. (*Carbon County Recreationalist*)

It's a real fine balance, in my opinion. I have the utmost respect for other interests….I know we have to work together. So I think that's why it's important that we do strike a balance in terms of some of the things people are looking at. For example, putting the rip-rap on the banks…may prevent erosion of their property and their interests, but, if it's not done properly, it could have some sort of adverse impact on the fishery, which concerns me. And then it takes away from

> that pristine environment….I like the fact that,…in this section [of the river, in] very few places do you see any man-made changes to the river. It meanders; it's pretty natural, and, as you can see [today], it's really roaring….When it starts to lower itself down, some new side channels will [form]; there'll be new obstructions,…new fish habitat, and so on. (*Stillwater County Recreationalist*)

> I don't see that the erosion itself is a huge problem, unless you are a farmer that is losing ground, which is big. I don't think there is much fighting [erosion]. I think rip-rap is a mistake. I think rip-rap is almost an arrogant way that man tries to control a force much bigger than himself. (*Sweet Grass County Recreationalist*)

> When you rip-rap the river, you get a series of jagged turns, big holes, and no ripples, no runs, no flats….It makes everything deep, and it doesn't allow that river to flatten out and create the ripples and runs….From a fishing standpoint, you are much more successful in a ripple, run, or tail-out situation. (*Sweet Grass County Recreationalist*)

> The Yellowstone left to its own devices would take care of itself because it is a wild river, but if you continue to rip-rap it….It can't handle that amount of rip-rap. The river goes where it needs to go, and when you change it, it doesn't just affect the flow; it affects many, many things.…It reaches a saturation point. (*Park County Recreationalist*)

> When you channelize the river, it takes away its wild characteristics….but every time you stabilize that bank, you tame the river more….The Yellowstone isn't allowed to spread out…,It stays in one channel and it just digs a big deep trench over the years.…A lot of people think [rip-rap] provides great habitats for fish [but]…the fish studies that have been done have documented that surprisingly the [smaller] fish aren't there like they thought they would be. (*Park County Recreationalist*)

Impacts of Development: Recreationalists have differing perspectives regarding the impacts of development on the recreational experience. In the eastern segments, recreationalists anticipate an increase in housing development but voice few worries regarding any negative impacts. Lively discussions of the negative consequences of development occur in the western segments where many recreationalists are in favor of efforts to curb the increase of residential development along the river's edge:

> In Sidney, the largest [building] project was the Assisted Living [facility], down by Pamida. That's on a flood plain. I've been in two foot of water, standing right in the middle of that spot. It hasn't flooded since they built it, but I'm not that old. I've been in floodwater right where they built that. That's why we need the Planning Commission. (*Richland County Recreationalist*)

> There are very few people in Prairie County that utilize the river. It is very undeveloped. (*Prairie County Recreationalist*)

Decisions would have to be local, but it's going to be tough for a community—for Treasure County or Prairie County—to come to some sort of a regulation. I can see the Council coming up with a template, 'Here is a riparian management scheme regarding development'….Then the county can take it…[and] rebuild it to what their needs are….In Prairie County, they may have concerns about putting feedlots down in a flood plain….That may not be a problem in Sweet Grass County [where] they're worried about houses….[We need some] kind of a template on developing things that will impact that zone. (*Custer County Recreationalist*)

Encroachment of people into the river valleys, you know….That's where I think, maybe, you're getting more of the demand for people to stabilize those river banks because, of course, you've just bought your 100 acres or 50 acres and the river runs through it and you don't want to see it washed down to Billings. (*Custer County Recreationalist*)

When they…develop in the flood plain…their actions can affect others. We have laws that limit what people can do on their property….Their development in the flood plain is not in the greater public interest and the greater public interest is what really needs to hold sway. (*Yellowstone County Recreationalist*)

[We need to] develop setbacks, like 300 feet back, and prohibit any development in the flood plain….We shouldn't allow any building out to the 500-year flood plain. Unless there is a high cliff, there should be a rigid setback in the planning. (*Yellowstone County Recreationalist*)

Recreationalists aren't really happy seeing a house right above them, or a row of houses, and looking on their back decks and patios as they are recreating. And people sitting on their back decks watching the river, or watching people recreate don't always appreciate…people who are having fun [and getting] loud….It is a great little view, but everyone is in view. And people that buy on rivers have to realize that…there are more people recreating. (*Stillwater County Recreationalist*)

I would rather see [setbacks of] 500 feet….There was a guy down-river that had his whole house go into the river….You shouldn't build that close to the river. That is where the setback comes in. If it is back far enough, and the river does change, it has room to change. Instead of saying, 'The river is going to take away my house…[so] I am going to change the river.' (*Sweet Grass County Recreationalist*)

I think one of the things that we see more is encroachment of development in the river corridor….Now you see a big house on the skyline instead of a natural habitat. (*Park County Recreationalist*)

It took three years at least of really difficult meetings to come up with a plan for Park County that was a comprehensive plan….The only way they were brave

> enough to approve it was to specifically preclude any zoning.…It was all about private property rights….There's many people who don't like planning, think its sort of a communist plot; it is breaching their private property rights. Well, I also own private property….I see it as…a balancing between my rights and my neighbors' rights, and…if the neighbor does something that is really obnoxious to me, do I have any recourse?...So I view it as protection of private property rights…and others view it as an infringement. It's a fundamental difference in outlook. (*Park County Recreationalist*)

Specific Concerns Among Recreationalists

The concerns identified here are, more or less, specific to this interest group. In most cases, the issues are linked directly to the vested interests of these individuals as recreationalists.

Montana Must Maintain the River's Uniqueness and Free-Flowing Character: For many recreationalists the river is treasure that must be appreciated for its uniqueness, for the richness it brings to people's lives, and for its power to impress:

> I grew up close to the Mississippi. I was on the Mississippi all the time,…fishing…and a little trapping. Down there it's 'Old Man River.' This one here—this is the 'Prom Queen.' (*Richland County Recreationalist*)

> This isn't a Cabela's fantasy….[We've] been making this three-day trip, annually, for 33 years….We build our own homemade canvas-covered boats…[and when] we poked a hole in one, we pulled over and all got to chewing gum and patched it on both sides. (*Custer County Recreationalist*)

> It is a symbol of nature and a symbol of godliness….It is at the river that I best understand my role as a human being on this planet. I am part of nature, as you are and we all are. When you stand by the river you have a tendency to realize that. (*Yellowstone County Recreationalist*)

> First of all, [the Yellowstone River] is a link to our historical past and…our cultural heritage here in the west. And I'm very much personally oriented towards that concept,…the historical significance....We're floating right down the same river that Captain Clark came down 200 years ago. I think that's important in preserving our western cultural heritage. (*Stillwater County Recreationalist*)

> It's a pretty remarkable river. With ten years of drought, you don't hear of problems on the Yellowstone. It's like an old survivor. It's being well used now [and it] can continue very easily. (*Sweet Grass County Recreationalist*)

> If you live on the banks of the river, it's a jewel, it's a free river….take care of it…it may be a little battered a little worn, but it still deserves a little TLC. (*Park County Recreationalist*)

> Hopefully into the future, this river will throw a flood every now and then and will astonish everyone with its power. (*Park County Recreationalist*)

The free-flowing nature of the river is unanimously important to recreationalists. They cite its ecological uniqueness, its healthy habitats for fish and game, and its importance as a national symbol as reasons for maintaining it free-flowing character:

> You don't want to dam this river. This is one of the—*the*—last wild river in Montana, and it may be *the* last wild river in the nation. There is no dam on the Yellowstone, and we really don't want a dam on the Yellowstone. (*Richland County Recreationalist*)

> A lot of landowners are paying taxes for land that's actually in the river now. I think that's all part of that natural free-flowing-river thing. It's been like this ever since the world has been created; why change it now? (*Dawson County Recreationalist*)

> I would hate to see them dam the Yellowstone. Isn't it the last free-flowing river, or at least one of the last? When they make changes, like when they put in that Yellowtail [Dam], that seemed to kind of effect the flow. (*Prairie County Recreationalist*)

> Without any dams on the river, it goes through a normal cycle like a river ought to, but the channel changes a lot because of that, a lot of new gravel bars come and go, and the river channel moves and changes. I put a boat ramp in here and five years later it's sitting on a gravel bar. So, you can't blame anyone for that; it's just the way it is. (*Rosebud County Recreationalist*)

> I would like to keep the Yellowstone a free-flowing river. It is a national treasure. (*Treasure County Recreationalist*)

> You know, every other river in the country is dammed, and it is nice to have something that's wild in your backyard. (*Yellowstone County Recreationalist*)

> [A free-flowing river] helps with cottonwood regeneration along the river. Cottonwoods are important for breeding birds….Cottonwoods need sandbars to germinate the seeds, and if you don't have a free-flowing river to help shift the course of the sandbars in the river then cottonwoods can't regenerate. And if you don't have trees along the river, it decreases the [habitat] for the birds. (*Yellowstone County Recreationalist*)

> Get an appreciation for it…[as] the longest un-dammed river on the continent of North America.…And talk about the diverse interests: agriculture, and recreation, and things of that nature. (*Stillwater County Recreationalist*)

> I love it. I mean, I've used it my whole life. And I don't think it would be as grand if it wasn't the way it is….I think of this dam [idea], and think of what you would cover up. Think of the beautiful country you would cover up. I mean, for God's sake. (*Sweet Grass County Recreationalist*)
>
> It is the longest free-flowing river in the United States and it should be maintained as that. (*Park County Recreationalist*)
>
> This Yellowstone River is the longest remaining free-flowing river in the lower 48 states. It's…unique in that sense. (*Park County Recreationalist*)

Montana Must Maintain Strong Public Access Laws: Coupled closely with concerns for the unique character of the river are concerns regarding public access. As access via private lands is less and less likely, many recreationalists argue for an increase in the number of public access sites:

> Fifteen years ago, if you went up to a landowner and ask permission, seven out of ten times they'd let you go….[But] now, it's paid hunting. They want money, or they have it leased out to outfitters. This river bottom has a lot of outfitters now, where it wasn't [that way] before. (*Dawson County Recreationalist*)
>
> One more thing you can put under important items is Montana needs to maintain its stream access law. That's real critical, although there are plenty of landowners who would like to see it go away. (*Custer County Recreationalist*)
>
> It seems like every couple of years, someone takes a run at the stream access law, and that's pretty important to our way of life….The riverbed is public property, [and] a pretty big asset to us. And, if they take that away, that would pretty much put the kibosh on most uses of the river. (*Rosebud County Recreationalist*)
>
> Montana is blessed. We are blessed because we have a tremendous access law….Compared to Wyoming and Colorado, this is paradise, because people can walk up and down the high water mark and not be trespassing. In Wyoming or even in Colorado, the landowner owns the riverbed, and, theoretically, you can't drop your drift boat anchor on his property because you'd be trespassing. (*Treasure County Recreationalist*)
>
> If you look back at the history of the United States, the public land and the public water have been enormously important. Our champions are people like Theodore Roosevelt and the national forest, the national park, the national wildlife refuge, the national monuments. All of those are part of the public estate, and we think the public estate is very, very important to our society—equally as important as private property….Our position is, what's private is private, but what's public is public and it should be treated with the same level of respect....You can't have private water where the Constitution says it's public anymore than you can have public water if the Constitution said it was private. And we don't just sue every

> time we turn around. We talk to people. We try to convince them it's wrong, that they shouldn't do it, but we have a hammer and we'll use it. (*Yellowstone County Recreationalist*)

> I can think of a situation where a guy across the river bought a place for fishing. He bought a couple miles of it. The guy on the other side of the river was letting whoever wanted to come and go fishing. [The new owner] didn't like that, so he got a buddy to come in and buy the land on the other side of the river. So now you can't access the river from either side. A lot of that's happening. (*Sweet Grass County Recreationalist*)

> Having all of these access points is a good thing….You don't have to be the monied gentry to get to the river and enjoy it. And our stream access law allows…you [to] walk up and down that bank a little bit and you can fish and that's a great thing. (*Park County Recreationalist*)

> I have been involved in the fly fishing industry all my life….Those access points are crucial to my business and my soul. (*Park County Recreationalist*)

Water Quality Concerns: Recreationalists link their concerns to the long-term viability of Montana's communities. With regard to water quality, they mention many issues:

> When you flood irrigate—they've got all the statistics—if you don't do it at the right time, you can flood out some of your herbicides, pesticides, and fertilizers. That'll go directly into the river systems….A settling pond, before the water could get [back in the river], would be good. Or, reuse the water again, before you put it back into the system.… The settling pond itself would take care of a lot of problems as far as pollution going back into the river….If you're a pregnant woman, there are constant warnings….I don't want to see those [chemicals] going back in there at such a high rate. Put it in a settling pond, let it set. Let Mother Nature do her work. (*Richland County Recreationalist*)

> When you go into Fallon from here, you will notice all this white stuff along the riverbanks, from irrigation cuts. I guess it is saline. I am sure that's from irrigation. They haven't been irrigating so long, maybe ten years. I never did notice it before. It's almost like it runs out of the bank….[It] kind of seeps out of the side [of the bank]. (*Prairie County Recreationalist*)

> Go back to Sidney, go to the west, and climb that hill. You can see the watershed. Look at the top of the watershed. It is an auto graveyard and an industrial site. And that all flows downhill, right through town and into the river. And that's the stupidest place to build something like that. If they'd gone just over the hill they would have been in a bowl, and they could have kept all of that out of the river. But, there it sits….It's 30- or 40-years-old, and abandoned now so nobody's responsible. And there it sits, [our biggest] pollution runoff issue….At some point, the county is going to own it [and] is going to have to find the money to

clean up that mess. And, you know, it is only about a mile from the Conservation District office. They have to look at it everyday because they are on that same hill. (*Richland County Recreationalist*)

You might want to take a look at spill response on the railroad. The railroad parallels that river for a long ways, and if you have a train wreck, how do we get to that stuff? It's pretty isolated, rural, most of this point. How do you get to it? Is the railroad in a position to get materials on that river to sop anything that's spilled into it? Probably not. And that railroad ownership changes hands from BN Santa Fe to Montana Railways, so really, [you've] got two railroads that traverse the Yellowstone. (*Custer County Recreationalist*)

It seems like the feedlot runoff is not being regulated very well. If you look at the size of feedlots now, they are huge. You can see one on the north side of the Yellowstone, a big brown streak running right parallel to the river. I mean, where's all that runoff going to? (*Custer County Recreationalist*)

I suspect that a lot of our fertilizers and poisons and stuff get into the river. I don't think that's good….[It comes] from agriculture, [but] not just agriculture.…[It's] from our town [too]….We need to educate everybody more on all that....Everybody used to [think] more chemicals will do the job better, but that's not necessarily the case. People need to be knowledgeable about what they're putting in there….I think they're getting better, but people are still thinking a little bit more is better….It's hard to get people to understand that. (*Treasure County Recreationalist*)

[When] the high water comes, or you have an ice jam, or…the spring run-off [comes], you flood your septic tank or cesspool…[and] that material in that pool goes right into the river. There's a capacity for the Yellowstone….You can exceed that capacity, and then you have a real problem….We need those setbacks. (*Yellowstone County Recreationalist*)

Regrettably the water quality particularly below Laurel has been compromised in places primarily as a result of agricultural use along the tributaries. And stream flows have been reduced to undesirably low levels during the summer. That's a result of large diversions on the river. (*Yellowstone County Recreationalist*)

You go down the Stillwater and they have sewer problems like crazy because the sanitarian let them build too close to the river. There is no way it can not violate the water table. It has happened several times with this community [because] the sanitarian, who got fired over there,…came over here. They allow people to build right on the river, and they allow them to pump their sewage up the hill so they can pass a perk test. That is not in the interest of the community or the resource….I think it [comes down to], basically, how well you know the sanitarian. I know he is congenial with some, and not so much with others. As far as septic law is concerned,…I know you have to have your septic system 100 or

> 150 yards away from your well. Other than that, it is where [the sanitarian] determines you can get perked. It is really a gray area. It is violating the water table on the Stillwater. Every time we allow someone to build on the flood plain, it is a public liability, from a water quality standpoint, from an erosion standpoint, and a liability for FEMA when the sanitarian allowed that to happen. (*Sweet Grass County Recreationalist*)

> The longevity of the Yellowstone and making sure of our water quality [are both important].…I honestly think we could make it better. We have irrigation upon irrigation, [and] that…water is coming out and going back in. You should have to send water from a field that is maybe not as clean, [and]…run it through a panel or something to clean it up. I don't know the solution. I am not a scientist, and I don't want to make it hard on the Ag community. Sometimes they put garbage water back in there after taking palatable water out. The wild fisheries in the states are evaporating. Colorado has had whirling disease so bad that a lot of their natural fisheries had to be helped by the state. I would say, when I am dead and gone, that river is going to be rolling like it is today. (*Sweet Grass County Recreationalist*)

> Of course you've got septic tanks and lawn fertilizers and the cutting down of the trees. I think that development is probably one of the biggest things [and] one of the main problems…on the Yellowstone. (*Park County Recreationalist*)

> Development brings sewage….My neighbor…[has] the sprinkling system. [He] waters that five acres every night and then he puts chemicals on there to keep the dandelions down…and all of that is just going right back into the river eventually and into our aquifers. (*Park County Recreationalist*)

> What resonates from both sides…is water quality….[But what is] water quality? Is it simply the chemical analysis?...Or is water quality [connected to] the system?…If you started from water quality, and worked gently outward…describing the mountains that create water quality, then there may be an incremental way to bring people into consensus. They [need to]…fundamentally understand why this water is good and why it is bad. Start from why is water so important to us. It may sound elementary. (*Park County Recreationalist*)

Implications of Recreationalists' Perspectives

Recreationalists may be playing a more of a financial role in local and regional economies than many Montanans realize. Not only is Montana's population growing, but a significant portion of that growth is occurring in the communities that border the river. Park and Yellowstone Counties have the most obvious increases in population, but Sweet Grass, Stillwater, and Carbon Counties are also growing. Each of these counties is experiencing increasing recreational pressures. Life-long residents and newcomers view the recreational opportunities associated with the river as a key component in their quality of life, and recreational opportunities are linked directly and indirectly to the new economies of several Yellowstone River communities. Towns benefiting from the economic inputs of recreational users must ensure that they preserve the ecological resources that draw people to them. The agrarian landscape and the undeveloped river are attractive to tourists, floaters, anglers, rock hounds, hunters and others.

Interrupting the river viewsheds with homes, developments and human obstructions may jeopardize the Yellowstone from being seen as a remote experience. If the banks were lined with homes, then there would be no reason to travel to Montana. As one recreationalist noted, ‘No one wants to float through a subdivision.’ Access opportunities, promises of abundant wildlife and healthy fisheries are appealing. For communities to maintain their recreational appeal, visionary measures may be needed. Calls for stricter planning regulations are not simply applauded by recreationalists, as they often initiate those calls. Landowning recreationalists do not tend to view zoning regulations as an assault on their individual private property rights. Rather they see regulations as a means of protecting everyone, including themselves from irresponsible neighbors.

Of course, the “crowdedness” of one’s recreational experience is a subjective matter. For newcomers, the river is a terrific recreational resource regardless of where they access it, whereas long-term recreationalists view the western segments as nearly intolerable and they have taken to traveling to the eastern areas as a means of escaping the throngs. The solitudes of the smaller communities are appealing to recreationalists, and positive experiences in a particular environment often engender a sense of attachment. Recreationalists are known to return repeatedly to their favorite places.

The increasing numbers of recreational users are changing both the economic structures and the cultural character of many of the smaller communities found in Eastern Montana. As positive impacts, some recreationalists who travel to the smaller towns shop at the local stores and use the local guides. Their desires for recreational solitude also prompt them to purchase exclusive leases and in these ways local economies benefit even when residential development is minimal. Unfortunately, as more lands are privatized, access becomes limited and the local friendliness of the small town seems to slip away.

Notably, many of the specific concerns that recreationalists voice are more generally mandated as concerns of the state and federal governments. Many of their interests are explicitly protected by law. For instance, regardless of the fact that over 80 percent of the riverbanks are under private ownership, the public has a legal right to enjoy the resources of the river. This is indisputable under the current access laws and it is obvious that recreationalists will vigorously oppose threats to these rights. Concerns regarding the health of the fisheries are on-going and extend far beyond the desires of weekend fly-fishers. Water quality degradation simply cannot be ignored by any level of government. The number and management of public access sites connect recreationalists to agencies. Some recreationalists worry about the effects of bank stabilization on the river ecology. They worry that communities are compromising the riparian zone via channelizations, but they are not, as a group, certain about the effects of rip-rap on the ecology of the Yellowstone River. Recreationalists recognize that their interests are often closely connected to the interests of various agencies, and they work to form partnerships and to maintain positive relationships with such entities. Their passion for improving the health of riparian habitats and their concerns about pollution demonstrate that many of them are conscious of the role of riparian plant growth in the health of the river system. Such enthusiasm for the ecological health of the river suggests there are opportunities for educational outreach and volunteerism that could positively affect the health of the river.

In many communities recreationalists are agriculturalists. They are only artificially designated as a distinct group. In other communities, recreationalists have different social networks, financial resources and expertise that could benefit agricultural communities. In either case, recreationalists appreciate the scenery and wildlife habitats that agricultural lands support, and the maintenance of the agricultural activities along the river is a priority for most recreationalists. Recreationalists appreciate the access granted by agriculturalists, and they consistently expressed sympathy and understanding for the financial and cultural difficulties agriculturalists regularly face. They understand that private landowners experience trespassing and other abuses by recreationalists, but they are quick to mention the block management program as an example of positive collaboration by recreationalists, land owners and state agencies. This program is viewed favorably because it is seen as being fair to all involved. Landowners retain control over who is on their property and responsible recreationalists gain access. Nonetheless, recreationalists and agriculturalists tend, at times, to take adversarial positions. Most often the schism results when recreationalists pressure agencies to deal with the pollution problems caused by farming and ranching practices. Agriculturalists should expect recreationalists to continue to press for the adoption of practices that can decrease the agricultural pollutants found in the river and the riparian zones.

Recreationalists also tend to be aware of local pollution events involving industrial sites, chemical spills, sewage overflows, outdated septic systems and flows from lawn chemicals. They are often uncertain as to whether or not these newsworthy events had been resolved, and they are unsure of the lasting impacts to the river and their communities. Such uncertainties regarding pollution on the Yellowstone constitutes an opportunity for developing informational sources that can be trusted and for potentially engaging groups in monitoring programs.

Most importantly, the recreationalists who participated in the study are members of particular communities. Their personal interests are often fragmented, and they understand that good answers are not always simple. Some work at the local power plant and some are farmers, but without fail they are committed to working *with* others:

> You can’t impose your ideas. You need to involve everybody and all sides. The difficulty is…all sides feel threatened.…A good process has to be inclusive and usually that is tedious and difficult to do….The hard part is paring away the rhetoric and getting down to what it is you actually value, and what threatens that. Not your fears, but the reality. It’s really hard to…trust people enough so you can actually talk about the real issue. (*Park County Recreationalist*)

Residential Interest Group:
A River-Length Overview

Interviews were conducted with 76 individuals representing the residential interest group. To recruit these participants the names of property owners holding 20 acres or less of land within 500 feet of the bank were obtained through a GIS search of public land ownership records. Twenty acres was used as a screening threshold to separate people who lived along the river corridor but whose incomes were from something other than agricultural practices (residentialists) from those who were predominantly farmers or ranchers (agriculturalists). The names were sorted by county and randomized. Recruitment proceeded from the county lists. A few other people living very near the river were also recruited. These additional participants may not have had property that technically bordered the river and/or they may have owned more than 20 acres. In all cases, the recruits did not consider agricultural as their main source of income.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Residential Interest Group: Analysis Table

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Residential Interest Group: A River-Length Analysis

Introduction

A review of the interview data for this river-length summary suggests that residentialists of the Yellowstone River share in four common sensibilities. First, they are unanimous in explaining that the Yellowstone River adds to their quality of life. Second, they are avid wildlife watchers and observers of the seasonal migrations. Third, they are generally concerned about water issues, wondering variously about quality, quantity and future human and industrial needs. Fourth, residentialists are generally enamored of the idea of the Yellowstone as a free-flowing river.

There are three topics about which residentialists are not in consensus. The first is that residentialists explain varying understandings of erosion and flooding processes. The second set of differing perspectives is found when examining comments regarding flood plain restrictions and the role of governmental agencies. Third, while many residentialists hold strong opinions concerning rip-rap, either in favor of it or against, only some residentialists are apt to discuss the complexities involved in deciding the circumstances under which rip-rapping should be approved. With regard to these three areas of disagreement, the differences are most pronounced when one compares the residentialists of eastern segments to the residentialists of the western segments.

Three concerns are of particular interest when considering the residentialists' perspectives. First, residentialists are especially protective of their property rights. They value their privacy. While they generally acknowledge the public's right to be on the river, they express varying degrees of understanding for recreationalists who violate the "high water" designations. They mostly oppose recreationalists using their properties as if they are public access sites. Second, when asked if they worry that they might be flooded or that the river might erode the bank away, there is a sizable group of residentialists who agree that over time such possibilities are real but who also explain away these threats by saying, "Not In My Lifetime/Years." These residentialists were identified as NIMLYs. They are residentialists who view the river as mostly benign and who see no real threat to their properties. The third particular concern of residentialists is that they believe unchecked development near the river will eventually either ruin the privacies they have come to enjoy or force the sale of their homes as they will not be able to afford the subsequent increases in property taxes.

Four implications emerge from an analysis of the conversations with residentialists. The first is that residentialists are potentially strong allies when looking for individuals to support practices that will promote the health of the river and the riparian areas. However, at this point some are not well enough informed to help. A second implication is that further residential development will decrease the informal paths that the public uses to access the river. Pressures will build for more public access sites. A third implication involves seemingly incompatible wishes. They appear to want a free-flowing river and the ability to protect private property. Given that the first wish is to some extent compromised every time the second wish is granted, it seems guidance is needed in the local communities regarding how to avoid further complicating matters with increasing riverfront developments. Finally, given that residentialists articulated so many different opinions and perspectives, it is apparent that every influx of new people and every new generation of adults will need to be educated and assisted in understanding the river, the management strategies, and the constraints of local governments.

Common Concerns Among Residentialists

The following concerns are common among residentialists, regardless of where one meets the individual.

Living Near the River Adds Quality to Life: Of all the participants interviewed for this project, residentialists were perhaps the most passionate in their explanations of why living near the river is important. Their lives are enriched by the Yellowstone River:

> [If] somebody asks me where I live, I tell them, 'Right on the Yellowstone River.' I probably don't even mention much about the house itself because that is almost secondary to me. Living on the river is very important to me. [As a child], I could throw a rock from my house to the river. I always thought that was kind of neat. I mean, the river that Lewis and Clark used was, basically, a stone-throw away….I just love being on the river. I love getting up very early in the morning, just before light, and getting on this river and not encountering another person. And seeing all sorts of wildlife, deer, turkeys. This winter there were a lot of bald eagles. (*Dawson County Residentialist*)

> My husband and his brother had their picture taken two years ago, by [the local newspaper], and when it was printed it was capped, 'Fishing Buddies.' This is one of my brother-in-law's favorite pictures. I had it…framed, and gave it to him for Christmas….It is hanging in his living room and I know he just cherishes that picture. (*Dawson County Residentialist*)

> I have a fantastic view; the scenery is wonderful. In fact, people that come here…say, 'What a beautiful view you have!'…It is just beautiful. (*Prairie County Residentialist*)

> [It's] less populated, thank God….I like it here. Open, Big Sky country—that's us. I don't know how the western part of the state can claim that. [There are] too many mountains and trees. (*Rosebud County Residentialist*)

> We're pretty fortunate to live in Montana. I like it. Not many people. And that suits me fine. *(Treasure County Residentialist*)

> I’ve always gravitated towards it because it’s always relaxed me….My church is the river….The fog comes up off the water….The sun pops up and your line is singing out there and you look down and see the little crystals on it, then I look down and see a herd of elk crossing a couple hundred yards from me. It gives you.…It’s what drug addicts are, the reason they’re drug addicts.…It gives you that feeling…with no side effects,…other than you’re hooked.…I’m not leaving here….This is a place to keep forever. (*Yellowstone County Residentialist*)

> We’re right along side the river….We just love the area out here. We didn’t want to be in Billings….We do a lot of fishing and hunting and floating and, you know, that kind of thing, and rafting….Just the trees, and that there’s nobody between us and [the river] so it’s quiet. Solitude. (*Yellowstone County Residentialist*)

> Everyday I walk down my hall, and I have a new picture window. And you know, it’s just awesome. The colors in the fall are beautiful, [and] most of the time the sun’s shining on the mountains. We can see Granite Peak, we can see all kinds of activity in the river with geese, and we just love it, it’s just awesome….My heart just feels so good. This is our place. (*Stillwater County Residentialist*)

> Paradise. It’s just great, great living. Private and beautiful. We are so lucky and privileged to live here; it’s just wonderful. We have about two and a half miles of riverfront, so we don’t have any neighbors close, and it is just great….The river is the reason we are here. It’s the whole thing. There is constant action going on at the river, whether it’s birds, or fishing, or deer, or whatever. There is always wildlife around which is our great love. We cultivate our land for wildlife. (*Sweet Grass County Residentialist*)

> I feel real fortunate to live here. I mean, they call it Paradise Valley and it is. (*Park County Residentialist*)

> The river is actually magical. I made the mistake of actually taking relatives on the river and now they want to come back every year. (*Park County Residentialist*)

Wildlife Is Appreciated: Of specific importance to the residentialists are their immediate and daily encounters with wildlife. Whether they observe from their windows, take daily walks or spend the weekend relaxing outside, they are able to offer exhaustive inventories:

> Oh, the wildlife. We can see wildlife all the time….I like nature….There’s never a day that I don’t get up and look at the river and be thankful that I’m right where I am….It’s our ‘Little Eden.’ That’s what we call it. (*Richland County Residentialist*)

People here enjoy going up the river and putting their boat in, and floating down. It takes two or three hours to float. It is just beautiful. You see crops, you see deer, you see beaver, you see rabbits. (*Dawson County Residentialist*)

The pelicans keep coming back and increasing….The bald eagles seem to be doing well. And we had a couple of osprey nests on the bridge over the river….I hope the people don't get overpopulated and push the animals away….[Maybe we should be] making areas along the river where nobody can go for a short ways because it's closed as a pelican relief or something. There must be a way we can give the rare animals…or endangered ones a private place to hide, [or] at least nest. (*Rosebud County Residentialist*)

I do like to fish, and we have a river boat. I enjoy that. There is a lot of wildlife. I like to hunt. I enjoy that. As far as recreation goes, there are a lot of things to do. (*Treasure County Residentialist*)

[We see]…eagles, ospreys, [and] we wanted to make sure they have places to stay so they can come and entertain us, which they do, constantly. It's just amazing….It's fun to watch them battle the eagles when there's a catch in one of their claws.…I didn't realize that an eagle could actually fly inverted with the fish—you know, roll over on its back in flight to address the threat. It was wild. Oh yeah, I'd have a $100,000 tape if I'd have just had the camera. (*Yellowstone County Residentialist*)

[I] absolutely adore the choice of the location….It changes daily….It's alive.…I would say that I'm one of the luckier guys in the world to have this view,…this untamed river that I always brag about….There's two of my [Canadian geese] parents out here going down with 12 of their babies….We see all the ducks,…the muskrats and the snakes….We'll have an eagle fly by and an osprey dive in the river….I'm a happy guy here. I've never worked a day out here, but I've sweat and toiled a bunch, but every bit of it has been so enjoyable. (*Yellowstone County Residentialist*)

There is a lot of wildlife out here….We see deer, turkeys, pheasants,…bears, cougars,…mountain lions, elk. There was a moose here….A big bull came across the river….The river is like a corridor for animals to travel, and they will move great distances along it….They actually use it like a highway, so you see a lot of different animals come through….Geese, ducks, sandhill cranes, two pair of bald eagles, and a couple pair of osprey….We have feeders up, [and we've seen]…probably 30 species that we identified in a book. We are not bird watchers, per se, but we just write down what we see, and we kind of expect them when they come. (*Stillwater County Residentialist*)

The beauty of our surroundings. You have all the wildlife, the birds. It's just fun to see all of that down at the river. The different birds,…the pelicans,…eagles nesting.…It's kind of a sanctuary.…It's a habitat.…The blue heron's nest, and the

> rookery. And it's unbelievable…the number of blue herons….There's a lot of bald eagles on the Yellowstone. I think that's a wonderful quality. (*Sweet Grass County Residentialist*)

> We're in the elk migration route. They've been migrating from Yellowstone down here for 10,000 years….They migrate off that flat up there on the top and come down here to the lower lands and…and they feed in that big grass field across the river….[and] they…come across the river to the islands….I just enjoy watching them. (*Park County Residentialist*)

> We…even [had] a black bear last week, right in the yard….My son was sitting across from me and he said, 'There is a black bear,' and I thought he was being funny. I said, 'Yeah, sure.' He said, 'There is a black bear!' And sure enough there it was. The dog saw it and when it barked it took off. We haven't seen it since. We keep anticipating it will come back. (*Park County Residentialist*)

> It's hard to believe but,…about two months ago,…way up on the top of the hill, there…[was] a mountain goat [and] I went out on the porch one day and a pronghorn was walking down the road and looked as us and a moose. (*Park County Residentialist*)

Concerns Regarding the Water of the River: When asked about any concerns they have regarding the river, residentialists often bring up water quality and water quantity issues. The specifics of their concerns vary but, taken as a group, the comments suggest that residentialists are paying attention to the water itself as the key resource. Comments concerning water quality issues include:

> The irrigation…in this area has been here since the '30s….Stop and think of all the water that's being diverted out of that river from up around Columbus…clear to the mouth of the river down, here. How many gallons are being pumped up on the ground?…Look at all the contamination and pollution from all the pesticides. (*Richland County Residentialist*)

> I [am concerned about] pollution [in the river], because it is our water source. You know we need to protect our rivers. If there is an industry that comes in, you can't let…[the river] be polluted. (*Dawson County Residentialist*)

> I don't know much about this methane, but I sure would hate to see it come in and ruin things….If they let it run down the river and we can't use it for our crops, or can't use it for our livestock, or it will kill our wildlife—that would be horrible. What good would the river be? (*Prairie County Residentialist*)

> The water and sewer was one big issue that we got over there….If your septic tank goes bad, [the city] won't let you put in another septic tank. But they won't furnish [us] with city sewer….I just believe that…if you're living in the city, they should provide water and sewer. (*Custer County Residentialist*)

I'm concerned about people dumping stuff into the river….I've heard there's still places dumping toxic chemicals. I don't know if it's true or not. That certainly shouldn't be tolerated. (*Rosebud County Residentialist*)

I know there's an awful lot of pollution around….My concern is with the refinery, but I have to be careful about that because they were there before I moved in and I know they were there before I moved in….I would like to see the refinery…closed, but that's wishful thinking. Quite honestly, I don't know what they do to [the river], but I'm sure there's something that goes on, even if they say there isn't. (*Yellowstone County Residentialist*)

The Yellowstone River really stinks after Laurel. I mean, not that I want to lose the refinery or anything….I don't know if it's necessarily the refinery or if it's just that it's more populated from Laurel to Billings, that stretch. I don't know really what the problem is. But there's no good fish after Laurel….Keeping it clean is my biggest thing. (*Yellowstone County Residentialist*)

You get people [in the subdivision] that think they are farmers and ranchers, and they are going to flood irrigate. Many things happen when you flood….[I was worried they would] flood my septic system, and I would have to go in and put an above ground septic system. I went to the lawyer and did some research and found out…that if you don't use [a ditch easement] for so many years [they can't use it]….Water hasn't been through here for 30 years. They are done….Who in the hell wants their septic flooded? That is the stupid thing about leaving water rights with the subdivision. Wells are a different situation. Water rights for flood irrigation should not be left with a subdivision. I think they should go back and get rid of them….People come in, and put in a septic system, and Joe Blow wants to start flood irrigating, and he is above [us]. It won't affect him, but he will get everyone downstream, and he doesn't give a damn. That is human nature. (*Stillwater County Residentialist*)

I think they have to be real careful with septic, and things like that polluting the river. I think they are already doing that. I don't think we could build here today, and have a septic system. I don't think we could ever get away with it, or ever get approval. (*Sweet Grass County Residentialist*)

The sewage overflow…[at] the plant…in Gardner….If we have an outage, they didn't have a switch that would cut it over to emergency generator to keep it going…until…the guy…working part-time get[s] there to start the generator….The concern that I have is Yellowstone Park should have their own facility and not be using Park County's facility. (*Park County Residentialist*)

In the last two years, in the spring run off…the river turns…orange and…it's coating over the rocks and everything….So there's run-off that's coming from somewhere. (*Park County Residentialist*)

Comments regarding the quantity of water available include:

> Another one is the lack of water….By August, you can wade across the river, here….There seems to be less water, a lot less. (*Richland County Residentialist*)
>
> We should figure out a way to replicate whatever the river flow was at that time, [Lewis and Clark's time]. So, it should go up in the spring and down in the summer. Whatever it takes to maintain that flow—let the cards fall where they may….Whoever gets the water, gets the water. You don't artificially give more water to one person because you hold back water [behind a] dam.…Obviously, it has implications for energy generation, and recreation, and floating barges downstream,…but I think that is the only fair way to do it. (*Dawson County Residentialist*)
>
> I would put a moratorium on any more irrigated lands, period. No exceptions,…because there's too little water, and too much land. Irrigated farmers…take as much water as is legally available, and sometimes more than is legally available. And, as time goes, the cities and towns that take water from the Yellowstone are going to be demanding more and more. That, also, has to be stopped….We, for example, take water from the Yellowstone and from a well. Well water, especially on the scale that is used in a municipality, is extremely expensive. This is one of the things that people are going to have to get used to: paying for water in the cities. And, when I say pay for it, I mean a reasonable amount. (*Prairie County Residentialist*)
>
> Recreation…doesn't use up water….I mean, you're using the water for play but you're not using it up….The growth in the community certainly could use more water, and I worry about agriculture, because I know…people are tending to take a lot more water than they have water rights to. It's a concern….Number one, enforce the water rights that the farmers and ranchers are using….[I know] that's their livelihood, so I'd hate to see that taken away, [yet] we have to have water to drink. (*Custer County Residentialist*)
>
> I wouldn't mind some water being diverted off into a big reservoir, so we can store water. That'd be nice…and I always thought we should try to hang onto as much water as they'll allow us to, instead of just letting it flow into the ocean, because we need it here. We live in a semi-arid desert. And sometimes the river gets so low, we're losing out on species of fish that need water to live in…[and] when the water table goes down there's certain types of trees that can't make it, too. (*Rosebud County Residentialist*)
>
> The big thing for me is the low water, the low water levels, but I'm not sure at this point what you can do. There's not a lot upstream that you guys can do to force it down stream. You know we rely too much on the snowfall. (*Yellowstone County Residentialist*)

> If you believe in global warning, I think [lack of water] will be a problem everywhere….There is apparently some evidence that there is getting to be too many people. (*Yellowstone County Residentialist*)

> Being an agricultural state, the river is very important all the way down….They've used it to irrigate croplands for years and years. I know…[because] I did a lot of crop insurance….We're such a great food source, for ourselves and other countries. I really think agriculture should have as much [water] as any. (*Stillwater County Residentialist*)

> I just take it for granted.…It is just there. It is a part of everyday life. We don't play on it a lot. Occasionally, but not very often. I am not a fisherman. We float it once in a great while. Go down and picnic once in awhile. I can't say it is important to me….It is not something I have to deal with on a day-to-day basis. I view it more as recreation than anything. (*Sweet Grass County Residentialist*)

> We're going to have a leasing meeting over on Mill Creek with the watershed group next week, and a lot of people are feeling that they're coming up short because [one guy is] leasing his water rights [to provide for the fish in the creek]. It is going to affect me, but we have a law that says, if it's beneficial use, you can do that…..Fish and wildlife…[are] beneficial according to our legislature now….And, let's face it, I'll be the first to say, that sometimes the fish in that creek are worth more than the hay I'm raising….[Most people] got their irrigation systems put in by the government—not totally free, but with lots of grant money—that was ten years ago….[Now, with this guy leasing his water, another] says, 'It's not fair.' Well, it may not be fair, but you did get a new pivot…for half-cost….So, I don't know. It's tough. I mean, that's going to be a real contentious meeting….We have water rights, but we dry up Emigrant Creek every year. So I can see both sides. But sometimes I [ask about the] outfitters and how much money they make on the Yellowstone River—it's tremendous. (*Park County Residentialist*)

Keep the Yellowstone River as Free as Possible: Along the course of the river, residentialists generally value the idea that the river is free-flowing:

> The river is going to take its course. I don't think man is smart enough or huge enough to change it. They have poured millions of dollars into rip-rap on the Missouri, and it has failed. I hope they never do it in the Yellowstone….Let Mother Nature do its thing, and it will be fine. It always has been. Don't try to change it. (*Richland County Residentialist*)

> I don't see any problems with the river if they don't do anything with it. Don't mess around with it. Leave it as a free-flowing river….It's got a couple of diversion dams on it, and they are probably needed for the irrigation, but…I wouldn't want them to build them any higher…. I never want to see the river blocked off. Never. (*Dawson County Residentialist*)

We appreciate the fact that [the Yellowstone River] is a free-flowing, long stretch of…water, which is so rare….We'd hate to see anybody improve it for irrigation or something by throwing [a dam] across [it]. (*Prairie County Residentialist*)

The Yellowstone is always there. It can get low, and I mean really low, and it can get really high. I've seen it in flood stages, flooding over on the north side, way over. But, it's always there; it's always flowing. In the winter time, it freezes over,…but you know it's there. It's a constant. I like that. I need that in my life. (*Rosebud County Residentialist*)

If it wasn't for the financial reasons, I would rather not have the dike and let [the river] do its thing….Had it never…had a dike, when the river got high, it would come and spread over the whole area….Maybe it would spread more gradually….You would have a bigger area, but not as much force…and there wouldn't be as much damage as with the dike….It would come up and flood,…and would cause a bit of damage on the bank….You would have junk, but that wouldn't be hard to clean up….If it had been let go, I am sure the channel would be wider than it is now. There would be some islands and…I don't think you would have as much debris.…The high water would carry it away….It wouldn't pile up as bad. I might be wrong, but I think that is what would happen….[However], it is financially impossible [not to have the dike]. (*Treasure County Residentialist*)

For all the trouble it is, I still like the idea of the Yellowstone just running free. That's more about the aesthetics and the recreation thing….There's a lot of stuff,…the wildlife, the floodplains, the swamps, all those things you have because it runs free. All the changes it has from year to year. It's really important.…I can see the dam….There will be a lot of advantages to control the flow of water. But I think we are back to economics….Irrigation—there needs to be more ditches. No flooding if you have a dam to control it. Plenty water for the growth [for] all these cities. (*Yellowstone County Residentialist*)

As long as it stays natural, that's the best. No dams, no changes. Just leave it…like it is today. I mean, I wouldn't like to see anybody going out there and building something in the islands, or anything else….I like to watch the river come up in the spring and go back to normal. And just, you know, wait for [William] Clark to come down. (*Stillwater County Residentialist*)

The public, and myself included, we need to have some available information….We [weren't] really good stewards when we moved here. We've done some rock work along our bank, and there wasn't anyone there [to advise us]…unless we could have paid for professionals….But at the time we couldn't afford it….If there's some kind of grants that may be available so you can hire a professional—if those professionals really have the answer—that's a question…I have. (*Park County Residentialist*)

Diversities Among Residentialists

Among residentialists there are a number of topics that generate diverse opinions. These diversities can occur among immediate neighbors, but they can also appear as differences along the length of the river.

Erosion and Flooding Concerns: It appears that the floods and devastations that occurred in 1996 and 1997 left lasting memories on some communities but not others. Put simply, those who suffered major impacts seem to have lingering concerns regarding the need to protect properties from the river. Near the confluence with the Missouri River residentialists are most likely to view the river as a kind of behemoth that will defy human efforts to control it. Upstream residentialists value its free-flowing character but also value efforts to protect properties:

> The Yellowstone River hasn't changed much since it formed. It isn't like the Missouri that can cut 400 to 500 yards out of a bank in a year. You don't see that here. (*Richland County Residentialist*)
>
> On my place there is a big meander, and it is starting to cut right across there. It wants to form a sandbar here. Maybe in 100 years or 200 years it will go right across here. (*Dawson County Residentialist*)
>
> The changing of the channel, at least in the areas that I have looked at, has been so infinitesimal. There's no way in the world, unless we get a tremendous deluge like the 40-day rain, that the river could change enough to do any actual damage….You'll find a farm in an aerial photograph, or you'll find a piece of land that came to one farm when it was taken off the other side….The biggest one is near the town of Savage. The river changed channels there, probably 150 years ago. It moved about half a mile. (*Prairie County Residentialist*)
>
> I think erosion is a natural thing, and that we should live with Mother Nature. I mean, the river's supposed to meander, so we'll have to live with it. (*Rosebud County Residentialist*)
>
> I know that it's eating up the bank on this side….The bank has really caved in….They've tried different things, but everything they seem to suggest the Army Corps of Engineers says, 'Nope, you can't do that.' They've tried rip-rap in different areas in different ways, and the Army Corps said, 'Nope,…it's not ecologically safe, or it's not economically feasible, or it wouldn't work'.…I would like to see [something] because I don't want my river to go away, and I don't want my town to go away. (*Rosebud County Residentialist*)
>
> It's a vigil every year to keep up with the river, to see if it's going to take out some more of the property. It's a living creature, that Yellowstone. (*Yellowstone County Residentialist*)

> The power of that river….The water comes up over that bank, and it just rolled. It was like a big roller coming at you, and it was the water coming over the banks, and the force of it, when it moved that huge ice up on the land, and it came around there, and it went all the way up to the neighbor's house before it broke. And it broke fairly fast. (*Yellowstone County Residentialist*)

> The river took that island out in about a week and a half. It had 50 to 60 feet cottonwoods. It was just covered in trees. It just took it right out, you know. That is what the river does. We just expect it is going to happen. (*Stillwater County Residentialist*)

> If you own property along the river, you expect erosion, you expect change….I wouldn't want property along the river, and if I did, I would have to look at it really carefully. It is horribly expensive to try and protect it. To me, it is a detriment to own land along the river. (*Sweet Grass County Residentialist*)

> In 1996 we lost quite a little bit [of land]….We lost quite a bit this year….We recently…got it re-surveyed and found out that there isn't, and never has been since we've owned it, as much land as we've been paying taxes on. We've been trying to obtain two titles on this property….Once we get that done we will take it to the county treasurer and see what we can do about that. (*Park County Residentialist*)

> The flood of '96 changed my property….The island broke in half and…when it broke the force of that came over and hit that island and doubled back. My neighbor had very poor rip-rap and [the water] found the weak link and just kept coming to my house….I lost 100 feet [of property]…and part of the house. (*Park County Residentialist*)

> Our bank changed.…The rocks used to go way out in the river. The main force used to be on the other side. We lost at least two feet in one area of bank. That changed the whole flow of the river. Now it comes around the bend and comes at us and then swings out the other way....It changed dramatically with the flood. You don't notice a flow change as much. (*Park County Residentialist*)

Flood Plain Restrictions and the Role of Governmental Agencies: Discrepancies of opinion appear when residentialists talk about development in flood plains and the role of governmental agencies. Clearly, the residentialists from areas with little riverfront development are much more willing to take a laissez-faire attitude toward imposing limits on the activities occurring in flood plains:

> They can build where…they want to. But, if they get flooded, that's their problem….If you want to be stupid enough to go down there on a sandbar, don't come crying to me….When they buy these little parcels,…it should be right on their deeds that this property is floodable….If they would have studied it, they wouldn't have built there to start with….Take the liability off me….You'd have

to be a damned fool to build a house on a place like that to start with. (*Richland County Residentialist*)

People know that river [will flood],…that is why we didn't look for a house over there.…I grew up seeing that whole area under water. So, I know what that river can do. I wasn't about to buy a house over there. Now, those stores have been built over there, but we wouldn't buy a house over there. (*Dawson County Residentialist*)

I always thought that any damn fool who wants to build on the river bank, sticking his neck out, if he falls in—tough shit-ski. He should know better. It's like those guys in California that build up on a mudslide; they ought to know better. (*Prairie County Residentialist*)

I'm concerned about people moving onto flood zones and expecting other people to pay for it [when they] get flooded. Whether it's the insurance companies, which means all of our insurance premiums go up, or whatever….I've seen more houses move near the river….Some of them are not above the flood plain, and that's their fault. If something happens, I don't think anybody should have to pay for it but them….They want to be close to the river. (*Rosebud County Residentialist*)

There's always gradual change, but in a high water year, it could happen in one year, in one season….The boat ramp was carved out a little bit more this year. So there's more water over there this year in that channel, whereas it was one the other side last year. So, it can happen,…like I said, in a season. And it's always happening gradually. (*Yellowstone County Residentialist*)

People…call it a flood plain for a reason, and if people want to build in the flood plain, then that would tell me that you're going to get flooded. (*Yellowstone County Residentialist*)

If somebody's going to build in the flood plain, they should sign something, 'I'm building in the flood plain. I'm willing to take the risk. I know what the implications are and I don't expect the government or my fellow Montanans or anybody else to bail me out if things go wrong.' (*Yellowstone County Residentialist*)

The last time they did a survey for the flood plain was probably over 20 years ago, and it is something that needs to be done and upgraded….If you look at the flood plain maps they have got, they show us in the flood plain, and that is wrong. We are not in the flood plain. We are too high for a flood plain, but that is the federal government. What are you going to do about it? As far as people building low, I don't think they should be allowed to build in the flood plain. All it does is cause problems for everybody concerned. And for people not in the flood plain, we are being penalized….If there are not enough regulations, or if they have not

> been reviewed, when the river changes over the years [the maps are not accurate]….Anybody along this side of the river is required, if you refinance, to have flood insurance, and you can't fight it. If you pay cash, you don't have to have it, but if you finance, [it is required]….I mean, there need to be regulations, and people need the proper insurance, but it needs to be looked at closer and more often. (*Stillwater County Residentialist*)

> Personally, I like knowing that the Yellowstone has no dams, and I am all for keeping it that way….Part of me says the river was there, first, and if you are going to live in a place like that, you should know before you do it….Probably, if I was buying a house lot, I wouldn't buy there. I wouldn't build a house there or in the flood plain, if there was a potential for more damage. The river will eventually go a different way. (*Sweet Grass County Residentialist*)

> We need to be looking pretty seriously at why we're still allowing homes to be built on the river. And…I'm kind of speaking out of two ends here because I do live on the river, but I do think that since the floods we need to look more seriously at what we are allowing….Each place wants to protect their property….Are we all going to be able to do that and still allow the river to be healthy? (*Park County Residentialist*)

Comments regarding the role of governmental permitting agencies run parallel to the comments regarding needs for restrictions:

> The biggest problem here is the diversion dam. They are having a big controversy over the Pallid sturgeon. It is an endangered species…and they are talking about a fish bridge for the sturgeon to be able to go up river….There are some conservationists that would like the dam to go away, but they rely on the dam for irrigation….Intake doesn't allow the fish to move upstream and spawn where they need to….And Pallid sturgeon and sauger get sucked into the canal….They are trying to get big fish screens in front of the canal so the fish can't get into the canal….Another plan is to have a lift station that would fill the canal....If those two plans don't work, they plan on digging this huge canal. For them to do that, they would have to run a canal that was 60 feet deep.…Logistically, it is such a mess.…It seems the fish ladder is more cost-effective….You'd have to have some pretty impressive infrastructure, ice gates and tree gates to keep the junk out of the canal,…and you would have to have a tremendous amount of dirt and…an easement and…bridges….I just can't see it being very feasible. I look at the map and it seems the river doesn't drop that much. (*Dawson County Residentialist*)

> The latest big flap was when Fish, Wildlife and Parks wanted to close a recreation area near town—that really upset a bunch of people. Also, the policies [for] out-of-state hunters and their permits have been quite detrimental to Fish, Wildlife and Parks. The consensus around here is that Fish, Wildlife and Parks is looking for more finances,…to build their own little empires.…For a while the ratio of out-of-state permits to in-state permits was too high. The proportion of hunting

license fees for in-state versus out-of-state were out of proportion, also. (*Prairie County Residentialist*)

Basically, [flood insurance] means that you're giving your money away to the federal government….It depends on the value of your property, but generally speaking, [it costs] about $300 a year. You're paying for insurance that really probably you or your children will never regain a penny from because…it doesn't really cover anything but the foundation of a house….It's a big waste of money…because you have to have your homeowner's insurance on top of it, and…the federal government always waits until the end. (*Custer County Residentialist*)

All he wanted to do was rip-rap to save his bridge….At one time, he had 20 guys standing down there on his bridge, discussing what he should do. Bridge finally washes out and down in the river it goes. The next day, to save the road, they are hauling big boulders, dumping them in…and, of course, in the spring he had to haul his bridge out. That's required….But, there you go. When you're dealing with water, you're dealing with a lot of different people. (*Yellowstone County Residentialist*)

The only problem we had was the reluctance on the Army Corps of Engineers and the DEQ to get [the weirs] done. It took us two years….We probably lost 30 acres and an eagle's nest. To me, that is very disappointing. The lack of vision on the part of people that think the river has to be natural and nothing else works….The length of time and meetings it takes and attitude of, particularly, the DEQ was very difficult. Some of the people in the Corps were very reasonable; some were not that reasonable. The DNRC in town was very good as far as helping us. But their hands are pretty-well tied. They wait for all of the bigger agencies to deal with it. I think they make it so difficult that people just don't want to do it right, frankly. (*Yellowstone County Residentialist*)

All through Montana history, you could do what you wanted. But now you have to have a permit for everything. So that's changed. (*Stillwater County Residentialist*)

Life isn't fair. You've got to do the best you can with the situation. It doesn't matter what we do, or where we're at, we can't choose our neighbors. I think you have to try to make the best of the situation,…[the] best for all. You're never going to please everybody, no matter how you do it. (*Stillwater County Residentialist*)

They just don't want [zoning]. I was raised on a ranch and I lived in town for awhile and the townspeople gave up the right to zoning. They just exchanged one right for another. I wouldn't live in town without zoning….When there isn't any zoning, they can't tell you what to do, but when you have zoning you have the

> right to stop a big farm next to you, for example. You give up one right and acquire another one. (*Park County Residentialist*)

> Private property rights are always an issue along the river. They often are trampled on by regulation and then those regulations cost the private property owners along the river money….There is always a balance and to find that balance and for everyone to be responsible along the river.…I think that's done through education not through regulation. (*Park County Residentialist*)

Rip-rap as an Appropriate Method for Protecting Property: Residentialists are generally aware that properties can be protected by using rip-rap, but many recognize that rip-rap can have negative consequences. In the upstream communities, where flood damages were great and where one county convened a task force, the calls for bank stabilization are most tempered by the awareness that protection of one's private property is not the only consideration:

> That's another problem: you rip-rap on one side, and you're shoving that water back over on another guy. He's going to be a squawking.…It wouldn't do…[anything] to the rivers at all, but it would take away from the natural beauty of it. I mean, you drive down the river and it is all rocks, which aren't supposed to be there, you know. (*Richland County Residentialist*)

> Rip-rap works pretty-well…I think the river is going to do what it is going to do.…I could rip-rap this, and I have always heard that if you do that, it will take it someplace else. (*Dawson County Residentialist*)

> There isn't too much to do about [erosion]….They piled debris from the old high school right here on the riverbank and that is what protected our riverbank. It stays pretty permanent, and when the water comes down, it keeps it out. (*Dawson County Residentialist*)

> I think they get concerned [about erosion] and do stuff for it. I know some people put in rip-rap.…If it is going to control the soil, then good. I might be speaking out of turn, but that is the way I look at it. (*Prairie County Residentialist*)

> We should have laws that limit erosion control along the banks…and it's going to have to be enforced so that everybody's treated right….It would have to be [regulated by the federal government] to…[encompass] the whole river. (*Rosebud County Residentialist*)

> The '97 flood took out the rip-rap and 500 yards of dike. I lost about seven or eight acres of irrigated ground. Ice jams are another one. It can go from a nice mild river and within about 30 minutes it will be running over the banks….When it flooded in '97 it deposited gravel over 18 acres of irrigated ground four feet thick of just gravel….We had to get the trees and debris off….[It took] two weeks….We used a tractor, a loader, a Cat, and a dozer. There were a lot of real

sandy piles….We had…to spread it out or push it into a hole. It was so fluffy it was hard to get around with it.…I suppose that took a week or ten days. Then we went in with a disk and disked it and chisel plowed and took our own level and leveled the land. We spent a couple of weeks at that. We spent most of the summer getting it so we could plant it the next spring….You don't realize all of the things that happen when you lose that much of a crop….I suppose [it took] ten years to [pay off the expenses]….Of course we lost seven to eight acres of ground that is totally gone. At today's prices, that is worth between $15,000 and $20,000. You still own it, and owe on it, and still pay taxes, but it is in the middle of the river. (*Treasure County Residentialist*)

I've been thinking about getting some huge landscape rocks and putting them down there along the bank, just on top of the bank. I understand that concrete blocks and concrete rip-rap are out now because of the lime and all of that other stuff. So you got to come up with some kind of alternative. (*Yellowstone County Residentialist*)

Rip-rap in key locations in the river is really important for landowners. If they're not able to rip-rap, they're going to lose land. (*Yellowstone County Residentialist*)

I don't think [rip-rap] would be effective—not on a curve like that, because I think eventually it just…gets behind the rip-rap, [and] you end up doing it again. So I don't believe rip-rap is the answer. (*Yellowstone County Residentialist*)

We put weirs in….[They were] incredibly successful….If it is done right, it works very, very well. We spend a lot of money and time and energy enhancing wildlife on a property like this that we are not compensated for. We do it because we like to….I spent hundreds of thousands of dollars doing the project we did on the river, doing the weirs the way we did it, engineered right. (*Yellowstone County Residentialist*)

You can attempt to control it, but when you have a flood, like in '96 and '97.…We hauled rocks that were huge, and [now] they are sitting out in the middle of the river, and the ground that they protected is gone. You can control it somewhat. (*Sweet Grass County Residentialist*)

When we're talking about the Yellowstone, we're not talking your normal Montana river. I mean,…there's a lot of power in this bad boy….It will do what it wants. So…to keep it from eating stuff up, you've got to get pretty tough with it. (*Sweet Grass County Residentialist*)

That guy spent tens of thousands of dollars rip-rapping it to protect it. Since the flood, he has done more rip-rapping. (*Sweet Grass County Residentialist*)

> Rip-rapping is the cheapest form of erosion control….Some people will use steel plates, and pound in bridge pilings, and make a wall if they are trying to protect a house. Concrete walls are very expensive. (*Sweet Grass County Residentialist*)

> I think you have to have rocks. If you do it right with vegetation, I think you could do a pretty fair job. I could show you on our place…one place where it has worked very well with vegetative growth, but [it doesn't work] in every place….I think vegetation with rock would be a great way to go, so long as it's done in a way that you're not going to cause damage downstream from you. (*Park County Residentialist*)

> Don't be too hard on the people that live on the river. I don't have the money to make big changes….I had a bunch of cottonwoods growing and the beavers came and ate every one of them. There went my stabilizing….[The beavers] are really destructive. I am trying to keep this place,…[even though] the moose come and they eat everything they see and…I am not going anywhere. I am going to stay here. (*Park County Residentialist*)

> [Rip-rap] can divert water. It can shift the problems up or down….The reason that I probably might not do the rip-rap is I'd lose ten years of vegetation that's out there since the last flood and the vegetation is as good or better than hard rip-rap…[and] once I talked to some people who explained that to me, I don't really want to tear it up to put some rock in…but [the information] didn't come from any of the [government agencies.] (*Park County Residentialist*)

Specific Concerns Among Residentialists

The concerns identified here are, more or less, specific to this interest group. In most cases, the issues or topics are linked directly to living near the river.

Private Privileges and Public Rights: Residentialists are likely to explain that they feel very fortunate to live near the river. They cherish their locales. They desire to protect their sense of privacy, their rights concerning who is on their property, and many are distressed that recreationalists violate the "high water" designation. They do not argue against the public's right to be on the river, but only a few speak with passion when discussing the need to maintain public access to the river:

> We lived in a small house in town, then we decided we would like a place in the country....I am two-tenths of a mile from the river. I am two miles from town and my closest neighbor is a quarter-mile [away]….It is somewhat isolated, but you are still close to town. (*Richland County Residentialist*)

> I like wildlife and scenery….I can sit on this deck, right here, and I can't see a neighbor. So, if I blindfolded someone and put them on the back deck, they might as well be out in the middle of wherever. You can't see anybody. (*Dawson County Residentialist*)

I don't see conflict between the different groups. Like I said, a lot of the landowners are very cooperative about access. The river can be used sometimes for hunting access to the state lands. They'll get in at a boat dock and go up to…state land. [There are] not too many concerns there, as long as the hunters stay where they're supposed to stay.…I think the…recreationists have to be aware of agriculture and be respectful…and I think for the most part that is recognized. Maybe the good access helps too. The roads are all graveled and nice. You can access in any kind of weather. That probably helps. (*Rosebud County Residentialist*)

There aren't enough people here yet [for conflict to exist.] I would imagine if we start getting a lot of people, we will get that. (*Treasure County Residentialist*)

Access—that is complicated….I would like to see just two accesses but…it would be better for the public to have one more….There have been times, especially during deer season, [when] they keep hounding me…to put a boat in. So far, I haven't let anybody use it except my own family. There can be hard feelings over it. It is private property so they should understand that….I am not real comfortable with [them going] right by my house….You are going to have people throwing stuff out and littering. You think they won't, but they will. (*Treasure County Residentialist*)

Nine out of ten of those people that…come from a public access are going to trespass….There's four-wheelers all the time that we are constantly reminding them are not to be up on motorized vehicles, even within the high water marks. 'Oh, gee, we didn't see the signs.' 'Oh, really, gee, we are sorry' [they say] after they have been down there tearing up the riverbank. (*Yellowstone County Residentialist*)

There's always the high water mark which I really like. As long as you can get on legally, you are legal. I don't believe in the circle the wagon thing neither, buying big blocks and just shut it down. (*Yellowstone County Residentialist*)

Quite honestly, if they're just pulling off for a few minutes to take a break, I don't really care. (*Yellowstone County Residentialist*)

We need more access so people can get on to fish. People just don't trust people anymore, and we can't blame them….Unless you know somebody, you can't get on...[so] they fish the bridge down here…[on] both sides, and they fish this corner up here, and they'll walk down the railroad tracks and fish that side, and there's a rancher over here that lets people that he knows on there to fish….[But] it's too close; you've got to get farther away to fish. To catch these here, you've got to go a long ways. (*Yellowstone County Residentialist*)

We realize that if someone is on the river they can get off and get out as long, as they stay within the high water mark….They can come along, and stop and fish

> along the bank, as long as it is at, or below, the high water mark. That is the law….[But,] as I understand it, there are some rich people that are trying to take it away. (*Sweet Grass County Residentialist*)

> I can see both sides: the people wanting on the river, and the private landowners next to [the river] that don't want people going through their land to get on the river. I like to use the river, but I also understand that people don't want you driving through their bull pasture, and leaving the gates open, and driving all over their pasture, and killing the grass and stuff. The best I can see is public access in spots along the river, so you can get down there, and then you can use it. You can use it next to a private land, as long as you get on it legally, which I agree with. Some people think that you shouldn't be able to use that river next to their land, but I don't agree with that. I think it's a public river. But, as far as any change, I don't know what could be done to make it better. I know there are problems. (*Sweet Grass County Residentialist*)

> This subdivision is unique in that there is a bridle path that follows the river for use by the owners in the subdivision. Anytime you have an easement like that, it is somewhat troublesome because there is no incorporated town out here. But if the towns grew enough, they could make a permanent easement, and everyone could use it. That is what bothers me….That bridle path was meant as a bridle path, and they shouldn't use it as access to the river. It may sound selfish, but I am paying taxes on it, and they don't. My liability covers only me, and if they got hurt, they could sue me. They wouldn't win, but they could still take me to court. That bothers me.…A guy bought a bunch of the land, and is going to put in 100 houses [behind me, away from the river]. That is a huge impact. If those people think they are going to use the bridle path, I will have a problem with that. It was designed for this portion [of the subdivision], not the whole. So, the enforcement problem may be a real problem. (*Stillwater County Residentialist*)

> We're not all rich people that can buy ranches and have our own private…hunting and fishing.…I think we have the highest per capita participants in hunting and fishing that live in Montana compared to other states and part of the reason is…the opportunities…we have. It's still good for the average person.…They can have as good of access to hunting and fishing as the rich people do and that's real important to keep it that way. (*Park County Residentialist*)

> I'd like to see public access maintained. I'm a real believer in the stream access law….Let's use the resources. I'd like to see sensible use of it. I don't want to see wildlife adversely affected by or during a drought year. I want to see enough water maintained to keep the fisheries stable and in good condition, if that's possible. (*Park County Residentialist*)

NIMLYs—Not I My Lifetime/Years: Even though many residentialists have a great deal of respect for the power of the river, a number of residentialists view the river as benign and see no real threat to their properties. When asked if they worry that they might be flooded or that the river might erode the bank away, some residentialists agree that over time such possibilities were real, but they would also explain that they did not see such threats as immediate. Such residentialists are referred to, here, as NIMLYs, "Not In My Lifetime" and "Not During the Years of My Life" are common ways of explaining why they do not worry. They seem fairly certain no harm will come to them. In fairness, some are probably correct, and the river's processes will not harm their properties in the next few decades. However, some people explain themselves rather clearly as Former NIMLYs. They experienced problems they never anticipated. Here, then, are comments reflecting NIMLY attitudes and former-NIMLY attitudes:

> I am almost positive that we are not in the flood area. Although, one spring it did almost come over the bank….It was that far from…running over the bank. It will probably happen again one of these years. (*Dawson County Residentialist*)

> We haven't had any [flooding]. This house was built later than most of the houses in the neighborhood, up on the ground, so a flood would still do damage here, maybe the basement….It would have to be a bad flood to damage this house….[It] doesn't really concern us now. There would be plenty of warning for it now….[You] insure your house and leave when they tell you it's going to flood….It's not something I am going to worry about living down here. It's the chance you take. (*Custer County Residentialist*)

> This house used to sit down there where the pile of dirt is. I had to move it…. High water came and washed the bank away….That was the 200-year high. There used to be an island down there about 100 yards and the 200-year high took it out. [The dike] was all rip-rapped and I thought I would never have to touch that again in my lifetime. In May [the river] took it all out. Some of it has been rocked since the early 1970s. (*Treasure County Residentialist*)

> The next year we had a 500-year high and it went right by me because the island wasn't blocking me….[That second year it washed away 100 feet of bank and] the river was running right by the whole south foundation….It cost probably upwards of $40,000 [to move the house]. (*Yellowstone County Residentialist*)

> As far as flooding and such? No, we don't [worry]. The town's going to flood before we would. We're higher than that, so we don't have a problem with that. I think if we're going to flood, I'd better call Noah in because, you know, it's going to get pretty high. (*Stillwater County Residentialist*)

> I don't know if during our time down here we will [see change]….But there again, it depends on the number of floods. That is going to have the biggest impact on it every time. If that happens there is something different every time….But I don't think we will see a major change. I don't expect a new channel to be going across the hills or something. If it does that, we will be out of here! We will be building a big boat with a lot of animals on it. And one thing down here where the river runs, there is that big hillside there, so if it is going to change,

> it isn’t going to impact this way….It was a big flood we had in 1996, 1997, and we weren’t living here prior to that, but we floated it a lot, and it didn’t make huge changes. That was a good-sized flood. (*Sweet Grass County Residentialist*)
>
> 1996 and 1997 were historical record flood years and…conversations have really been stark because of those two major floods….I think people got scared about protecting their properties and some properties were lost. And so with the protection of property and living on the river, there’s controversy. And I think before the [floods, the] controversy probably wasn’t as strong….I think we can be good stewards to the water and the river ways but also [we can] protect our homes….Somehow we have to come up with a balance instead of just saying, ‘Oh, you can’t do this, and you can’t do that.’ Somehow we have to work together to come up with what is the best thing for the river and [the people]. (*Park County Residentialist*)

The Impacts of Development: When asked about the future, residentialists often discuss how further residential development will impact their communities. In communities where little development is occurring there are few concerns, but in communities where development has been relatively intensive, residentialists are aware of problems, even when they recognize the irony of their concerns:

> Instead of a lot of the river frontage being locally-owned or farmer-owned, there is a big chunk that is being bought by out-of-staters....We are not that concerned with the river’s impact on people as much as we are concerned with the people’s impact on the river. If they don’t take care of it, it will continue to get worse. We have had a lot of people come by here, from all over the place. I had a guy from Minnesota stop one day and want to hunt turkeys in the yard. (*Richland County Residentialist*)
>
> Where we are, right here, sure, there might be some more development….More development might be nice. We need to stimulate our economy. (*Dawson County Residentialist*)
>
> Out-of-state people are driving up prices and changing the politics…the Ted Turners tend to have a political agenda. And, in some instances,…[they are] successful. (*Dawson County Residentialist*)
>
> I see it growing because of the energy in the area. There are companies coming in that deal with energy. If it grows, it’s going to be because of energy. It’s basically right now an agriculture town and hasn’t grown a lot at all….There’s always the possibility of the Tongue River railroad. They talk about power plants….Energy is becoming more and more important….At some point, it’s going to come in and we’re going to see the town grow. (*Custer County Residentialist*)
>
> The whole area is getting less populated. Our school is truly downsizing….There are no jobs that pay well in this area, unless you’re lucky [with] the

railroads….There's agriculture jobs…but they don't pay well: $40 or $50 a day….When you start adding it up at the end of the week, it truly isn't [much]....Montana does not take care of its people….They cry that they don't get any tourists, but they don't do anything to welcome them to the state. They have lousy rest areas and…they shut down in the winter time….They don't do anything to promote tourism [and] then they cry that everybody else gets the tourists. I'm sorry, I'm spouting off. Montana is a beautiful state. I love Montana and there are nature's wonders all over the place, but they don't do anything to promote them, and they don't do anything to take care of them. (*Rosebud County Residentialist*)

I would like to see it stay in agriculture. I would hate to see a bunch of houses here. (*Treasure County Residentialist*)

We're losing more farm ground every year for people to build on….It's going to grow. If they get a sewer system in here, it'll grow. It's grown a lot now, all these houses down here are new. There's a block over here, there's three new houses on it. (*Yellowstone County Residentialist*)

When you have more people, you need more water. How do you share that with the agriculture? That's going to be one of the big questions.…What happens to agriculture? I know in Billings a lot of that Ag land is being bought up and is being subdivided. Is the amount [of water] they use less or more in those subdivisions versus what farming would use? What is the trade off there?…I think that would be as big a concern as any. (*Stillwater County Residentialist*)

HUSBAND: Another thing that is grinding people bad [is the] rich people buying up this land along the river, and shutting it off to hunting and fishing. That is a big issue. WIFE: As a subdivision, we don't allow access to the river. HUSBAND: If somebody asks, we would let them down there. WIFE: Not just someone off the street. HUSBAND: No, [but we would] if we know them. It isn't a public access; it is private land. We wouldn't deny access. WIFE: We do to outsiders. If someone comes from Billings, and wants to fish, we would tell them no. HUSBAND: That is our policy to keep it kind of private. The Fish and Game need to have all the accesses they can get. They need to maintain them, and clean them. There are a lot of rich people buying land and shutting it off. Public access is important. (*Sweet Grass County Residentialist*)

The development is just unreal….At night,…I used to drive around and see a dozen lights in the old days, and now there are just hundreds of them, thousands of them, literally. So a lot of the ranches have been chopped up. But it's dollars….They can make more selling it for a house site than they could making hay. (*Park County Residentialist*)

[My kids] will be lucky to afford to live here, I'm afraid. We're lucky we bought our property when we did because we couldn't afford it today….We just got a new law passed by Congress on conservation easements that's a lot more user-

> friendly. Before, the only people that could use those conservation easements were multi-millionaires, basically. And this new one, in fact I was reading about it this morning, you can defer this for, like, 16 years, where before you had to take your tax deductions in six years. So there are some positives there, although you mention conservation easements to some people and they think they are wicked. I think it will help me for estate planning to be able to pass our place on to the kids easier. (*Park County Residentialist*)

Implications of Residentialists' Perspectives

The perspectives and concerns voiced by residentialists suggest that very particular issues must be accounted for both in the near future and in on-going resource management strategies. For instance, residentialists clearly pay close attention to the resources of the river. They feel deeply connected to many forms of wildlife and to the quality of the water. Having chosen to live near the river, they are studious observers of what is happening to the river and the environment, and many of them keep detailed journals of their observation. Importantly, even though many of them are enamored of their locales, only a few speak in detail of riparian functions. For example, many residentialists view the cottonwood trees as beautiful and as important bird habitats, and they often recognize that the cottonwood stands are quite old. Yet, only a few seem to ponder why there are no young cottonwood trees, and fewer still explain that flood regimes are important to the regeneration of cottonwoods. Another example is to consider that some residentialists are actively working to eradicate noxious weeds on their properties while others never mention the issue.

The implication of these examples is that residentialists can be some of the strongest allies when looking for property owners who will voluntarily adopt practices that promote the overall health of the river and the riparian areas. Unfortunately, it will take a concerted, focused and sustained effort. Residentialists do not appear to have a sense of oneness with fellow residential river-dwellers. They are, perhaps, the least likely to band together as a group. Yet, their deeply-held personal attachments to the places they live make them obvious candidates for becoming good stewards of the river's resources and good protectors of the public's interests.

In a different way, however, conversations with residentialists imply that a somewhat taken-for-granted aspect of the public's use of the river will eventually, if not soon, disappear. Namely, as residentialists occupy more of the riverbank, and as they become more concerned with protecting their personal privacies, there will be fewer informal paths to the river. It is also implied that violators of the "high water" designations will not only encounter disgruntled property owners, but that they will encounter property owners willing to engage legal remedies and recourses for trespass. Groups with recreational interests will want to promote respectful observance of property rights. It seems entirely possible that a time will come when formal public access sites will be the only means of getting to the river if one is simply a member of the general public.

While alarms need not sound at this time, the conversations with residentialists suggest that pressures will grow for new public access sites but property owners will be unwilling to accommodate the demand. The state may be able to remedy the pressures in some cases, but another implication is that organized recreational groups, especially those willing to self-monitor their members, will attempt to privatize access in some areas.

A rather troubling third set of concerns is introduced when considering the difficulties involved in maintaining a free-flowing river while simultaneously protecting personal properties. It is apparent that individuals with structural investments near the river will eventually request permission to protect those investments. Where setbacks are not in place, homes can indeed be built in the flood plain. Current federal regulations make it an expensive proposition, but it is not beyond the financial means of many newcomers to Montana. As well, homes that sit well above flood plain concerns can be jeopardized when the river channels take new courses or return to old ones. A few “bridges to nowhere” attest to such channel movements, as do many stories associated with the floods of 1996 and 1997. It makes sense to avoid building near the river, yet the attraction to do so is strong and it is not difficult to understand why residentialists want to protect their homes once they are built. NIMLYs may be happily oblivious, but they are not necessarily safe.

By implication, then, it is important for fullest breadth of the river to be identified and mapped. Not only do local communities need periodically updated flood plain maps, but they must be assisted in minimizing development projects that will eventually be threatened by the river’s natural changes of course. Arbitrary setbacks, such as 300 feet or 500 feet, are unlikely to garner public support. However, the establishment of informed limits, one’s based on historically verified changes, have a chance of generating support. Even though current owners will continue to ask for permits, or to take matters into their own hands, it will be easier to maintain the free-flowing nature of the Yellowstone River if further developments are kept well out of the path of the river.

As demonstrated in the above, residentialists have rather wildly dissimilar understandings of the physical processes of the river, the riparian functions and reasons permitting complications. It certainly should not be expected that the general public understands the river very well because even the experts admit that there is a lot about the river that is not predictable. An attitude of conservative flexibility should be fostered so that the public and the riverfront property owners can understand that local governments do the best that they can, given the available information. Also, because new information is always coming into view, mangers and local governments will necessarily change the rules at times. Every influx of new people, every new generation of adults, and every group of individuals that acquires the means to own a “slice of heaven” will need to be educated and assisted in understanding the river, the management strategies, and the constraints of local governments.

Native American:
River-Length Overview

Interviews were conducted with seven individuals representing Native American interests, including members of the Crow and the Northern Cheyenne tribes. Participants were recruited from referrals provided by various project supporters and by Dr. Jeff Sanders, Associate Professor of Native American Studies, Montana State University-Billings.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

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Native American: Summary

Introduction

A review of the Native American interview data for this river-length summary suggests that people share four common sensibilities when discussing the Yellowstone River. First, the Yellowstone River is known to the both the Crow and Northern Cheyenne as the Elk River. The namesake refers to the abundance of wildlife along the river valley, and the Elk River occupies an important role in the tribal histories of the Crow and Northern Cheyenne. Second, the tributaries of the Yellowstone River, the plants, the wildlife, the human cultural practices, and all other living beings are interrelated. Life-forms are connected through water. Third, water is considered a spiritually-significant and deeply important element within the Crow and Northern Cheyenne cultures. Fourth, the recent years of drought are troubling.

Despite these commonalities, Native Americans express dissimilar opinions and beliefs. These diversities are primarily based on their unique situations and specific geographic locations. The Northern Cheyenne are concerned about the water pollution caused by the current Tongue River coalbed methane wastewater operations and the future development of additional extraction sites. They are also concerned about the restoration of native fish populations in the Tongue River and its tributaries in relation to diversion dams as barriers to spawning sites. Finally, members of the Northern Cheyenne Tribe discuss how noxious weeds and their various forms of dissemination threaten the native plants that have cultural and medicinal significance. Crow participants spoke of the rapid development and its effects on the destruction of fertile farm ground in the river valley. They felt more thoughtful steps towards planning to preserve fertile farmland should be undertaken.

There are three sets of concerns specific to Native Americans. They are concerned about pollution in the Yellowstone tributaries, especially as those problems are a function of faulty wastewater treatment facilities on the reservations. They are also concerned about the cultural separations occurring as each generation seems to be not only physically removed from the river, but spiritually removed as well. In some cases, these detachments from the Yellowstone River have caused tribes to relocate cultural practices onto the river's tributaries. The third set of concerns are articulated as vulnerabilities due to economic hardships and political problems that allow for unfortunate natural resource decisions.

Finally, there are four evident implications derived from these discussions. The first is that the Yellowstone River should be managed according to holistic principles that include the entity of the basin and its constituencies. Second, tribal communities should be given as much support as possible when dealing with problems that ultimately effect downstream quality and quantity. Third, oral accounts of the river should be more fully gathered and incorporated into the official records of the river. And fourth, there are many mutually-beneficial opportunities for partnerships between the interests of the Native Americans, other interest groups, and managers.

The quotes included in this summary are for illustrative purposes. They are also found in the detailed analysis that follows.

Common Concerns Among Native Americans

The following concerns are common among Native Americans interviewed, regardless of where one meets the individual and regardless of which tribe the person is a member. In the past, the river and its environs provided abundant game for the tribes and thus it has great historical significance in the histories of each tribe. Moreover, river waters were, and continue to be, viewed as a life-force that links lives together and that must be respected as sacred.

The Elk River: The river known to Crow and Cheyenne as the Elk River is known to others as the Yellowstone River. The Elk River occupies an important role in the tribal histories of the Crow and Northern Cheyenne:

> It was named the Elk River because there was quite an abundance of elk along the river, drinking, using it as a life-giving source. They had to drink water. From what I understand there used to be hordes of elk along the river. We used the hide. We used the teeth and we ate the meat… Wedding robes were made from elk hide. Wedding robes are beaded strip blankets and porcupine quill work was put on there or later after trade came to this area beaded medallions looked beautiful and they were given to brides of Crow men. The hides were valuable because of the size. Of course, we used the teeth too. Two teeth from each elk were put on the elk tooth dress. If you had a dress with a lot of teeth on it that meant you were from a wealthy family. That your husband, your son, or your brother was a good hunter. That elk teeth were symbolic of wealth and the ability to hunt. (*Crow*)

> The Cheyenne hunted buffalo all through that area. They had a lot of contact with the Yellowstone River. They allied with the Sioux and evolved into the confluence of the Yellowstone and Missouri. There was a lot of game. (*Northern Cheyenne*)

Water Integrates Life—It is Not Simply a Part of Life: The main river and the tributaries link all life forms together:

> The river is *in* the willows that form the lodge that comes from the riverside. [A medicine man] said that the wood too comes from the riverside that we use for the fire. (*Crow*)

> It is a belief system. It is not something you can look at scientifically. It is so important that it is part of our religious belief. You can't separate it [water] into farming, etcetera; it goes way beyond. You can't separate the importance of water in our belief system. It is who we are and you can't separate that. The western world is very segmented…[but from] the holistic view…you can't have a coherent system broken into parts. (*Northern Cheyenne*)

> I enjoy looking at the river, because water is life. That's what we've been taught. And it's precious, the water is. And anything that is growing along the river because of the water, the life that the water gives, you know, I always think about those things,….because I'm an American Indian and because I appreciate those kind of things. I've been taught by my mother to think about those things and, of course, you know in these modern times when everybody, red white blue, anybody, has become aware of so many of these kinds of things that are important to us as human beings, you know, no matter what race we are, what culture we come from, water should be important. (*Crow*)

> It is a living entity for the Cheyenne people. Where does it come from? Springs are also sacred to the Cheyenne. There are stories that say you can't be around springs at night. There is an animal that protects it and if you see it you will go haywire or move on…take a journey because of this animal. Why does this animal have this power? You have to go back further and say why does it protect the springs? It also lives along the creeks. (*Northern Cheyenne*)

Water is Sacred: Water holds a special place within the Crow and Northern Cheyenne cultures as a sacred life-force:

> The river is a giver of life but it can take your life away also. There is this sacredness that we attach to water and the animals. "Fish" in Cheyenne also means "turtle." Turtle is a sacred symbol to the Cheyenne. It is symbolic of a male also. These things are so interconnected, that when we talk about water, we have to look at everything that deals with water because water is everything. It is in the form of fish, it is in the form of humans, it is in the form of animals. When we talk about ceremonies it is all in reference to life. (*Northern Cheyenne*)

> When the elders told me that story about how God looked down and wanted to formalize the Crow tribe with formal relationships, I always think about the Yellowstone River, that's what he saw. (*Crow*)

> A medicine man took us in there, he was an elder. Before he took us in there he explained the importance of the water. And back then, when I was young, maybe the water wasn't so polluted because we did jump in. He took a dipper of the water, and he prayed over it. He said, 'This water is life to us human beings, and to the natural resources that grow around here, and to the animals who depend on this water.' He said, 'Don't ever be cruel to this water. No matter what form, whether if comes out of your faucet or if it is free running like this.' (*Crow*)

> Culturally speaking, water is everything. (*Northern Cheyenne*)
>
> Yes, it's sacred. Lots of things are sacred to American Indian people; water is especially so, because we use it in so many things, you know. Not only do we drink it to nourish our bodies, we pray before we drink it, because we know what it does for the body. We also use it in our sweat bath, we use it in the Sun Dance, we use it in the Tobacco Society, which is a religious organization in the Crow Tribe. We use it in almost everything that is connected to our beliefs in nature and in God. It connects us with God. And so it's a very sacred commodity. We just cannot live without it and we know it. So, it's not taken lightly, water, it's not taken lightly. (*Crow*)

Drought is Troubling: With recent droughts, the future of the quantity of water in is of special concern:

> I don't know what has happened there. Lame Deer Creek is basically dry. I remember in the winter time having to chop holes in the ice to get water. (*Northern Cheyenne*)
>
> The drought is the biggest problem, even in Billings in the Blue Creek area. (*Crow*)

Diversities of Opinions Among Native Americans

Members of both tribes express concerns about the effects of historic and contemporary development on the health of the river. There are a number of topics that generate detailed discussions; however, some topics seem to be more particular to the Northern Cheyenne while other topics are seemingly more immediate to the concerns of the Crow.

Concerns Highlighted by the Northern Cheyenne: Issues regarding coalbed methane development and plant species are discussed extensively among members of the Northern Cheyenne tribe.

Water is a by-product of the extractive processes used to gather methane from underground coal seams. The quality and quantity of the extracted water varies greatly depending on the particular well, but typically it is discharged into the local environment. Thus, as the coalbed methane fields in northern Wyoming are further and further developed, the Northern Cheyenne have become more and more concerned. Not only do many of the methane fields in northern Wyoming ultimately drain such waters into tributaries such as the Tongue River, but there are efforts to develop similar fields throughout southeastern Montana. Concerns over the impacts on water quality are commonly voiced:

> You hear about the coalbed methane water. It has already affected the health. It is probably high in saline and that is number one polluter right now of both the Rosebud and the Yellowstone. (*Northern Cheyenne*)

> We were in court with Fidelity. And the judge finally made a ruling that Fidelity could go ahead and drill and sink some more CBM wells and there was a certain percentage that I can't remember that they could dump untreated into the Tongue River. That is on top of what Wyoming is dumping into the river. There is pollution from the Montana CBM wells. (*Northern Cheyenne*)

The Northern Cheyenne also express a great deal of concern regarding the restoration of native fish populations. They view irrigation projects, in particular diversion dams, as detrimental to restoration efforts:

> You can look at the native fish that used to be coming up from the Yellowstone, the sturgeons and there are other species. [We need to] try and increase the water flow….I think that is a benefit to the tribe as well as others. (*Northern Cheyenne*)

> Instead of using everything, leave some for the fish. (*Northern Cheyenne*)

> There was a study done before they had these diversion dams. There was no fish passage. Now we are working on installing fish passages on these diversion dams so we can get back our native fish. That is what we are working on. They found…a sturgeon way up close to the border that migrated way up there. They want to see more spawning the area. More native that comes from Yellowstone that comes up to spawn. That is what we are working on. (*Northern Cheyenne*)

For members of the Northern Cheyenne Tribe, noxious weeds and their various forms of dissemination threaten the native plants. As invasive plants, these weeds often overtake the plants with cultural and medicinal significance:

> The Rosebud and the Tongue are all kind of deep in the noxious weeds…the salt cedar. (*Northern Cheyenne*)

> Also vehicles…because we don't have ordinances that say you have to stay on this road otherwise your vehicle can be a carrier of noxious weeds. A friend always comes out to the place and picks different herbs and medicines. He said you have a virtual pharmacy here. There is about 35 different herbs that they use. We try not to drive over it. He comes out and we give him permission to pick those. (*Northern Cheyenne*)

> We have noticed a real change in the cottonwoods. They have almost been non-existent, more so than other species of trees in other areas. That means we don't have a good riparian area and that might be another cause of erosion. Not only erosion but the introduction of other species of plants like noxious weeds [is a problem]. The weeds, are opportunists and that is an area where they can survive. (*Northern Cheyenne*)

> Introduction of new plants is pretty substantial because when you import hay from other counties you run the risk of introducing new species….You are seeding noxious weeds when you feed hay every winter. (*Northern Cheyenne*)

Concerns Highlighted by the Crow: Crow participants spoke of the rapid residential development and the loss of fertile farm ground in the river valley. They felt better steps towards planning could be made:

> If I had anything to say about it at all, there would be no subdivisions in the Yellowstone Valley. I would really try to get people to move out of the valley and then rip up the blacktop and concrete that we have down in the valley. Because one of these days we are going to go to the fridge and we are going to say, "Wow, there is nothing in it because we have blacktopped every acre of the finest, fertile land in the world. Yellowstone Valley is a great producer. (*Crow*)

> Why can't we go up on the ridges up out of the valley and save the valley for farming? It is really kind of ridiculous what is going on. I moved up to Billings almost eight years ago, and west Billings has moved a mile up river; probably three or four miles up river and all the way across the Yellowstone Valley and took up two, maybe three thousand acres of the finest, fertile land in this nation. It is fertile because of the Yellowstone River and we could irrigate it. (*Crow*)

> The Yellowstone has always flooded. When the Indian people were here, if it looked like the water was getting high they just moved out. They never fought nature, they lived with nature. Now today, we fight nature; by rip-rapping the rivers as we do, by trying to hold the course, trying to keep it from washing away land. We are constantly in a battle with nature and I think nature is pretty unbeatable when it makes up its mind. (*Crow*)

> Nature can't clean [the valley] and sweep it anymore. And nature would if we would just leave it alone. And the thing of it is, we keep rip-rapping it and the banks are getting deeper and further down because of the rip-rapping. It is not good. (*Crow*)

> The rip-rapping and the fertilizing and everything that is going on in the land right now are affecting the river because nature cannot cleanse it. Nature cannot cleanse the valley. (*Crow*)

Specific Concerns Among Native Americans

The concerns identified here are, more or less, specific to this interest group. In most cases the issues are linked directly to the immediate and/or vested interests of these individuals as Native Americans.

Tributaries Suffer Pollution: Tribal participants expressed concerns regarding pollution events in their home areas:

> It's become so polluted on the reservation now; there are a lot of concerned individuals. They can't even use it in sweat baths anymore. They used to come out of the sweat bath and jump in the river... They would go in the sweat even in the winter time and jump in the water. Now a-days there is a little hesitancy. They will bring the water from maybe their faucet. They'll bring it in great big buckets and they'll use that. They rarely jump into the river anymore because of it's pollution on the Big Horn River or the Little Horn River. So, that's the kind of concerns that American Indian people have. (*Crow*)

> The real contamination is our sewers down there. Holding ponds and those things are overflowing into Lame Deer Creek. You can see where it has killed all the vegetation. It is starting to smell. I don't know how far down it goes. I know they walk along there. There is a spring down there and it has been impacted by the overflow. Nobody seems to do anything about it. That is a tributary into the Rosebud. And it contributes to the Yellowstone. (*Northern Cheyenne*)

Separation from the River and Nature: Due to Native Americans having been placed on reservation lands, tribal practices that were once associated with the Yellowstone River are threatened. Some practices have long since been relocated to tributaries, but others are apparently at risk due to the modernizations in tribal members immediate lives:

> Not very many of my people listen any more to nature and it's kind of sad. I blame it on economics. Life is really, really hard anymore for Indian people… We're competing with the modern world too. (*Crow*)

> The traditional use is still with us today. They don't practice it as much as they used to because we are losing our elders. (*Northern Cheyenne*)

> Geographically speaking the limited access to the Yellowstone is an issue. The Yellowstone River is an important cultural location. As time goes on, memories start to fade and physically the usage of the Yellowstone is almost nonexistent today just because we don't have access to that river anymore. There are certain times that we can have access to it like any other citizen. That is recreation. (*Northern Cheyenne*)

> I think we still own some of the islands on the Yellowstone River, I think. We're supposed to own the mid channel of the Yellowstone, the southern end which is still supposed to belong to the Crow Tribe. (*Crow*)

> Some of the things that we do here…we still do them on the Tongue or the Bighorn or the Rosebud. Those things were part of the cultural practice along the Yellowstone. (*Northern Cheyenne*)

Politics and Economics Impact Natural Resource Decisions: Native American participants express concerns that the political and economic pressures faced by tribal members are sometimes at odds with long-term objectives:

> Growing up, there weren't that many cars here. You could go into the hills and run into deer. They propagate real quick. Then cars were introduced and then pickups and then four wheel drives and spotlights. People hunted and started killing the deer population. They never implemented a season or some kind of control. When I became superintendent they passed a spotlight ordinance. In three years time the population came back. (*Northern Cheyenne*)
>
> The EIS [Environmental Impact Statement] for Otter Creek [coal plant] development is kind of a repeat of another court case that the Bureau of Reclamation wouldn't include the impact on the Northern Cheyenne in the study. They went clear to the Supreme Court and it was handed down that the Bureau of Rec. needed to do that. I guess they are not good learners because they did it again. (*Northern Cheyenne*)
>
> The Crow Tribal leaders sold our water rights away. Some of the Crow, we call them the Allottees' Landowners Association, which is the organization I am part of. One of our members wrote a letter to the Department of Interior, in Washington, D.C. and stated that the tribal administration as a whole, as an organization, has no jurisdiction over our land. Tribal allottees are individual land and water owners and they have no right to negotiate on their behalf. So the judge over there in Washington D.C., Lamberth, I believe, he acknowledged that. So the US Justice Dept. stopped that ten million dollars the administration was trying to get for the individual water rights, between here and all the way to the Yellowstone. (*Crow*)
>
> There are people always handing money under the table for tribal council to not let our people develop anything at all. (*Crow*)

Implications of Native Americans' Perspectives

Taken as a group, the perspectives and concerns voiced by Native Americans suggest that very particular issues must be addressed in both near-future and on-going resource management strategies. There are four primary implications for the Native American interest groups, agencies, communities, the Tribal Council, and other interest groups.

More than any other interest group, the Native American communities speak of the river in holistic terms. They speak in terms of not separating the parts from the whole, and they consistently expand conversations to include both the physical tributaries and the broader social communities that share the resources of the basin. The first implication, then, is that management decisions concerning the Yellowstone River are incomplete unless they take into account the entire river basin, including its system of tributaries, its 70,000 square miles of drainages, and its diverse constituencies. Inclusive management schemes are certain to be difficult to coordinate, especially if the new scheme either implicitly or explicitly brings more people and more perspectives into consideration.

This expanded view suggested leads to a second implication. Namely, it may be necessary to provide assistance to tributary communities as a means of insuring the long term health of the river. For instance, there is an apparent need for improved water quality measures and water treatment facilities on the reservations. Participants explain very specific problems that could ultimately degrade water quality in the main stem of the Yellowstone River. They note accidents, cite irresponsible behaviors by tribal members, and discuss a lack of monitoring as their primary concerns. Other problems are derived from improper, outdated, or failing infrastructures. Also, the Native American participants noted that many people simply do not understand the impacts of their individual activities, nor do they understand that some of the historical practices may be unsafe given the current water quality conditions. Agencies, downstream communities, and other organizations should partner with tribal members to work towards solving these problems and towards helping tribal members better understand the dangers associated with improper wastewater treatment.

A third implication is exposed by considering that many of the cultural and historical resources of the Native American communities are threatened by the inevitable aging and loss of elders. When one considers the brief attention paid by this project to the oral histories of Native Americans in terms of their associations with the river, it is clear that these histories should be more fully gathered and incorporated into official records concerning floods, droughts, ice jams, wildlife, and fisheries, to name a few. Stories about the river and its tributaries are passed down generation to generation among Native Americans and act as a collected history. If these Native stories are treated as simple folklore—or worse, as myths—then the informative power of these histories is lost to managers.

Finally, Native American communities struggle to avoid a variety of vulnerabilities. A recent example involved a “near-miss” regarding the Crow Tribe’s water rights. By the accounts given, tribal leaders had been misled, and if it had not been for the vigilance of a few people, the agriculturalists on the Crow Reservation would have lost their water rights. The potential effects could have caused devastating problems for the reservation and for downstream users. Thus, a final implication, here, is that even though the Native American communities are threatened by numerous vulnerabilities, these threats should be taken into account along with the threats to agricultural, recreational and municipal interests. It is towards everyone’s benefit to identify and support a strong and stable nexus of Native American allies who are dedicated to a healthy watershed. Partnerships that build from mutual interests can serve the entirety of Yellowstone River communities.

Native American: Detailed Analysis

I. Cultural Meaning of the Elk River

A. The "Elk River" at the Center of Living

There is no Yellowstone River. There is the Elk River. (*Crow*)

I heard old folks call it the Moose River or Elk River. The Elk River. Eeyohe River. (*Northern Cheyenne*)

They used to call it the Elk River. Back then, it gave life to them. There were good camping areas with a lot of Cottonwood trees….Even today we still have stories of what took place in those areas; buffalo hunts, battles, ceremonies around the Yellowstone. The stories are important to carry on about the Yellowstone. I think that is one of the most important things for the people here. They talk about how they would cross it and how they would watch the flows and how it fluctuated. There were some individuals who kind of liked science. They studied water, however it moved and the flood plains. (*Crow*)

You take the contribution of the tributaries that sustain these rivers. Everybody here knows that the river is life. It is a living entity for the Cheyenne people. (*Northern Cheyenne*)

The river, the land area was at one time Crow Country and we love this place because it provided us with a lot of food and water of course. We gave it its first name which is Elk River….Even some people still call it that today. I notice that there's Elk River this and Elk River that. (*Crow*)

When you look at river tributaries, they all have a meaning when you view how they are connected. Rivers and springs are to be respected. You can't be around them when night falls. Otherwise there are certain spiritual entities that come into play. (*Northern Cheyenne*)

It was named the Elk River because there was quite an abundance of elk along the river, drinking, using it as a life-giving source. They had to drink water. From what I understand there used to be hordes of elk along the river. We used the hide. We used the teeth and we ate the meat… Wedding robes were made from elk hide. Wedding robes are beaded strip blankets and porcupine quill work was put on there or later after trade came to this area beaded medallions looked beautiful and they were given to brides of Crow men. The hides were valuable because of the size. Of course, we used the teeth too. Two teeth from each elk were put on the elk tooth dress. If you had a dress with a lot of teeth on it that meant you were from a wealthy family. That your husband, your son, or your brother was a good hunter. That elk teeth were symbolic of wealth and the ability to hunt. (*Crow*)

The Crow used the Yellowstone River from the very headwaters to where a trickle of water comes out of the rock that takes you five minutes to fill a cup. They used every inch of it. (*Crow*)

The water was always there, as us Crows, just like the other tribes, we camp along the rivers, and the Yellowstone is a river that runs through our reservation. (*Crow*)

The Indian people always fed the river before they crossed it… They would give it a piece of fat or a piece of meat. And ask for safety before they crossed it. We still do that. Even today occasionally those who believe in the traditions will go up there and throw a little bit of fat or something and ask for blessings because of its power. (*Crow*)

God looked down and saw the driftwood going down the river. And the river is life. River is symbolic of life and as driftwood goes down this life, float down, they eventually will end up on some bank and another one will come and another one will come. And if you ever seen the driftwood, they eventually tangle together and stay together. That's what he meant for the Crow tribe to be; to drift along with life but to form somewhere, to cling together and to help one another. To relate to one another. That's the clan system. I envision it to be the Yellowstone River, I don't know why. (*Crow*)

B. Descriptions of the River

It used to be that grizzly bears were [native to] this area. Same way with elk, they originally were a plains animal that got pushed out of their normal, natural habitat. They made the adjustment and are thriving. (*Northern Cheyenne*)

The Yellowstone River was like a big sweep that came down this valley and it was constantly changing directions. Why do you think we have this great soil that we got here? (*Crow*)

The Cheyenne hunted buffalo all through that area. They had a lot of contact with the Yellowstone River. They allied with the Sioux and evolved into the confluence of the Yellowstone and Missouri. There was a lot of game. (*Northern Cheyenne*)

There's a lot of elk in this valley, the richest valley in the state of Montana. Right now, they're growing sugar beets and whatever….They make a lot of money on that, farmers do. (*Crow*)

Do you want to keep this conversation focused on the Yellowstone or with the tributaries? They contribute too. This is all part of it. You know we are closer to the Tongue and the Bighorn and they are tributaries to the Yellowstone. (*Northern Cheyenne*)

Though it's life-giving and it can be beautiful to look at, it can be dangerous too, because it can ruin a lot of land, threaten a lot of homes. I thought about whether someone was cruel to this river, but of course it was from extra melting winter snows. So all of it can be good or bad. But those are the things I think about. (*Crow*)

You can use that water; you know that water is there… For us we know it is going to flow all the time so we know that there is a bigger river we can run too just in case. (*Crow*)

I enjoy looking at the river, because water is life. That's what we've been taught. And it's precious, the water is. And anything that is growing along the river because of the water, the life that the water gives, you know, I always think about those things,….because I'm an American Indian and because I appreciate those kind of things. I've been taught by my mother to think about those things and, of course, you know in these modern times when everybody, red white blue, anybody, has become aware of so many of these kinds of things that are important to us as human beings, you know, no matter what race we are, what culture we come from, water should be important. (*Crow*)

In one of the stories, in the wintertime they would go down there and bust up the banks to get water. They would swim in it too and get water for soups and to bathe themselves. These were some of the important stories that relate to the mouth of those tributaries in the Yellowstone that affected them. There were a lot of mosquitoes at that time so what they did was go by the banks and get themselves wet and put that mud all over themselves. That is how they kept the bugs off… With mud on, the bugs don't really get to you. There is good in that little mud over there too. (*Crow*)

When the elders told me that story about how God looked down and wanted to formalize the Crow tribe with formal relationships, I always think about the Yellowstone River, that's what he saw. (*Crow*)

They used those areas [tributary confluences] a lot more in the wintertime because those areas had a lot of trees held the winds back. (*Crow*)

The Yellowstone River was detrimental to the Crow Indians. In 1838, a riverboat came up the Missouri River; Fort Union, unloaded. Ten days out of St. Louis, one of the people on the ship got very ill. The captain immediately recognized it as small pox and they quarantined the man… Well this guy with the smallpox got up and started counting his blankets he had to trade… He traded his blankets to all of the tribes of Indians, and it killed approximately 77 percent of all of the Plains Indians in 1838. (*Crow*)

Crow country was the last area settled in the whole United States and it wasn't until the treaty in 1868 when the Crow ceded away the western part of the Crow nation, the nine million acres that is from Livingston down to Park City on the Yellowstone River. (*Crow*)

When Clark came down the Yellowstone, and he was getting down close to the Missouri River in the Sidney and Glendive area, his diaries talk about having to put his canoes ashore and wait for the buffalo herd to cross the Yellowstone River. This happened to him in the diaries three different times between Terry and Glendive. He said he would have to get out and wait maybe an hour for all these buffalo. So you know there was thousands that crossed right there in front of him... the Yellowstone Valley was larger than all of the tribes of Indians. Why do you think the Sioux wanted this country over here? They wanted the buffalo. I always call it the buffalo economy, because at one time we depended on the buffalo for our lodges, our clothes, food. There was absolutely nothing that was not used out of a buffalo. (*Crow*)

We used to swim there a lot but then they started closing off Two Moons Park. I think there are still some individuals that get firewood from around that area. (*Crow*)

C. River Valley Plant Life

In the plants and the vegetables that flourished near the Yellowstone River is what drew us. Plains Indian people always tried to live near rivers because of water. (*Crow*)

There are certain herbs and medicinal plants. Certain pockets of areas only found along these tributaries of the river (*Northern Cheyenne*)

In the past, we were river agriculturalists. We grew corn. We were with the Hidatsa at one period in time. The Hidatsa lived in North Dakota, and we were one tribe. We planted corn, we ate fish, and the game, deer, buffalo, elk, whatever that was there, but we grew corn, squash and all these vegetables. The Native Americans in this country have provided 60 percent of all the foods, squash and all these other vegetables that were there. And there's some other plants that people think are weeds, but they aren't. They are foods and medicine, we use them. (*Crow*)

D. Ceremonial Uses

I want to go back a little bit and talk about the cultural uses. If we go back to the connection of historical use, we need to focus on that a little more and say how the river is used by you and the tribal members. I think we have to start with our world view as to how the world operates as seen from the Northern Cheyenne there are ceremonial uses. (*Northern Cheyenne*)

There are many Crows that go into the Yellowstone Valley today to do prayers and fasting because they are traditional sites. (*Crow*)

The river is a giver of life but it can take your life away also. There is this sacredness that we attach to water and the animals. "Fish" in Cheyenne also means "turtle." Turtle is a sacred symbol to the Cheyenne. It is symbolic of a male also. These things are so interconnected that, when we talk about water, we have to look at everything that deals with water because water is everything. It is in the form of fish, it is in the form of humans, it is in the form of animals. When we talk about ceremonies it is all in reference to life. (*Northern Cheyenne*)

Some of the things that we do here…we still do them on the Tongue or the Bighorn or the Rosebud. Those things were part of the cultural practice along the Yellowstone. (*Northern Cheyenne*)

Whether it is having sweats or fasting, you would fast standing up inside the river. (*Northern Cheyenne*)

We have to look at all these different cultural values. Why we have so much respect for water itself. Water ultimately flows out to the oceans. (*Northern Cheyenne*)

It is a living entity for the Cheyenne people. Where does it come from? Springs are also sacred to the Cheyenne. There are stories that say you can't be around springs at night. There is an animal that protects it and if you see it you will go haywire or move on…take a journey because of this animal. Why does this animal have this power? You have to go back further and say why does it protect the springs? It also lives along the creeks. (*Northern Cheyenne*)

Culturally speaking, water is everything. (*Northern Cheyenne*)

And yet, it's one of the most powerful elements that can destroy and kill people… So we pray with this water and we take it as maybe a sacrament like as Christians, we pray on it. Even our children, we pray that when they go swimming, they don't have any accidents in the water or we pray that sometimes we get flooded. (*Crow*)

Water is one of the most important elements that we have. As a tribal member, we use water in our ceremonies, our sweat lodges, you know. There's mainly four important elements that are very important in life. Water is one of them. Without them you can't survive. (*Crow*)

A medicine man took us in there, he was an elder. Before he took us in there he explained the importance of the water. And back then, when I was young, maybe the water wasn't so polluted because we did jump in. He took a dipper of the water, and he prayed over it. He said, 'This water is life to us human beings, and to the natural resources that grow around here, and to the animals who depend on this water.' He said, 'Don't ever be cruel to this water. No matter what form, whether if comes out of your faucet or if it is free running like this.' (*Crow*)

And the Crow term for water… means "going along." And when you say go get me some water, or bring me a dipper of water, it means to disturb the flow and bring some of it. (*Crow*)

Yes, it's sacred. Lots of things are sacred to American Indian people; water is especially so, because we use it in so many things, you know. Not only do we drink it to nourish our bodies, we pray before we drink it, because we know what it does for the body. We also use it in our sweat bath, we use it in the Sun Dance, we use it in the Tobacco Society, which is a religious organization in the Crow Tribe. We use it in almost everything that is connected to our beliefs in nature and in God. It connects us with God. And so it's a very sacred commodity. We just cannot live without it and we know it. So, it's not taken lightly, water, it's not taken lightly. (*Crow*)

You can use stories of the old people like Plenty Coups. They came out of the sweat bath and jumped in the river no matter if it was ice cold. They would go in the sweat even in the winter time and jump in the water. (*Crow*)

If you go on a fast… you will know that importance of water. (*Crow*)

It's serious on the earth, the land. It was just amazing to me what kind of power and life that water holds. (*Crow*)

E. Interconnectivity

The river is *in* the willows that form the lodge that comes from the riverside. He [medicine man] said that the wood too comes from the riverside that we use for the fire. (*Crow*)

It is a belief system. It is not something you can look at scientifically. It is so important that it is part of our religious belief. You can't separate it [water] into farming, etcetera; it goes way beyond. You can't separate the importance of water in our belief system. It is who we are and you can't separate that. The western world is very segmented…[but from] the holistic view…you can't have a coherent system broken into parts. (*Northern Cheyenne*)

In a nutshell from a cultural point of view all these things are interrelated. (*Northern Cheyenne*)

II. Beliefs of the Elk-Yellowstone River Valley

A. Water Rights

Part of the Yellowstone River in terms of water 'acre feet' flows in there. We have the opportunity to be able to use that amount of water we use. From a business kind of view. (*Northern Cheyenne*)

All those rivers were in our lands and territory, and there's a treaty or there was an act that says all the waters still remain to the people that have the first right, first there, first right. (*Crow*)

We own water but how can you own water? Like how can you own the air? You can't. We understand the white man's system of ownership but it is tough to integrate those things together. For us we still retain those cultural boundaries of how important water is. (*Northern Cheyenne*)

I guess it is the States that are fighting over the barges down on the Missouri and Mississippi. We are all one but down in the lower states a judge ordered more water for more people downstream. So North Dakota, South Dakota, and Montana has suffered a loss of how much water they can use up here and there is more water being used for the barges. That is one of the battles between the lower and upper states of the Yellowstone. I see a battle for control of the flow. (*Crow*)

The most important thing is for the State, the tribes, and individuals that use the water should get their fair share of the use of the water, and benefit the people who live on the water. I believe the distribution of the water is the most important, because what ever happens along the Yellowstone affects us too. (*Crow*)

The Crow Tribal leaders sold our water rights away. Some of the Crow, we call them the Allottees' Landowners Association, which is the organization I am part of. One of our members wrote a letter to the Department of Interior, in Washington, D.C. and stated that the tribal administration as a whole, as an organization, has no jurisdiction over our land. Tribal allottees are individual land and water owners and they have no right to negotiate on their behalf. So the judge over there in Washington D.C., Lamberth, I believe, he acknowledged that. So the US Justice Dept. stopped that ten million dollars the administration was trying to get for the individual water rights, between here and all the way to the Yellowstone. (*Crow*)

B. River, Land Ownership

I think we still own some of the islands on the Yellowstone River, I think. We're supposed to own the mid channel of the Yellowstone, the southern end which is still supposed to belong to the Crow Tribe. (*Crow*)

Geographically speaking the limited access to the Yellowstone is an issue. The Yellowstone River is an important cultural location. As time goes on, memories start to fade and physically the usage of the Yellowstone is almost nonexistent today just because we don't have access to that river anymore. There are certain times that we can have access to it like any other citizen. That is recreation. (*Northern Cheyenne*)

I used to be very bitter about the things that were taken from us, until I visited a tribe in California and we dug a village site right in front of Nick Nolte's house, the movie star, and he allowed us to do this … The tribe was just pitiful… They took us to a hill overlooking Malibu and there were these naked people in bikinis doing volleyball and she was up there praying and I thought what a contrast this is. And I asked her and her father, he was all decked out in shells and stuff. I said, you know so much has been taken from us as Native American people, I said, are you bitter?... He said we are the old Americans, they are the new Americans. It was meant to be. We remember who we are. We value these things and we will continue to do so. The new Americans value what they value and they do what they do, because God meant for them to be that way. I have no hostility toward them because they are God's creatures and they are meant to be here just as we are meant to be here. Holy smokes, we were digging one of your old villages in front of a movie star's home and you are not bitter? No, I'm not why should I be. They are God's creature too. That really changed me. So, when I come here and I talk about the Yellowstone and the people who are living by it now, the ranchers, the farmers and they took all that land away from the Crow people and reduced it in size and time and time again, they took the Yellowstone River from us. But they were meant to be there. They're hard working people… I hope that it benefits them and what they produce for life. The life continues there, see. And my visit to that Californian tribe has completely changed my life… They had no bitterness in them. I started thinking differently. And that's how I look at the Yellowstone now. (*Crow*)

III. Management Concerns

A. Protecting the Quality of Water

We were in court with Fidelity. And the judge finally made a ruling that Fidelity could go ahead and drill and sink some more CBM wells and there was a certain percentage that I can't remember that they could dump untreated into the Tongue River. That is on top of what Wyoming is dumping into the river. There is pollution from the Montana CBM wells. (*Northern Cheyenne*)

The cattle that are along the river, they have runoff that pollutes the water. And sometimes we have people that dump their house sewage into the rivers. We don't see it, but they dump that junk into the rivers, and I guess stricter laws and I guess enforce these laws and maybe give them some stiffer penalties, but they need to manage that water. (*Crow*)

You hear about the coalbed methane water. It has already affected the health. It is probably high in saline and that is number one polluter right now of both the Rosebud and the Yellowstone. (*Northern Cheyenne*)

From the coal fired power plants, we have that liquid metal mercury that is in the pollution that comes up out of the smokestacks when the rains come and the snows and the spring waters runoff, these liquid metals go to those points, and they end up in the rivers. And when they end up in the rivers, the fish have mercury in their bodies… When that mercury gets into the drinking water that is the point where we don't want to see our kids having birth defects. (*Crow*)

We are forgetting about the biggest contributor to the Rosebud on into the Yellowstone and that is Lame Deer Creek. The mouth is south of us here. I am old enough to recall that it was a very vibrant creek. There were fish in that creek. We used to swim in that creek. We used to get our drinking water out of the creek…nowadays… talk about human damage to the creek. (*Northern Cheyenne*)

It's become so polluted on the reservation now; there are a lot of concerned individuals. They can't even use it in sweat baths anymore. They used to come out of the sweat bath and jump in the river... They would go in the sweat even in the winter time and jump in the water. Now a-days there is a little hesitancy. They will bring the water from maybe their faucet. They'll bring it in great big buckets and they'll use that. They rarely jump into the river anymore because of it's pollution on the Big Horn River or the Little Horn River. So, that's the kind of concerns that American Indian people have. (*Crow*)

The real contamination is our sewers down there. Holding ponds and those things are overflowing into Lame Deer Creek. You can see where it has killed all the vegetation. It is starting to smell. I don't know how far down it goes. I know they walk along there. There is a spring down there and it has been impacted by the overflow. Nobody seems to do anything about it. That is a tributary into the Rosebud. And it contributes to the Yellowstone. (*Northern Cheyenne*)

We don't even know what kind of water quality we have here. 2002 was the last time the tribe had an EPA staffer study the water quality from the creek down here all the way down to the Yellowstone… So whatever you do here, it goes into the Yellowstone. (*Crow*)

We are slowly…we have natural resources we have Native American studies. We have policies. We are trying to make it work and segment it. (*Northern Cheyenne*)

The problem is stable drinking water down the road from the creek. We know there are springs underneath and people that used to get good water, but we just wanted to know about the creek. Because some people still use it, like the kids. They swim here and then they drink the water. So it is those kinds of issues that the tribe isn't doing anything about. The conversation district should gather information like that letting people know what we have here, you know? (*Crow*)

Right above the creek here is where people started putting in their game kill. I tell them it was a tradition from back then, but I tell them that back then this whole land was different. It was safe to do that but not anymore. (*Crow*)

B. Water Quantity: Drought and Shortage

The drought is the biggest problem, even in Billings in the Blue Creek area. (*Crow*)
The Rosebud used to be called a river at one time. That has been drying up. There has been a drought area and stretches where there is nothing and that has impacted from Kirby to Busby and to the northwest part of our reservation which then goes off the reservation near Jim Town. That impacts what isn't delivered to the Yellowstone. Tongue River water users association has used our water, I don't know if we have a contract or whatever. When there is a shortage they lease from us. (*Northern Cheyenne*)

There is an idea floating out there, that they wanted to take all that water out of the Tongue River Reservoir and pipe it to Kirby. They had at one time talked about it but lately I think it has been sitting idle. (*Northern Cheyenne*)

I don't know what has happened there. Lame Deer Creek is basically dry. I remember in the winter time having to chop holes in the ice to get water. (*Northern Cheyenne*)

The drought has been impacting us the last ten years. It is no different than out there. Farmers and ranchers have had to tighten their belts. (*Northern Cheyenne*)

The thing more locally that comes to mind is erosion. One of your questions is what kind of changes have you seen in your lifetime. A lot of it has. Especially along the creek area. A lot of the trees and plants have disappeared. I don't know if that is from drought conditions. (*Northern Cheyenne*)

C. Free-Flowing River

I wouldn't want a dam controlling it because of its legendary ….it's long, and I have heard that it had not been dammed up. And I was glad of that. I don't know. To me it's a free river, it's a free-flowing river and I kind of like that idea. (*Crow*)

I look at it this way. This valley has probably taken care of itself for the last forty to fifty million years. Why do we have to start screwing around with it now? (*Crow*)

Mother nature's doings, and we can't control those things. (*Crow*)

But that is my feelings about the Yellowstone Valley and the Yellowstone River. From the headwaters to the mouth of it, leave it alone. (*Crow*)

I think it is the last free-flowing river. There are no really obstacles. (*Crow*)

D. Rip-Rap: "Fighting Nature"

The Yellowstone has always flooded. When the Indian people were here, if it looked like the water was getting high they just moved out. They never fought nature, they lived with nature. Now today, we fight nature; by rip-rapping the rivers as we do, by trying to hold the course, trying to keep it from washing away land. We are constantly in a battle with nature and I think nature is pretty unbeatable when it makes up its mind. (*Crow*)

Nature can't clean [the valley] and sweep it anymore. And nature would if we would just leave it alone. And the thing of it is, we keep rip-rapping it and the banks are getting deeper and further down because of the rip-rapping. It is not good. (*Crow*)

The rip-rapping and the fertilizing and everything that is going on in the land right now are affecting the river because nature cannot cleanse it. Nature cannot cleanse the valley. (*Crow*)

E. Riparian Areas and Wildlife Concerns

One of my relatives caused a lot of damage to the upper Lame Deer Creek. You talk about damage to the riparian. He stripped about one-half mile of the riparian area. He has alfalfa in there now. That is a real no-no. And the Rosebud the same way. I think that is another one. They stripped the riparian area so they could have more cropland. (*Northern Cheyenne*)

The riparian zone is and is not healthy. About a month ago we had chronic wasting disease training. That is a disease that is carried by deer. It is coming this way. This season we are encouraging hunters to bring in the heads so we can take some of the brain stem and send in a sample. (*Northern Cheyenne*)

The deer population was almost decimated. The settlers here, the cowboys had a lot of conflicts. As a result the deer population almost disappeared. The Cheyenne started butchering some of the beef to sustain. They were on the verge of starvation. There was a point when the antelope and deer were just about all gone. (*Northern Cheyenne*)

Growing up, there weren't that many cars here. You could go into the hills and run into deer. They propagate real quick. Then cars were introduced and then pickups and then four wheel drives and spotlights. People hunted and started killing the deer population. They never implemented a season or some kind of control. When I became superintendent they passed a spotlight ordinance. In three years time the population came back. (*Northern Cheyenne*)

We could have an elk population but when someone says elk you have two hundred people out trying to get the elk. (*Northern Cheyenne*)

I remember the catfish and the bass and the gold heads and yellow bellies. That was the extent of my diet when I lived in Birney. In terms of culturally speaking…a lot of the water animals were pretty significant to the Cheyenne people. (*Northern Cheyenne*)

You can look at the native fish that used to be coming up from the Yellowstone, the sturgeons and there are other species. [We need to] try and increase the water flow….I think that is a benefit to the tribe as well as others. (*Northern Cheyenne*)

There was a study done before they had these diversion dams. There was no fish passage. Now we are working on installing fish passages on these diversion dams so we can get back our native fish. That is what we are working on. They found…a sturgeon way up close to the border that migrated way up there. They want to see more spawning the area. More native that comes from Yellowstone that comes up to spawn. That is what we are working on. (*Northern Cheyenne*)

Because of the drought and some of the species that we depend on…deer are getting scarce, though lately they have been coming back. (*Northern Cheyenne*)

Vegetation growing along the river and some of these vegetation things control the river itself. God put those things by the river to help the river I think. The water gave life to those things so that it would happen. That was the riparian use of the river. The vegetation maybe willows, maybe reeds, all those kinds of things that grow naturally along river ways. They're all meant to help the river itself. (*Crow*)

That there is a lot of natural life there, and I hope that people don't destroy that. There are turtles, water beings that are put there by God. That's their home. (*Crow*)

We must be careful not to kill off all the animals and things that are natural to our earth. That goes for the Yellowstone too. We must protect it for all time because it was meant to be there and everything that grows along it was meant to be there and every thing that is in it was meant to be there. (*Crow*)

F. Weeds

Introduction of new plants is pretty substantial because when you import hay from other counties you run the risk of introducing new species….You are seeding noxious weeds when you feed hay every winter. (*Northern Cheyenne*)

The Rosebud and the Tongue are all kind of deep in the noxious weeds…the salt cedar. (*Northern Cheyenne*)

Cook Creek and Tie Creek in Birney are all in the watershed. I see in the erosion and noxious weeds taking over because of cattle overgrazing. There is some management but they have to have rotation. (*Northern Cheyenne*)

Also vehicles…because we don't have ordinances that say you have to stay on this road otherwise your vehicle can be a carrier of noxious weeds. A friend always comes out to the place and picks different herbs and medicines. He said you have a virtual pharmacy here. There is about 35 different herbs that they use. We try not to drive over it. He comes out and we give him permission to pick those. (*Northern Cheyenne*)

We have noticed a real change in the cottonwoods. They have almost been non-existent, More so than other species of trees in other areas. That means we don't have a good riparian area and that might be another cause of erosion. Not only erosion but the introduction of other species of plants like noxious weeds [is a problem]. The weeds, are opportunists and that is an area where they can survive. (*Northern Cheyenne*)

G. Managing Human Use

Human use should be managed carefully. I do know that the Yellowstone River has a lot of recreational use, and sometimes human beings can cause damage. I think…[we should be] careful about…access…because human beings are naturally destructive….They step on things or maybe kick a turtle out of the way. Those kinds of things are what my primary concern would be. (*Crow*)

Billings is growing with no direction. All the City Council can think of is, 'Let's add them on so we get more taxes.'….They are not thinking of the land, they are not thinking of the future….I truly worry…. My children's grandchildren are going to be in a deep hurt. That is about one hundred years from now. (*Crow*)

Instead of using everything, leave some for the fish. (*Northern Cheyenne*)

To see those people recreating on the river gives me a feeling that human beings still appreciate it as much as I do. Not only is it beautiful to see, but those people were having a good time. Hopefully they're loving and nothing bad happens to them because if you are cruel to the river, it will be cruel back to you. (*Crow*)

I hope they are not peeing in the river or something. The water doesn't like that when refuse is being put into the water. You think of all the refineries and factories that might be dumping in there that the water doesn't like that. It's the life of it. (*Crow*)

From a Crow Tribe member, I guess there was a buffalo feeding ground that was the hub of the other tribes coming in and feeding off it and we would always have to tell them to get enough and then get out, to leave. But they wouldn't do it so that is where all the battles were. (*Crow*)

I would maybe manage the recreational use better because of human destruction. You hear about people going out there floating on the river, whenever I see them, and I did just recently when I went to Bozeman, I saw some people on the river and I prayed for them. I just said a real quick prayer for whoever was on the float, because the river can be cruel. It is life giving but it can take you like that. (*Crow*)

If I had anything to say about it at all, there would be no subdivisions in the Yellowstone Valley. I would really try to get people to move out of the valley and then rip up the blacktop and concrete that we have down in the valley. Because one of these days we are going to go to the fridge and we are going to say, "Wow, there is nothing in it because we have blacktopped every acre of the finest, fertile land in the world. Yellowstone Valley is a great producer. (*Crow*)

Why can't we go up on the ridges up out of the valley and save the valley for farming? It is really kind of ridiculous what is going on. I moved up to Billings almost eight years ago, and west Billings has moved a mile up river; probably three or four miles up river and all the way across the Yellowstone Valley and took up two, maybe three thousand acres of the finest, fertile land in this nation. It is fertile because of the Yellowstone River and we could irrigate it. (*Crow*)

H. Threats to Cultural Activity

The traditional use is still with us today. They don't practice it as much as they used to because we are losing our elders. (*Northern Cheyenne*)

You have to depend on the Anglo historian and archaeologists and anthropologists because our language is just now being written. We finally have an orthography that is approved by the council. They are trying to teach reading and writing to Cheyenne with some pretty fluent speakers of Cheyenne. The aboriginal use is also in that particular document. We were connected with that Native Action. (*Northern Cheyenne*)

Dr. Boggs…he used to be with UM but he is an anthropologist and he has a really interesting history. He was working with the tribe back in the late 70s or early 80s. The tribe had a research project and they did some really outstanding research and I think it all burned up when the building on this site burned. (*Northern Cheyenne*)

To go down to the river and have a ceremonial sweat we would have to have special permission. There are many obstacles of bureaucracy getting in the way to do what is done on any other tributary… Federal Indian policy has dictated why we don't use the Yellowstone as much as we could. (*Northern Cheyenne*)

There was a lot of game…[and] it is history to us. The first thing the dominant society asks us is, 'Where is your empirical evidence?' Well, they died off. (*Northern Cheyenne*)

Early on….you can document and they wanted to make farmers and ranchers out of Native Americans. At that same time you have these federal laws that say you can't do that anymore. (*Northern Cheyenne*)

The EIS [Environmental Impact Statement] for Otter Creek [coal plant] development is kind of a repeat of another court case that the Bureau of Reclamation wouldn't include the impact on the Northern Cheyenne in the study. They went clear to the Supreme Court and it was handed down that the Bureau of Rec. needed to do that. I guess they are not good learners because they did it again. (*Northern Cheyenne*)

Not very many of my people listen any more to nature and it's kind of sad. I blame it on economics. Life is really, really hard anymore for Indian people… We're competing with the modern world too. (*Crow*)

The US government can decide what they want to do. They can wipe us out at any time with the stroke of a pen as a tribe, Congress can… If there's something good, they want to take that land away, whatever we have. (*Crow*)

There are people always handing money under the table for tribal council to not let our people develop anything at all. (*Crow*)

Appendix
An Adapted Protocol—Agriculturalists

1. How many years have you been in operation here?
   a. Do you live here full time?
   b. IF NOT: How many months a year is your home occupied?
   c. How do you describe your place to people who have never been here (there)?

2. What was it about this site that made you (your family) want to locate here originally?
   a. Is the river important to you?
   b. What do you like best about being near the river?

3. Are there any problems associated having property this close to the river?
   a. What do you think is the most important problem?

4. Has there ever been erosion damage to your lot?
   a. (If yes) How much of your place was affected?
   b. Is there anything that should be or that can be done about erosion?
   c. Why would that be your course of action?

5. Looking ahead 10 years, what do you expect your place to be like?
   a. Will the physical facilities change?
   b. Why is that?
   c. As you think about the next generation, what are your primary concerns?

6. Some people talk about the river corridor….How is the river corridor different from the river itself? (follow-up to explore "riparian" zone –with or without using that word)

7. Besides what you have already described, what are the various uses of the river?
   a. How do you think the rights of all users can best be balanced?

8. What keeps you here?

9. Of everything we've talked about, what is most important to you?

An Example Excerpt from a Verbatim Transcript

Question: Is there anything else we should talk about?

Response: There has been a time or two when I've wondered how come we couldn't hook an electric generator up to Yellowstone Falls in Yellowstone Park and generate some electricity. That just seems so simple to me. We wouldn't have to buy from PPL Montana, or whoever the hell they are. We'd just have our own…(laughs)

Question: Hey, I think that's in Wyoming. (laughs)

Response: Yeah, but they wouldn't know. They wouldn't be checking on us that close.

Question: Now see, I'm from Wyoming. Obviously, we have to watch out for you guys up here. (laughs)

Response: Oh, I see. Well, we'd try it anyway. Believe me, we'd try it. Besides, there's probably enough there for both of us, both Wyoming and Montana. There's a lot of waterfall there, you know….I don't know just how fast you could turn a generator, but I'll bet you you'd create a lot of electricity.

Yellowstone River Cultural Inventory—2006

Part III: Big Horn River to Laurel

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The team also acknowledges the members and administrators of the local Conservation Districts for their assistance in identifying and recruiting participants. Additionally, members of the Resource Advisory Committee of the Yellowstone River Conservation District Council provided invaluable support. Finally, the team wishes to acknowledge the support given by the Yellowstone River Conservation District Council, the Technical Advisory Committee of the Yellowstone River Conservation District Council, Dr. Tarla Peterson from Texas A&M University, the Montana Department of Natural Resources and Conservation, the Montana Office of Natural Resources Conservation Service, and the US Army Corps of Engineers.

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Preface

The Significance of the Yellowstone River

The Yellowstone River has a long history of serving human needs. Native Americans named it the Elk River because of its importance as a hunting environment. William Clark explored much of the river in the spring of 1806 and found it teaming with beavers. By 1906, the US Bureau of Reclamation was sponsoring diversion projects that tapped the river as a source of irrigation waters. The river then enabled "twentieth-century progress" and today it supports many nearby agricultural, recreational and industrial activities, as well as many activities on the Missouri River.

Management of the shared resources of the Yellowstone River is complicated work. Federal and state interests compete with one another, and they compete with local and private endeavors. Legal rights to the water are sometimes in conflict with newly defined needs, and, by Montana law, the public is guaranteed access to the river even though 84 percent of the riverbank is privately owned.

Interestingly, in spite of the many services it provides, the Yellowstone River in 2006 remains relatively free-flowing. This fact captures the imaginations of many people who consider its free-flowing character an important link between contemporary life and the unspoiled landscapes of the Great American West. As a provider, as a symbol of progress, as a shared resource, as a management challenge, and as a symbol of our American heritage, the Yellowstone River is important.

Purpose

The Yellowstone River Cultural Inventory—2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.

There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants' views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river's resources. Special attention is given to the ways

in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

Identification of Geographic Segments

The Yellowstone River is over 670 miles in length. It flows northerly from Yellowstone Lake near the center of Yellowstone National Park in Wyoming. After exiting the park, the river enters Montana and flows through Paradise Valley toward Livingston, Montana, where it turns eastward. It then follows a northeasterly path across Montana to its confluence with the Missouri River in the northwestern corner of North Dakota.

Five geographic segments along the river are delineated for purposes of organizing the inventory. These five segments capture the length of the river after it exits Yellowstone National Park and as it flows through eleven counties in Montana and one county in North Dakota. The geographic delineations are reflective of collaborations with members of the Yellowstone River Conservation District Council and members of the Technical Advisory Committee and the Resources Advisory Committee.

Working from the confluence with the Missouri River towards the west, the first geographic segment is defined as Missouri River to Powder River. This geographic segment includes some of the least populated regions of the entire United States. This segment is dominated by a broad, relatively slow-moving river that serves an expansive farming community whose interests blend with those folks living along the seventeen miles of the Yellowstone River that traverse North Dakota. Here the Yellowstone River is also important as a habitat for paddlefish and Pallid sturgeon. At the confluence with the Missouri River, the size of the channel, significant flow and substantial sediment carried by the Yellowstone River makes its importance obvious to even the most casual of observers. Prairie, Dawson and Richland Counties of Montana are included in this segment, as well as McKenzie County, North Dakota.

The second geographic segment, Powder River to Big Horn River, is delineated to include the inflows of the Big Horn and Tongue Rivers as major tributaries to the Yellowstone River and to include the characteristics of the warm-water fisheries. This segment is delineated to recognize the significant agricultural activities of the area and the historical significance of the high plains cowboy culture. This segment includes Treasure, Rosebud and Custer Counties.

The third geographic segment, Big Horn River to Laurel, essentially includes only Yellowstone County, but it is a complex area. To begin, important out-takes near Laurel divert water to irrigations projects further east. Additionally, it is the one county along the length of the river with a sizable urban population. Billings is known as a regional center for agriculture, business, healthcare and tourism. This area is notable for its loss of agricultural bottomlands to urban development. Irrigation projects are important east of Billings, especially in the communities of Shepherd, Huntley and Worden. These

communities and Laurel also serve as bedroom communities to Montana's largest city, Billings. It is in Yellowstone County that the river begins its transition to a warm-water fishery.

The fourth segment, Laurel to Springdale, ends at the northeastern edge of Park County, Montana. The river in this area is fast-moving and it supports coldwater fisheries. While there is little urban development in this segment, there are some rather obvious transformations occurring as agricultural lands near the river are being converted to home sites for retirees and vacationers. The geographic segment includes Sweet Grass, Stillwater, and Carbon Counties.

The last geographic segment is defined as Springdale to the boundary with Yellowstone National Park at Gardiner, Montana and is within the boundaries of Park County. The river leaves Yellowstone National Park and enters Montana at Gardiner. It flows in a northerly direction through Paradise Valley and is fast-moving. It supports a cold-water fishery that is well-known for its fly fishing potential. Near Livingston, Montana, the river turns easterly and broadens somewhat thus losing some of its energy. However, severe floods occurred in 1996 and 1997, and local groups have since spent many hours in public debates concerning river management.

Recruitment of Native Americans

Native Americans also have interests in the Yellowstone River. They are active in maintaining the cultural linkages between their histories and the local landscapes. For the purposes of this study a number of Native Americans from the Crow tribe and the Northern Cheyenne tribe were included. Native Americans were recruited by means of professional and personal contacts, either as referrals from state agency personnel, from Resource Advisory Committee members of the Yellowstone River Conservation District Council, or from other project participants.

Recruitment of Geographic Specific Interest Group Participants

The participants represent a volunteer sample of full-time residents of the towns and areas between the confluence of the Yellowstone and Missouri Rivers in North Dakota and the town of Gardiner, Montana at the north entrance to Yellowstone National Park. Participants were recruited from four major interest groups: agriculturalists, local civic leaders, recreationalists, and residentialists living near the river. A database of names, addresses and contact information was constructed for recruitment purposes. Nearly 800 entries were listed in the database, representing a relatively even contribution across the four major interest groups.

Individuals representing agriculture interests, including farmers and ranchers, were identified and recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of the Natural Resources Conservation Service.

Individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and public works managers, were identified and recruited through public records.

Individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity, were identified and recruited from referrals provided by members of the Resource Advisory Committee. Participants were also identified and recruited by contacting various non-governmental organizations such as Ducks Unlimited, Trout Unlimited, the Audubon Society and by contacting local outfitting businesses.

The names of property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank, were obtained through a GIS search of public land ownership records. Twenty acres was used as a screening threshold to separate people who lived along the river corridor but whose incomes were from something other than agricultural practices (residentialists) from those who were predominantly farmers or ranchers (agriculturalists). The names were sorted by county and randomized. Recruitment proceeded from the county lists. Other people living very near the river and whose primary incomes were not generated by agriculture were also recruited. These additional participants may not have had property that technically bordered the river and/or they may have owned more than 20 acres. In all cases, the recruits did not consider agricultural as their main source of income.

Participants were recruited by telephone and individual appointments were scheduled at times and meeting places convenient for them. Many interviews were conducted in the early morning hours and the late evening hours as a means of accommodating the participants' work schedules.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

A total of 313 people participated in the project, including 86 representatives from agriculture, 68 representatives in local civic roles, 76 representatives of recreational interests, 76 residentialists and seven Native Americans. A relatively equal representation was achieved in each geographic segment for each interest group.

Description of Interviews and Collection of Participant Comments

A master protocol was designed from questions provided by the US Army Corps of Engineers and approved by the Office of Management and Budget (OMB approval # 0710-0001; see example in the appendix to this volume). Questions were selected that would encourage participants to describe the local environs, their personal observations of changes in the river, their uses of the river and any concerns they may have had about the future of the river as a shared resource. Open-ended questions were used as a means of encouraging participants to speak conversationally.

The questions were adapted to the participants' interest groups. For instance, interviews with agriculturalists began with the question, "How many years have you been in operation here?" while local civic leaders where asked, "How many years have you lived in this community?" Similarly, agriculturalists were asked, "Are there any problems associated with having property this close to the river?" and local civic leaders were asked, "Are there any problems associated with having private or public properties close to the river?" The overriding objective of the approach was to engage the participants in conversations about the river, its importance and their specific concerns.

Participants were promised confidentiality, and open-ended questions were asked as a means of encouraging the residents to talk about the river, the local environs and their personal observations and concerns in their own words. All respondents were interested in talking about their perspectives, and they represented a variety of views of the river, including: farming, ranching, agricultural science, commercial development, recreation, civic infrastructure, environmental activism, historical views and entrepreneurial interests.

With only three exceptions, the interviews were audio-recorded and verbatim transcripts were produced as records of the interviews. In the other three cases, hand-written notes were taken and later typed into an electronic format. The total resulting interview data totaled approximately 2,700 pages of interview text.

Steps of Data Analysis

The content of the interview texts was distilled by way of analytical steps that would retain geographical and interest group integrity.

Segment-Specific Interest Group Analyses: Taking all audio-recordings, transcripts, and field notes as the complete data set, the research group first set out to determine the primary values and concerns for each geographic segment-specific interest group. The team began with the four interest groups from the segment Springdale to Laurel. Team

members read individual interview transcripts and determined a core set of values and concerns for the individuals represented. As a team, notes were compared and a combined outline of values and concerns was constructed for each interest group in the geographic segment. Quotes were then taken from each transcript in the set to illustrate the particular values and concerns.

Outlines of the interest group analyses for the Springdale to Laurel segment were then used as aids in constructing the interest group analyses in all other geographic segments. Care was taken to adapt the interest group analyses to highlight if, and when, the core values and concerns were different in each geographic segment. The Native American perspective was addressed as an individual analysis with attention to the specifics of those perspectives. Each of the 21 segment-specific interest group analyses was then illustrated with quotes from interviews.

21 Segment-Specific Interest Group Analyses

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
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Segment-Specific Geographic Summaries: A summary of the values and concerns for each geographic segment was constructed using the sets of four geographic-specific interest group analyses. Geographic summaries were written to reflect the concerns that crossed all interests groups of the segment, either as points of agreement or disagreement, and were illustrated with quotes from the four relevant interest group analyses.

5 Segment-Specific Geographic Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

River-Length Interest Group Summaries: River-length interest group summaries were constructed for each of the four primary interest groups. For example, agricultural concerns from the five geographic segments were compared and quotes were taken from the segment-specific interest group reports to illustrate commonalities and differences. Similar reports were constructed for local civic leaders, recreationalists and residentialists.

4 River-Length Interest Group Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Organization of the Reports

Overall Summary of the Yellowstone River Cultural Inventory—2006: An overall summary of the inventory was written as a means of highlighting the values and concerns that cross interest groups and geographic segments. The segment-specific geographic summaries and the river-length interest group summaries were used as the bases for the overall summary. This report is by no means comprehensive. Rather, it is written to encourage further reading in the reports of each geographic segment and in the interest group reports.

Part I: Missouri River to Powder River: This volume includes the geographic summary for Missouri River to Powder River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part II: Powder River to Big Horn River: This volume includes the geographic summary for Powder River to Big Horn River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part III: Big Horn River to Laurel: This volume includes the geographic summary for Big Horn River to Laurel and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part IV: Laurel to Springdale: This volume includes the geographic summary for Laurel to Springdale and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

***Part V: Springdale to Gardiner*:** This volume includes the geographic summary for Springdale to the boundary with Yellowstone National Park and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Research Team and Support Staff

The project was directed by Dr. Susan J. Gilbertz, Montana State University—Billings. She was aided in data collection and data analyses by Cristi Horton, Tarleton State University and Damon Hall, Texas A&M University. Support staff included: Amanda Skinner, Amber Gamsby, Beth Oswald, Nancy Heald, Beth Quiroz, Jolene Burdge, and John Weikel, all of Billings, Montana.

Big Horn River to Laurel: Geographic Segment Overview

Interviews in the geographic segment Big Horn River to Laurel were conducted July 7-17, 2006. A total of 66 interviews were conducted, including individuals with agricultural, civic, recreational, or residential interests as their primary concerns.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Big Horn to Laurel:
Geographic Segment Summary

Bureaucracy is a tool that you can either use to your advantage or disadvantage. The fellow that [complains] probably doesn't realize the benefit he's getting from these layers of bureaucracy. (*Yellowstone County Local Civic Leader)*

Introduction

The study segment Big Horn to Laurel includes data from the people of one large county: Yellowstone County. Three themes dominate conversations with the four interest groups. One theme focuses on the evolving communities of Yellowstone County, most of which are influenced by the economic success and sheer growth of Billings. The second theme focuses on the evolving relationships that the people have with the river. While traditional agricultural activities continue in the county, many people discuss notions related to urban and residential experiences and how the river becomes an asset that improves one's quality of life as an urban dweller. The third theme involves a complex tangle of pressures and demands that require managerial strategies capable of dealing with a future that has arrived.

Evolving Communities are Dominated by Urban Growth

Agricultural activities are recognized as the primary transformative force in the valley. Yet, agricultural activities are seldom mentioned without references to other river-dependent activities and services:

> It is a very productive area, producing excellent crops on land irrigated out of the Yellowstone River. If it wasn't for the Yellowstone River, there wouldn't be anything here but desert. (*Yellowstone County Agriculturalist*)
>
> Because of irrigation in this valley, this valley has changed tremendously from what it was in the 1870s….This whole valley was an alkaline flat….There was a nice riparian area, because the Yellowstone is a wandering river, but it was probably a mile wide at its most. Now it is ten miles wide. (*Yellowstone County Local Civic Leader*)
>
> [The river] is the lifeblood of the valley….It keeps a lot of farmers in water and able to grow crops and it's a good source of recreation….I have a boat that was made for river use; it's got a jet on it. And I'd rather boat any day on a river than on a lake. It's just so much more fun. It provides a lot of habitat for wildlife that is fun to watch and fun to hunt….Fish are fun to eat and catch. So it's a wonderful thing for this valley. (*Yellowstone County Residentialist*)

Some people question whether or not agricultural practices, some of which were adopted at the turn of the previous century, are adequate today:

> Most of the irrigation projects in Montana were built around…1900 to 1920. They're over 100 years old and they're still operated [today as]…they were when they were built, say in 1910….They're operated very, very inefficiently. There is much more water diverted than is really needed to water the crops. That tends to dewater the river. There's much more water returned to the [river] than needed…and that water is usually laden with silt and Ag chemicals, pesticides, nutrients and so forth….And I'm not anti-agriculture at all. I mean, I don't want to come across as hypocritical at all. I eat the meat and I appreciate it. But I think there are some gross inefficiencies in operation, and that unfortunately degrades the quality of our river. (*Yellowstone County Recreationalist*)
>
> One of the things we hope to see happen…is modernized irrigation practices….Most of the farmers are using 1,000-year old irrigation [methods]….In this hot weather, [they] put as much water on those crops as they can, and they over irrigate in spots and so it carries away silt [and] chemicals back into the river. (*Yellowstone County Recreationalist*)

Others note improved awareness of potential problems with agricultural practices and question whether or not agriculture is used as a scapegoat for larger issues:

> Some of the nitrogen probably gets in the water table because it goes down pretty fast. Phosphorous hangs with the soil a while. We use the waste water again when it comes through the drains. We use the same water twice. (*Yellowstone County Agriculturalist*)
>
> The biggest problem that I think is going to be faced on the Yellowstone is ignorance of the natural process, and bad practices. They blame everything on the farmer and rancher. Well, there aren't many left….Those guys [still farming] are getting old, and they're selling off. (*Yellowstone County Agriculturalist*)

As important as the comments regarding agricultural activities are, conversations quickly turn to the other industries and activities supported by the river, especially as they are related to the growing urban center. Billings is the largest community in Yellowstone County, and everyone realizes the town has played an important regional role for years:

> [This area] has always provided jobs. My grandparents came here with the railroad. My dad met my mother and moved here from Butte….They stayed here [because of work]….With the refineries, the railroads and the medical corridor, there…[are] jobs available, and I think that is what's real distinct. (*Yellowstone County Local Civic Leader*)
>
> We are the largest metropolitan area between Spokane, and Minneapolis, and Calgary, and Denver, and Salt Lake….Our medical corridor will continue to

> grow…[because of] that whole bubble of the generations that are retiring [here]….Businesses that need transportation [locate here]….[and] retail businesses [do well because] you've got people. (*Yellowstone County Local Civic Leader*)

Outlying communities, such as Laurel, Worden and Shepherd, are becoming bedroom communities for Billings, and in some areas the agriculturalists are aware that the increasing land values are not compatible with agricultural activities:

> The place right next to me sold to a doctor from Billings. He bought up the land, inflated the prices…[and now a farmer] can't buy land….The outlook hasn't been real good on farming for the last few years….The land is too expensive, and the cost is too high to try to farm. (*Yellowstone County Agriculturalist*)

The local understandings of what it means to have such vibrant, or some might say high-pitched, activities driving the evolution of the valley are of particular interest. Within these understandings, people begin to mention the many concerns they have about the demands placed on the river:

> Down around Columbus, you start getting into row crops, and corn, and beets, and into a lot more expensive land—a lot more productive land….We've got to protect some of that. Urban sprawl is taking that out. (*Yellowstone County Agriculturalist*)

> [The river] is huge for agriculture, but it is huge for economic development, too. We have three refineries, and…the Montana Power generation plant takes water. Nothing works around here without water. (*Yellowstone County Local Civic Leader*)

> The river has to change. As Billings grows, and Laurel grows, and everything else grows, our water supply comes out of the Yellowstone River [and the river has] got to go down….[But, in terms of] habitat, it's essential that the river rise, that floods sub-irrigate [the] ground and create the nesting habitat for…ducks and geese….It has to do its natural flooding. But if we keep drawing more and more water out of it, it's going to change the natural habitat. (*Yellowstone County Recreationalist*)

> The first people that should have the opportunity to use water are those that are fighting things like wildfires….Second are the municipalities, and their water systems, so the public has drinking water….Third are the farmers. You know, that's their lifeblood for…irrigation and stuff. And then you finally get down to the rest of it. (*Yellowstone County Residentialist*)

Municipal water uses are sometimes compared to agricultural uses:

> [Billings takes] about 24 million gallons a day, peaking at over 50 million in the summer and down to about 15 to 16 million in the winter….We aren't even a pipsqueak compared to irrigators….We return 75 percent of it to the river [and] another 10 to 15 percent is returning to the aquifer. Ok, so we've evapotranspirated 15 percent, but we've gained great things from that. (*Yellowstone County Local Civic Leader*)

> [Laurel] uses a maximum of seven million gallons of water a day and our intake is designed for 20 million per day. We have good excess capacity. Informally we have talked to the City of Billings about selling them water….[Laurel has] the second water right on the [entire] Yellowstone River, so the chances of us not having water accessibility are very remote. (*Yellowstone County Local Civic Leader*)

Some assume that the capacity for growth is, or will be, limited by the availability of water and that contentious situations are sure to arise out of attempts to share this limited resource:

> My elders always told me, 'Whiskey was for drinking and water was for fighting.' I think it's true….When you have the amount of people…and the amount of land that is good land, the only thing that's going to prevent that from being developed is the use of water….Right now there are opportunities for development that are being held back until you find the proper mix of how you are going to supply water….Water holds the key. (*Yellowstone County Local Civic Leader*)

> You do have all the industry, too. There's an awful lot of industry that's down by the river that creates not exactly what you would call pleasing environments….Yet it is part of our culture. I guess we all have to be a little tolerant of everybody else, because we can't have everything our own way. (*Yellowstone County Recreationalist*)

> If it wasn't for the Yellowstone River the City of Billings wouldn't exist. And one of the things I think that all of us ought to be concerned about is that, with the terrific growth in population that we have, water is going to become a very valuable commodity. We have lots of water, but we make very little effort, if any, to store it. (*Yellowstone County Agriculturalist*)

> I think it is too bad we can't divert it somehow, the high water, and put it to use. Once it leaves this state, it is gone. I think we could develop more agriculture if we had some diversion. I'm not sure how'd you do it. Maybe it would take a dam and that would be pretty hard to do anymore. (*Yellowstone County Agriculturalist*)

> Another conflict would be between power generation and wanting to use more of the water for power generation and also for cities…and agricultural diversion dams….It's not too much of an issue right now, but in ten years…, I think it might be. I think there will be conflicts of development versus leaving the river in its pristine character. (*Yellowstone County Recreationalist*)

> There won't be [enough water] in 100 years. There won't be enough. (*Yellowstone County Residentialist*)

The growth of subdivisions near the river generates a great deal of discussion because the subdivisions are obvious in the physical landscape:

> All of the ground that you see between Laurel and Billings is dotted with development. Between Laurel and Park City, and Park City to Columbus, it's the same thing….I think in 30 years,…when you come off the Columbus hill, it's going to be all developed, probably to Custer. (*Yellowstone County Agriculturalist*)

> If the realtors had their way, they would fill the flood plain with houses as they have in so many parts of the country. (*Yellowstone County Recreationalist*)

> The way Billings is growing, the irrigated farm land is vanishing. I even noticed it in the Worden area. (*Yellowstone County Agriculturalist*)

> It is beautiful along the river and fun for kids….[It's] peaceful….We sit out on that patio in the evenings and listen to the ducks and the geese and watch the pelicans in the sky….[We see] beavers in the river,…marmots.…The deer like to run through here.…The river islands now have turkeys on them….[We're] seeing the turtles….The river is…unique…and it's free-flowing….It's a beautiful river. (*Yellowstone County Residentialist*)

The growth of subdivision developments is understandable when one takes into account the many attractions of these residential settings:

> It's beautiful….It's located on the slope that drops down to the river bottom….Since the house was elevated, we get a great view of the river and the water fowl on the river and the deer in the pasture and the pheasants in the yard and all the other great things that go along with living out in the country….I love to watch the ducks and geese and pelicans and the critters that habitat the river. (*Yellowstone County Residentialist*)

> Here in Montana, we…really don't care if there is a city park next door because we've got a little greenery in our…five-acre-tract…..We are a plains culture. You don't see three story houses with huge oak trees….We have a different look, we have vistas, we are flat and wide. We are not high rise people….They bring planners from the east to tell us how to do things, they want to stack us up

> downtown and make everybody believe we are all going to give up driving our automobile and move back downtown. It isn't going to happen….The market demand is for a little elbow-room….It is not a Boston, Massachusetts….If you want people to come here to live and work, they've got to have a nice place to live, nice schools, and they have to have a job….That precipitates housing, schools,…paved streets,…and so on. So I think we need to…keep protecting that that makes Montana great. Let's protect our water, protect our air, protect our space…but allow growth….There is no reason that we can't enjoy this same lifestyle with a $250,000 house or 250,000 population. Right now, we are at a 100,000 population. What's the difference? (*Yellowstone County Local Civic Leader*)

However, concerns about subdivisions multiply as more and more are constructed. In particular, concerns are voiced regarding the long term costs associated with residential development, the lost character of the river as the banks are transformed from agricultural to residential uses, and lost points of access to the river as a public resource:

> We're seeing some development with the golf course; that's bringing in quite a few more houses. And we get a lot of people out here that are bedroom community. You know, it's a bedroom community so we get a lot of people that don't want to be in Billings. It's cheaper out here. You don't have to pay the city taxes, so I expect that we'll see some development. (*Yellowstone County Residentialist*)

> Urban sprawl [occurs] because people wanted to get…cheaper land….It used to be that the city…was able to zone [up to] five miles around the city. Well, the legislature struck that down. Can't do that—can't be zoning, even though these places are going to be in the city someday and they don't meet city standards. The streets aren't the right width, they don't have sidewalks, curb, gutters, sewer, they don't have the same grade of water system piping….Then [later] the city has to annex [those areas] and assume the costs….If you happen to through those subdivisions south of Grand and west of Shiloh, you'll see that the roads have no curbs or gutters….They are very narrow little country lanes with huge homes….They were trying to sell [one home] for $1.4 million, [and] it's got this road that doesn't meet cross sectional design requirements….People will spend $300,000 to $400,000 for their house…[but] their infrastructure is awful. So, it's a $500 saddle on a $50 horse. (*Yellowstone County Local Civic Leader*)

> For farmland, we could pay $1,800 an acre, but they are getting $18,000 an acre for that stuff. I don't see us continuing to farm in the next generation….Maybe another 20 years, and then it will all go to houses. (*Yellowstone County Agriculturalist*)

> I think another problem with people building so close to the river is that, aesthetically, it's not very pleasing….From what I understand they're going to put in some riverside trails….Hopefully [those trails] will keep the areas pristine and

> wild.…It ought to be just like the rims, [with] easements that set aside that [area]….Don't allow people to [build] right up to the river. (*Yellowstone County Recreationalist*)
>
> The Department of Fish, Wildlife and Parks was proposing a fishing access site near the Duck Creek Bridge….A few of the people that built homes right on the river [near the bridge] were at this public meeting. Their big argument was, 'We don't want recreationists on the river. We bought a piece of the river to have it for ourselves, and we don't want the public out there.' And really that's the kind of attitude that just can't be tolerated by our public managers….The Conservation Districts and the County Commissions [have to protect] the greater public interest,...not those few individuals that bought their little stretch of the river front….They really need to look at the long-term public interest and the real values that that river has for the greater public into the future. (*Yellowstone County Recreationalist*)
>
> I think it will change drastically as far as people building along the river…[and how] that relates to access to the river….I think that a whole lot more private access show up…[and] it will detract from [the public use] of those areas of the Yellowstone….If it were mine, I would do the same thing. I think that is the way it should be as far as landowners' rights….I don't feel encumbered by houses on top of me. I might when the number doubles or triples or multiplies by ten, and it will. (*Yellowstone County Recreationalist*)

In the eastern-most areas of the county people seem less concerned about Billings and its growth, but even there people recognize the potential for growth:

> East of Billings you're not going to see major changes because agriculture is still king. There isn't going to be huge development. There will be some…out by Pompey's Pillar, if it's not all burned up,…[and] some development along the river [in] Park City….[In] Columbus [and] down this way, you're probably going to see…the smaller acreage type of things happening, which is going to take out some productive cropland, and some of it isn't. (*Yellowstone County Agriculturalist*)

While it is easy to note that Yellowstone County is changing, it is more important to recognize the extent to which those changes suggest or necessitate changing relationships with the river.

Redefining River Relationships: Urban and Residential Demands

As Yellowstone County evolves into a more urbanized community, a number of issues are being discussed that suggest the community's relationship to the river is also evolving. These re-definitions of how people use, appreciate and adapt to life by the river are grouped here as the second theme exposed by the data collected in the segment Big Horn River to Laurel.

Individuals representing each of the interest groups offered comments that illustrate how the river adds to their quality of life and serves as an amenity to the community. Foremost, the river environs offer people a refuge from their more stressful and chaotic endeavors:

> A retired teacher told me he thought [fishing] was just an excuse for doing nothing, so he never fished. I thought he missed something in his life. Even if it's a good excuse for doing nothing, it's a great way to do nothing….I'm pastor and I'm involved in a lot of things….I go out there…[and] the pressure's gone. [I like to] watch the river. Something's moving that I don't have to push. (*Yellowstone County Recreationalist*)
>
> It's peaceful. It is just someplace that we have always wanted to be. We both were raised on acreage. We weren't town-oriented at all. (*Yellowstone County Agriculturalist*)
>
> I've always gravitated towards it because it's always relaxed me….My church is the river….The fog comes up off the water….The sun pops up and your line is singing out there and you look down and see the little crystals on it, then I look down and see a herd of elk crossing a couple hundred yards from me. It gives you.…It's what drug addicts are, the reason they're drug addicts.…It gives you that feeling…with no side effects,…other than you're hooked.…I'm not leaving here….This is a place to keep forever. (*Yellowstone County Residentialist*)
>
> We're out in the country. We have a view of the mountains. The neighbors aren't that close. We have a little open space to breathe. (*Yellowstone County Agriculturalist*)
>
> When you go down [to the river] you might see somebody else. But you could be down there all day, or all morning, and probably not see somebody else. I have an eight to five job, where I answer the phone 100 times a day and solve everybody's problems, and when I go out duck hunting or fishing or hiking, the only problem is, 'Should we stop here for lunch or over there?' (*Yellowstone County Recreationalist*)
>
> It's beautiful down [by the river]. You still got your wildlife down there, and that's what people like….With Riverfront Park, people are utilizing that more. That's great. And then with the new McCall subdivision going in, I think that's going to be good. I think people are looking at it and finally realizing we've got beautiful scenery here, we should use it….Riverfront Park was a beautiful idea….If we could do that…along different areas of the Yellowstone, I think it would be great. (*Yellowstone County Local Civic Leader*)
>
> It's wild. It's untamed. It almost speaks to me. It's a spiritual thing. When I'm on the river, and I just flow with the current, it relaxes me and it kind of de-stresses me. (*Yellowstone County Recreationalist*)

> [In Huntley] we were going to put some paths in, and we wanted to incorporate the east side of the river….[We wanted to] incorporate Main Street and go around the park. We wanted to tie it all in….There are plenty of places to access [the river], but sometimes they've come and gone with ownership. [Some people] get a little wrathy about people crossing their land to get to the river, but I think…it comes down to communication. The people that want to use the river need to…ask [permission]…[and] close the gate when it's closed. (*Yellowstone County Local Civic Leader*)

For some, the river environs offer important ecological services that should be respected:

> [The Yellowstone River is] one of the most important riparian areas in this part of Montana….The riparian zone is a place that is adjacent to the river and it extends from the river back two or three miles….It's important for bird species and animal species…and aquatic [life]….[It] filters out the dangerous things that might filter into the river. It decreases erosion…and aesthetically it's very pleasing….[It is nice] to kayak the river and camp along the shores in the cottonwood groves. (*Yellowstone County Recreationalist*)

> Well, I guess Aldo Leopold probably said it the best, 'The flood plain belongs to the river.' (*Yellowstone County Recreationalist*)

However, for many more people, the river is associated with wholesome human sensibilities and family values:

> I think it was a good place to raise a family. We have a lot of history here. (*Yellowstone County Agriculturalist*)

> To me, it goes back to mental health….[We] need that ability to be outdoors and enjoy. Our kids…and grandkids are becoming so much more urbanized….Kids don't have the kind of freedom…I had when I was younger. I think we need those opportunities to keep a sane community.…That's why it is so fun to live in Montana because you've got so many opportunities to do that. (*Yellowstone County Recreationalist*)

> I was going to say recreation, but it's not recreation: it's a refreshment, a rebuilding time. I bought this when I was still working full-time, and working with people and you're uptight, [and] you come out here [to the river] and can renew yourself. Even busy working, irrigating, it's a great way to refresh yourself. (*Yellowstone County Residentialist*)

> Industry [owners] will…be looking for quality communities to live in, and the river can be a tremendous asset for quality of life enhancement. (*Yellowstone County Local Civic Leader*)

> I am surprised that you use the term river recreationist. It almost belittles the use because it is not just a matter of recreation. Recreation almost trivializes it, like it is something we don’t need to do. With the river it is more than a matter of recreation, our very life depends on the Yellowstone. (*Yellowstone County Recreationalist*)

Long term residents of Yellowstone County recognize that, in some regards, the river is treated better than it was in the past:

> I think the attitudes of people have changed from [the river] being a garbage dump to more of recreation or beauty. [The change] has taken place gradually over the years. Hopefully it will stay that way. (*Yellowstone County Agriculturalist*)

> The refineries [used to] put their waste oil in ponds and it seeped into the river. In the ’30s and ’40s you could see the colors of the rainbow in the water from the oil. They have really cleaned that river up. It is amazing. It is really clean now. People are pretty careful about dumping stuff now. If they catch you, they will fine you. Years ago they used to dump their garbage in. (*Yellowstone County Agriculturalist*)

> Oil slicks [occurred in] the ’60s from spills at the plants….Those don’t happen anymore, [since] the Clean Water Act….We’ve had a water treatment system here since 1915….[Before 1915] people died every year from cholera and typhoid. They installed a treatment system in 1915 and lo-and-behold there wasn’t anybody dying anymore….On the sewage side, they didn’t recognize they were the contributors to their own problem. They didn’t really build any kind of sewage treatment here, other than direct drains to the river…[until] ’46 or ’47. (*Yellowstone County Local Civic Leader*)

> When I was a little kid,…our landfill dump was down on the other side of Conoco, where Midland packing used to be—that’s where our landfill used to be….That’s where the garbage went, and…we would bulldoze it to the river. That’s why there’s so much debris….When people [went] down there and they started the bike path through there, they couldn’t believe the junk that was in there. But we bulldozed that for years down there, and that’s where all the junk went. (*Yellowstone County Local Civic Leader*)

Others point out that modern uses are carefully managed:

> The river is not safe [for human consumption] as it is. We remove all the fine particles, all the bacteria, and the viruses that are harmful….We improve its potability in the sense of its aesthetic quality to users. It’s clear, it has a good quality taste….People find it pleasant….There’s lots of water that’s safe drinking water but not potable. The [Yellowstone River] is a good quality source. It’s a bicarbonate water. We’re pretty far up the watershed. There’s only a minimal

> amount of interference from man, but enough that it wouldn't be safe for anybody to drink as it comes down the river. (*Yellowstone County Local Civic Leader*)

> [In Billings, we treat on] average [over] 14 million gallons per day….Approximately 20,000 pounds of solids a day come in, and we put out…maybe 400 pounds….We are removing about 95 percent of the total system solids and bio-chemical oxygen demand. (*Yellowstone County Local Civic Leader*)

However, a great many people believe that the river has been neglected or is potentially threatened by human activities:

> I did this Nature Conservancy thing to protect the land so it could never be developed….My kids would sell it, and there would be all houses built. We don't want that. There is enough of that around here. There is so much traffic. They drive too fast. They almost ruined my second cutting last year because it was so dusty. (*Yellowstone County Agriculturalist*)

> I know there's an awful lot of pollution around….My concern is with the refinery, but I have to be careful about that because they were there before I moved in and I know they were there before I moved in….I would like to see the refinery…closed, but that's wishful thinking. Quite honestly, I don't know what they do to [the river], but I'm sure there's something that goes on, even if they say there isn't. (*Yellowstone County Residentialist*)

> I would hope that the City would learn to respect the river more than they do now. The banks and the industrial development in Lockwood are just terrible. The County Commissioners think everything should be zoned industrial and Lockwood is very close to the river. I would like to see us change all of that so that all along the river it is a natural corridor. (*Yellowstone County Recreationalist*)

> I think Billings is really lucky to have the Yellowstone flow through it. Unfortunately, Billings turned its back on the river and lost sight of its value. Consequently, we get a lot of bad development down by the river. It's almost like throwaway land….In some cases development is good if…it reorients us to understanding the value [of the river]….We've allowed our industries to be along the river….I see a lot of waste and bad development occur along the river….It's almost plighted. (*Yellowstone County Local Civic Leader*)

> The Yellowstone River really stinks after Laurel. I mean, not that I want to lose the refinery or anything….I don't know if it's necessarily the refinery or if it's just that it's more populated from Laurel to Billings, that stretch. I don't know really what the problem is. But there's no good fish after Laurel….Keeping it clean is my biggest thing. (*Yellowstone County Residentialist*)

> [In Custer] we are about to redo our whole sewer system….We do not have city water, [but] we should….The business people have to chlorinate [their water]….We've been dumping animal and human waste into this groundwater for 100 years now. These people are kidding themselves if they think it's not in their wells. (*Yellowstone County Local Civic Leader*)

> It seems like we use it, but we don't honor it….We use it for our own industrial interests, but we don't seem to give any of it back to the citizens…in terms of beautifying the many spots [along] the river. Of course, it is beautiful by itself in the more rural areas. But, when it comes through the many cities,…it doesn't seem like we've done much with it. (*Yellowstone County Recreationalist*)

> [Outside of the city water system, we have some areas with septic systems in] pretty shallow gravel….[And] on the bottom is shale, which is not porous. So the water…just moves down the gravitational gradient….You sink in your well…[and your water has] lots of minerals in it…It tastes like shit. You end up putting in a reverse osmosis system to get the minerals out:…[the] high calcium, high magnesium, high sulfate, and lots of nitrates. Nitrates are causing problems for Blue Baby Syndrome. About 10 mg per liter of nitrates in water is associated with babies [who are] unable to take up oxygen. So, that's a problem if you were to drink water…above 10 mg per liter, and there are areas like that out there. They need to be urbanized; they need to be put on a water system. (*Yellowstone County Local Civic Leader*)

> I serve on the county zoning commission and [sometimes when] we get a request that is close to the flood plain…we don't even get a map with the request. So I ask, 'Where is this?' and they will say, 'Well, maybe a corner is in the flood plain, but it won't cause much problem.' So, we are changing the flood plain regulations….If I lived downriver from Lockwood, I would worry. (*Yellowstone County Recreationalist*)

> The ranchers and landowners should not build so close to the river, and I think they [should not]…have their cattle graze right next to the river….Cattle go down to the river and drink and they trample all the…shrubbery and grasses. (*Yellowstone County Recreationalist*)

As more people live along the river there are increasing pressures to protect properties, especially those with structural investments. The goals are often site-specific and are related to how the river affects personal properties:

> This house used to sit down there where the pile of dirt is. I had to move it…. High water came and washed the bank away….That was the 200-year high. There used to be an island down there about 100 yards and the 200-year high took it out. The next year we had a 500-year high and it went right by me because the island wasn't blocking me….[That second year it washed away 100 feet of bank and] the

river was running right by the whole south foundation…. It cost probably upwards of $40,000 [to move the house]. (*Yellowstone County Residentialist*)

Sometimes it's heartbreaking to see [erosion]….But, on the other hand, it's a wild river and it's expressing itself in such a way that it makes it what it is. It's a living entity that gobbles up one bank one year and might turn around and gobble up the other bank the next year. That's what's uncontrollable and that's what makes it wild and adventurous for those of us who like to get on that sort of thing. (*Yellowstone County Recreationalist*)

My next door neighbor…tells me he used to drive their old Ford truck over to the island. The deepest [the river would be] in the fall would be two and half or three feet deep. We've sounded that and we know it's eight, ten, 12 feet deep with some deeper holes….Somewhere back in late-'80s, early-'90s the river took a turn, and, instead of going on the other side of the island, ice jams and blockages of one form or another carved the river over here. And we know it's been here because everything here is a product of river sediment over the last million years, and it goes back and it goes forth. (*Yellowstone County Residentialist*)

There's always gradual change, but in a high water year, it could happen in one year, in one season….The boat ramp was carved out a little bit more this year. So there's more water over there this year in that channel, whereas it was one the other side last year. So, it can happen,…like I said, in a season. And it's always happening gradually. (*Yellowstone County Residentialist*)

It's a vigil every year to keep up with the river, to see if it's going to take out some more of the property. It's a living creature, that Yellowstone. (*Yellowstone County Residentialist*)

The time that the river changed course drastically, and started moving into our property, it was just horrific….There was a big island out there, and it was full of trees….You would hear the trees….It sounded just like bowling pins going down….It literally lifted those trees every which way out into the river….It was just unbelievable. [Then, the fallen trees were] knitted and packed with mud just like somebody had created it by hand, but it was just the force of nature….[The fallen trees] diverted the water,…which brought it into our place….It just basically changed overnight. (*Yellowstone County Agriculturalist*)

If we don't get some stabilization on that bank, this place, in ten years, is going to be in trouble, and so is everybody else in this valley if this river gets high enough. We've had two neighbors down there that it flooded already. (*Yellowstone County Agriculturalist*)

The power of that river….The water come up over that bank, and it just rolled. It was like a big roller coming at you, and it was the water coming over the banks, and the force of it, when it moved that huge ice up on the land, and it came around

> there, and it went all the way up to the neighbor's house before it broke. And it broke fairly fast. (*Yellowstone County Residentialist*)

> The river changes courses. The river as it exists today is changed significantly as far as meanders and the way it picks its course….I built a cabin on the Yellowstone River bank 60 years ago that is now an island, and this is just from the natural flow of the Yellowstone River….It's a natural thing for the river to do….and it will continue to change. (*Yellowstone County Local Civic Leader*)

> When they start having big ice flows again,…this entire thing will be eight to ten feet thick in ice that will be exploding and cracking, and it can crush a car in a heartbeat. It breaks rocks….And that water doesn't stop....There will be ice 15-, 16-, 18-feet out from the bank, just packed in against the banks. And all that ice then cuts loose and just slops into the river, and it comes down the size of buses….You've got something that's moving five, six miles an hour by water, and it slams into stuff, it changes a lot of things. (*Yellowstone County Residentialist*)

> I'll tell you where the water was one time. Remember when you drove by here? It was right up to the highway. I was here with my fins on….This road in here is new. They built it up higher, thank God. It saved us there, but here, coming around the corner, there's nothing there. The river…[doesn't] have to rise very much to get over and flood. (*Yellowstone County Residentialist*)

Other discussions address how the community ought to systemically think about and manage the flood plain:

> People…call it a flood plain for a reason, and if people want to build in the flood plain, then that would tell me that you're going to get flooded. (*Yellowstone County Residentialist*)

> It is appropriate to build subdivisions within viewing distance of the river but out of the flood plain….People like to live [near the river], but is also appropriate to keep park land in-between there because then you not only have the chance to enjoy the river but to protect it also. So I think we have come up with a pretty workable balance. (*Yellowstone County Local Civic Leader*)

> The Yellowstone…is free-flowing and it floods a lot. So you better not put a house right on the edge of the river; it might flood and wash away. (*Yellowstone County Recreationalist*)

> People want to live where it's pretty, but if you're going to build on the river, expect to be flooded. And don't cry to me when you're flooded because, if you're stupid enough to build there, then it's your problem, not mine. (*Yellowstone County Agriculturalist*)

> I think there's a lot of guess work that goes into those flood plain maps, frankly….I think there are probably better ways now through GPS technology that they could very closely identify whether it is in the flood plain. (*Yellowstone County Residentialist*)

> The photos are of great value to see [past flooding], but I think since that flood in '97 the river has actually changed course and you can see that in the photos from year to year. Historically, the water hasn't come up that far, but since the river channel has changed a little bit in that area and we have lost some land, even last year we lost a big chunk….I can't say what would happen in the future. (*Yellowstone County Residentialist*)

> If somebody's going to build in the flood plain, they should sign something, 'I'm building in the flood plain. I'm willing to take the risk. I know what the implications are and I don't expect the government or my fellow Montanans or anybody else to bail me out if things go wrong.' (*Yellowstone County Residentialist*)

> When they…develop in the flood plain…their actions can affect others. We have laws that limit what people can do on their property….Their development in the flood plain is not in the greater public interest and the greater public interest is what really needs to hold sway. (*Yellowstone County Recreationalist*)

> I like the fact that, for the most part [the river,] is left open to function naturally, that there is still a lot of flood plain left, realizing that it's heavily armored in places….The flood plain is essentially storage for flows that are above normal flows. Without adequate storage, it would be discharged downstream and have to go somewhere and force itself into places that would probably cause a lot of destruction. So, if you can maintain natural flood plains, then you can pretty much protect property from inundation. (*Yellowstone County Local Civic Leader*)

> If you ever notice, farmers and ranchers don't have their houses right on the banks of the river. Gosh, I wonder why. But you see the city folk [saying], 'Oh, that's a great place to build, great view. Boy, we can walk out the back door and throw the fishing line in the river; that's fantastic. We can put our jet ski out on the river right out our back door….Oh, my God, now the back door is the front door, the river has changed channels.' I'm not going to cry for those people. Common sense says you don't build in a hazard area. (*Yellowstone County Agriculturalist*)

Rip-rap is generally considered an effective method of bank stabilization:

> I lost eight acres on the one field, but it was also endangering the railroad [so] they came in and rocked it….Yeah, it worked. It was spendy, but it worked. (*Yellowstone County Agriculturalist*)

> In ’97 we had the highest flood on record….[It] was a 500-year flood....[The] REA was afraid it was going to…flood their new unit….They rip-rapped it perfect [for] a half mile…and there has not been one piece go out of place. There’s always a hole or something that may have been done better originally, but if you throw…rip-rap [in the hole] it just makes it better….To do it right, you want [there] to be about 16-foot width at the base, so you have a big strong base for the other to lock with, and then bring it up to about a three-foot width at the top….The weight crushes it down….You’ve got the dirt walls behind it that are packed and it doesn’t seep very well. (*Yellowstone County Agriculturalist*)

> I know they don’t let you put concrete in the river anymore. I don’t really understand that and nobody has explained it to me, so I guess I’ll have to figure that out. (*Yellowstone County Residentialist*)

> I’ve been thinking about getting some huge landscape rocks and putting them down there along the bank, just on top of the bank. I understand that concrete blocks and concrete rip-rap are out now because of the lime and all of that other stuff. So you got to come up with some kind of alternative. (*Yellowstone County Residentialist*)

> Rip-rap in key locations in the river is really important for landowners. If they’re not able to rip-rap, they’re going to lose land. (*Yellowstone County Residentialist*)

> You get a guy with more money than he knows what to do with, and he’s paid tens of thousands of dollars an acre for land along the river, and here comes the damn river and starts washing [his land] away. Now he can afford to do something about that, and he will do it. What he doesn’t understand is that the degree to which he does that, it is going to hammer the guy downstream. So, he has [created] unintended consequences which he’s not responsible for—he should be. (*Yellowstone County Recreationalist*)

Most people agree rip-rap is expensive. Some people explain that rip-rapping can both push the problem elsewhere and result in other problems:

> You…[have to] watch out. If you are rip-rapping on the south side, and somebody’s got farm land on the north side, that can create some problems….We were very fortunate because there was no effect to people to the sides of us or across from us….We had no one but ourselves to protect. In fact…the river was affecting [the neighbor] tremendously, [and]…when we got done, it turned the river away from their property. They now feel safe and secure. (*Yellowstone County Agriculturalist*)

> Rip-rap diverts water into the neighbors’ land if you don’t do it right. That is something you have to be concerned about. You could subject yourself to a lawsuit. That is something the Corps and the local Conservation District should look at. (*Yellowstone County Agriculturalist*)

> Rip-rap is an eyesore and takes a tremendous amount of material. And most people can't afford it. (*Yellowstone County Agriculturalist*)

> The natural processes of the river [include] erosion and deposition….I understand why [people who live near the river] would [want to stop erosion], but from a geologic or scientific viewpoint, once someone affects one part of the river it will affect another part of the river. There are consequences….If you put in…rip-rap then that may cause scouring in some places and deposition in others. You may be affecting your neighbors….Those types of things need to be considered….I think it is important to approach this from the scientific point of view. (*Yellowstone County Local Civic Leader*)

> Pretty soon you have a ditch, you know, rather than a river. In some cases [rip-rap] is legitimate, in other cases it's probably overdone. (*Yellowstone County Recreationalist*)

> The riparian zone along the river is altered as soon as you channelize the river. You don't have the over-bank flows…that renew the riparian zone along the river. And that's habitat for wildlife of all kinds….If left natural it can actually help alleviate flooding problems downstream. So, a lot of the times, the channelization of the stream just creates more problems….[And] there's a loss of values in terms of recreationists being able to enjoy…a viable fishery. (*Yellowstone County Recreationalist*)

> [The river and the riparian areas are] less healthy for two reasons. One, there's been a lot of development taking place—I'm talking the entire river, not just around Billings. And [two, I see]…miles and miles of channelization of the river…that very seriously compromises the riparian zone. So, sure, it's gone down hill a lot in the last 30 years. (*Yellowstone County Recreationalist*)

Difficulties in getting permits are cited as a common, but not universal, problem:

> After the '96 and '97 floods, there [were]…multiple projects….The Corps approved some, didn't approve too many, but as the pressures build, we will have ourselves a canal instead of a river. There's a 404 permit process [and] sometimes it works, sometimes it doesn't. It depends on the Conservation District….They can, depending on who [sits on] the Conservation District board, be very rigorous….I think there ought to be some basic principles that have to be satisfied, and I think that those are conservation of the riparian zone, and conservation of the hydrologic character of the river. (*Yellowstone County Local Civic Leader*)

> I got along with them. They knew the emergency and so they rushed it through so we had it in a couple of days. They did not bitch about the emergency….It had to be done or else it was wrecked. So they allowed them to come in and fill where

> the hole was leaking…then the permit followed the deal. (*Yellowstone County Agriculturalist*)
>
> All he wanted to do was rip-rap to save his bridge….At one time, he had 20 guys standing down there on his bridge, discussing what he should do. Bridge finally washes out and down in the river it goes. The next day, to save the road, they are hauling big boulders, dumping them in…and, of course, in the spring he had to haul his bridge out. That's required….But, there you go. When you're dealing with water, you're dealing with a lot of different people. (*Yellowstone County Residentialist*)
>
> It took us two years to get it permitted to do it right….We lost 20 to 40 acres. Had we…done it without the permit, we'd have saved that land….We stood down on the river bank looking at the project after we did it…[and] DEQ guy was complaining about a couple of inches variation in elevation….Yet we looked across the river where they had dumped in car bodies and concrete without permits. I said, 'How can you give me a bad time about doing it right, but being off a few inches in elevation, when you can stand here and look across the river and not do anything about what everybody else is doing?'…If I've got a permit…he's going to make it miserable for me. (*Yellowstone County Residentialist*)

While alternatives to rip-rap may or may not work, Bendway weirs get mostly positive reviews:

> [Our neighbor] had a lot of problems with the dikes washing out. He laced willows on the face of the dike, but if there was a hole started, the river ate it out. (*Yellowstone County Agriculturalist*)
>
> We actually looked at using rip-rap. We used to do a lot of rip-rap work.…And it was just lining the bank…[to] keep the bank from eroding, but you don't…really do anything about that. The weirs…actually slow the water down next to the bank and you don't have to line the entire bank with rock or concrete….So it will fill back in with grass and trees….It looks much better when it's done and matures. And it is less expensive than lining the bank in its entirety. We just felt that was the best option. (*Yellowstone County Residentialist*)
>
> We put weirs in….[They were] incredibly successful….If it is done right, it works very, very well. We spend a lot of money and time and energy enhancing wildlife on a property like this that we are not compensated for. We do it because we like to….I spent hundreds of thousands of dollars doing the project we did on the river, doing the weirs the way we did it, engineered right. (*Yellowstone County Residentialist*)
>
> [Weirs] are a good idea. A guy…just put some in a while ago. They seem to be helping a lot….In some cases, [weirs are preferable to rip-rap]….[Now,] putting a

> weir in still causes an eddy behind it that I think would cause some erosion when the water gets that high.…You can see some kind of scalloped areas behind it. But it does push, helps push the current out away from the bank. (*Yellowstone County Residentialist*)
>
> Bendway weirs…[can] angle the river 20 degrees and they gently move it across to the other side….It's moving the river….You can just see how it hits the first one….Then it subtly moves it out to the second, third, fourth….My experience has been the weirs create habitat. There's more fish behind the weirs….The weirs…are a blessing that's not intrusive, creates growth, creates fisheries. (*Yellowstone County Residentialist*)
>
> We used Bendway weirs. I think we put in six of those….We have had very good success with the weirs except one….They simply keep the power of the water away from the bank. They don't wash out the side of the river. You don't ruin anything downstream, which is a common belief. They don't seem to be like the hard stuff where you throw the current to the other side. They are gentler….DNRC had some money a few years ago and they funded 75 percent of the weirs for the ditch company. (*Yellowstone County Agriculturalist*)
>
> The Yellowstone is so powerful that we get water behind the weirs and it washes behind them….The placement of the very first one is critical. If you don't get it right, it will wash behind it….That is the hard part….The person designing those spent an entire year on that…[and] the next spring the river washed away 20 feet of river, and we were back at square one….These were the most highly engineered weirs on the Yellowstone. They must have spent 200 hours on the planning, and they had two people on site watching the placement of every rock. So there couldn't have been any more scrutiny on a set of weirs. It is not an exact science, but they work most of the time. (*Yellowstone County Agriculturalist*)

It is often difficult to grasp how a project on a particular property can degrade the river system, especially given that virtually everyone agrees that any one project probably does not have a significant effect. However, governing agencies are, more earnestly than ever, attempting to understand the summative effect of such projects. They are charged with understanding those effects before they happen as a way of preventing future damage. The result is the future is here. The various agencies must attempt to manage in ways that protect the future of the resources before they are degraded, yet they are further charged with to avoid infringing on personal property rights.

The Future is Here: Management is Complex

While it is comforting to speak nostalgically about a simpler past, most of the people interviewed in the segment Big Horn River to Laurel explain that the Yellowstone River presents a complex tangle of pressures and demands that requires rather complex managerial strategies. The river, as a shared resource, is under increasing demand. Yet, many people realize it has a limited capacity, and it will not be able to provide all things to all people. Any number of entities—individual, governmental, formal, informal, public, and private—have vested interests in the river. Almost everyone agreed that the river is a public resource that must be shared:

> It is the lifeblood of the valley….It keeps a lot of farmers in water and able to grow crops and it's a good source of recreation….I have a boat that was made for river use; it's got a jet on it. And I'd rather boat any day on a river than on a lake. It's just so much more fun. It provides a lot of habitat for wildlife that is fun to watch and fun to hunt….Fish are fun to eat and catch. So it's a wonderful thing for this valley. (*Yellowstone County Residentialist*)

> It's got to be managed for multiple-use. I enjoy seeing the people on the river enjoying the river and the fishing and stuff. (*Yellowstone County Agriculturalist*)

> Of all the natural things that occur…[the river] is the most important thing. It provides water for drinking, flood irrigation, and recreation. It is the lifeblood of our community. (*Yellowstone County Local Civic Leader*)

> I hope we understand that the river is something that belongs to the people of Montana. Just because you own land along it, you can't really own the river. (*Yellowstone County Recreationalist*)

However, opinions vary greatly regarding the best ways to share the resources and to protect the public interests. For instance, private wells and septic systems generate discussions regarding how they affect, or do not affect, underground aquifers and the river:

> I wouldn't allow septic tanks….If they want to put in a subdivision of 30 cabins along the river, they would have to pipe that water, pump it back, away from the river, away from the river gravels, maybe to a pond and have their own septic system there. (*Yellowstone County Recreationalist*)

> [When] the high water comes, or you have an ice jam, or…the spring run-off [comes], you flood your septic tank or cesspool…[and] that material in that pool goes right into the river. There's a capacity for the Yellowstone….You can exceed that capacity, and then you have a real problem….We need those setbacks. (*Yellowstone County Recreationalist*)

> There's a lot of issues with subdivisions….Look at how we look at drain fields on the septic systems. You have places where the groundwater table and the septic system are mixing, but,…mathematically, it doesn't appear to be an issue. See, the problem is this subdivision may not be an issue, but what about [adding] the one above it? Now there's 72 houses above in this aquifer…but the assessment was done here [on one subdivision]….This is decided and this is decided [separately]. We never go like this [and look at all of the subdivisions together]. (*Yellowstone County Local Civic Leader*)

> These guys were here this morning…[concerning] a piece of private property out in Lockwood [near] the river. He received a permit to build a cold storage without a restroom. Now he comes back and says, 'You know I need a restroom.' We are denying it. He is into the flood plain, and his permit was clear. It identified that you're in a flood plain, and you cannot build a sanitary system there. The statutes don't allow that so he is not going to get a variance. (*Yellowstone County Local Civic Leader*)

> As that aquifer [west of Billings]…can only become more contaminated as more development sits on top of it…[and] the [irrigation] ditches are shut down because there's no agriculture anymore….If they are annexed they would have to get on the [city system]. So, there's a cost there. (*Yellowstone County Local Civic Leader*)

> What's the cumulative effect [of development] on the underground aquifers?...I don't think it is as big an impact as people are trying to make it to be….I think we have plenty of water. It snows like heck every time, and we [have] water coming down the Yellowstone….And if you read in Genesis, God set the whole thing up to where the river comes down, [and] evaporates, and the salt sea is almost a purifier….Now, that's a pretty good ventilation system that He developed. And that's here in Montana. Now we are running through some droughts, and you can get into global warming….But what I see in Montana is, we've got lots of water. We are not going to run out of water unless there is this global shift that changes things. (*Yellowstone County Local Civic Leader*)

Any number of topics comes up when the residents of Yellowstone County are asked about the management of the river. Agriculturalists discuss many issues, for instance:

> I own this property, and the State owns that river. I understand that and I am perfectly fine with it. I can't go out in that river and mess around, because that is the State's. So, I think the State should have to keep that river off of my property, too. If I can't mess with the river, why can the river mess with me? (*Yellowstone County Agriculturalist*)

> I am not a supporter of letting the river meander. Why must we destroy an acre of mature cottonwood trees that are 100 years old in order to provide areas for new ones? (*Yellowstone County Agriculturalist*)

> The most important resource that Montana has is the Yellowstone River, and we're giving it away to downstream interests. We should not be doing that. The Federal government should not be allowed to do that. (*Yellowstone County Agriculturalist*)

> The County came out here, and they told us all these things we needed to do [about the weeds,]…or they can come out and spray it and charge me money. I told them, 'You go up to the head of the Yellowstone River and you kill all the

> knapweed and spurge down to me, and then I will kill mine, and then you can go on down there. Until then, there's nothing we can do about it.' I can…show you every place that river has ever overflowed—it just spreads them weeds, and that is exactly where the knapweed and spurge is. (*Yellowstone County Agriculturalist*)

Local civic leaders have a number of concerns. To name a few:

> Obviously, you need to maintain in-stream flows….There needs to be flowing water to provide for those plants and animals…but there is typically more water than that. (*Yellowstone County Local Civic Leader*)

> Under the state constitution in Montana, you don't own water, you own the right to use water. And [the various users are] aligned by, 'First in line, first in right'.…A full listing [of users] and a full court decree [defines] who is first, and if they're first, how much water can they take. That's what a general stream adjudication is….In the end, if the court ever has to administer the waters of the stream, they have to have the list to do it correctly….But in the older basins history has shown that sometimes you have to [go to court] more than once because they never get it quite right. (*Yellowstone County Local Civic Leader*)

> There is much of the Yellowstone River from roughly Huntley east…that is in need of official flood plain mapping….Say a subdivision comes in that is near enough to a flood plain that…a 2,000 foot proximity to drainage area kicks in…If it does, then these [flood plain] stipulations enable one to determine the proper setbacks. (*Yellowstone County Local Civic Leader*)

> We have supported the Yellowstone River and Parks Association and looking at the trail process through Yellowstone County….We recognize the river greenway and how important it is. We are starting to see subdivisions pop up that are using that as selling points….We have Riverfront Park and have worked with the County Parks Association….Our whole trail project of trying to intertwine the city and the trails along the river….We may not have perfected it like Great Falls. (*Yellowstone County Local Civic Leader*)

> [Landowners] do not have the right to…do anything they want….[In one] situation, where [a fellow wanted] a subdivision,…[there was a] big petroglyph on the site…[and this] conservative planning board…[was] saying, 'The guy owns the land and he should be able to do what he wants with it.' Now, wait a minute….This is a cultural resource. It belongs to all of us….[We can] force this guy to do a cultural resource inventory, which would be really expensive….But, [he can also] register this site with the State Historical Society and…put a deed restriction on the lot. (*Yellowstone County Local Civic Leader*)

Recreationalists' concerns include topics such as:

> I think that we've been really lax in our state, county and city government. They've been allowing people to build too close to the river, and then the river rises in the spring, floods them out….Then, first thing you know, the people start rip-rapping and protecting the banks. (*Yellowstone County Recreationalist*)

> The pressures from industry, agriculture, and urban areas are not benign on the quality of the Yellowstone River. Also, we're beginning to channelize the river and drastically affect the biota, the quality of the water, the quality of the scenery, and the quality of the recreation potential. It has limited capacity to supply all of these things….It's over-adjudicated and it's under-regulated, but there's not a conservation strategy….There's a direct tie [between] how well we manage all these activities and the health of the river. (*Yellowstone County Recreationalist*)

> The private property lobby has tried half a dozen times to turn over our stream access law in both State and Federal court and [the lobby] lost every time. They're afraid of…the setback strips [and] controlling the kind of thing they do in the flood plain….They are worried…that [the river] is such an important public resource that there will be some kind of limitations on what they can do on their land. And there probably will be. (*Yellowstone County Recreationalist*)

> I really believe that every species has a place and…if you didn't have one species, it would hurt another species. So, it's very important to keep that…riparian zone….If you don't keep that, [a species] is going to die, or become extinct, and that's going to throw everything off. (*Yellowstone County Recreationalist*)

> The riparian area should all be restored. We have a lot of restoring on the river that needs to be done….[A natural corridor is] a natural habitat area. It does not mean [a] lawn right down to the river that is sprayed with pesticide to keep it green. It does not mean that. To me, [the riparian area] is a natural, protective thing. Maybe there could be bike trails and walking trails so people can enjoy that. Not storage and parking lots. (*Yellowstone County Recreationalist*)

> Public access is being squeezed….When people…pay tens of thousands of dollars for small acreages up against the river, they don't want a lot of company there. A lot of them don't like it honorary either. The tendency is, and will continue to be, to close off access….Landowners, who own 84 percent of [river access in Montana], say, 'We don't want to have you here. We bought this…for ourselves, and we don't want it where you can go through here.' (*Yellowstone County Recreationalist*)

> We have the tension between an urbanizing population and a rural philosophy legislature. And generally governmental bodies…lose opportunities for the parks and access….So the immediate problem is that you have this significant population influx, and subdivision development, and it's bumping into the rural

> philosophy of …‘Leave us alone. This is our land we can do with it what we want.’ So, that’s having an immediate effect. (*Yellowstone County Recreationalist*)

Residentialsts also discuss a great variety of management concerns:

> They change the rules. Like if we want to do something in the river, we have to go through six agencies to do all this crap. Laurel was having trouble getting water. They just take bulldozers and drop them in the water and do whatever the hell they want. If I did that I would have been fined quite seriously. So they don’t enforce the laws equally either that do exist. (*Yellowstone County Residentialist*)

> I just disagree with that whole concept of habitat management. I don’t think it needs managing. I think it needs maintenance….Managing the river itself… would sure be nice rather than spend money trying to figure out which way to make the river go. It would be really nice to get the dead stuff out of here, because it is…a fire hazard. (*Yellowstone County Residentialist*)

> I guess my biggest concern would be to lose any [boating] privileges that we currently have….If you get enough canoers and kayakers together to get the river to themselves, that would be a big deal to me. (*Yellowstone County Residentialist*)

> They need to choose areas [for public accesses] that you can really move up and down. It’s a waste of money to have them in the wrong spot.…Because the high water mark is right to the edge…[and you have] the concrete down there that’s really unsafe to walk on or you’ve got a 12-foot bank….You have to get up and over the high water mark to get around and that’s illegal. So if they did choose any kind of more accesses, they need to find the spot where they can actually get around a little bit. (*Yellowstone County Residentialist*)

Taken together the above examples suggest that the most difficult management task is to balance the rights of the private property owner against the need to protect public resources. Many people offer insightful comments that suggest ways to build a robust and palatable management approach:

> You have to have a benchmark….[Then] you can look and see if something is having a devastating effect or no real effect. This mapping is the first step. You can’t make these decisions without it….[We need to know] what are the cumulative effects, as opposed to…just hot air in the wind….You [need] a firm basis to make your decision. That way they can make intelligent decisions. That is the major role [for management]. Eventually they will be able to make decisions because they know what has happened and they will have evidence to support those decisions. (*Yellowstone County Agriculturalist*)

> You have to have a goal…[and you have to] see the pieces of the puzzle that you need to produce that goal. Then move forward. If you’re so hesitant to move

forward that people along the roadside are going to grab you and take you away from your goal, then chances are you have to step back and evaluate because maybe you don't really understand your goal. (*Yellowstone County Agriculturalist*)

We respect private property rights, but we also respect the fact that the river is going to flow where the river deems that it needs to go. And if you build homes in the floodway and the flood fringe, you are probably going to get wet. We saw that a few years ago….We watched Bill Keller's place, over in Custer, as the river chipped away…at the banks and then all of a sudden we watched the building fall right into the river. It is still a free-running river, the Yellowstone, and she has a mind of her own. You have to be respectful of that. You have to understand that we have many, many uses of the river, but we also have to know that if we are going to do subdivisions,…we need to make sure that people are safe and that they don't affect this river. (*Yellowstone County Local Civic Leader*)

Bureaucracy is a tool that you can either use to your advantage or disadvantage. The fellow that [complains] probably doesn't realize the benefit he's getting from these layers of bureaucracy. (*Yellowstone County Local Civic Leader*)

[I heard it] said our society has a bundle of sticks and society…controls those sticks. They issue them out one at a time to private landowners, and they can take them back to depending on the situation. I think most of us don't want to do away with private property. We all live, or were raised, on private property, for heaven's sake….But there comes a time when private property might be impacting [the] public resources of our society….There has always been some limitations….As an example, you can't sell your topsoil to the Saudi Arabians…But that doesn't mean that's the end of private property. It means that society is going to take back a few sticks. (*Yellowstone County Recreationalist*)

If you look back at the history of the United States, the public land and the public water have been enormously important. Our champions are people like Theodore Roosevelt and the national forest, the national park, the national wildlife refuge, the national monuments. All of those are part of the public estate, and we think the public estate is very, very important to our society—equally as important as private property….Our position is, what's private is private, but what's public is public and it should be treated with the same level of respect....You can't have private water where the Constitution says it's public, anymore than you can have public water if the Constitution said it was private. And we don't just sue every time we turn around. We talk to people. We try to convince them it's wrong, that they shouldn't do it, but we have a hammer and we'll use it. (*Yellowstone County Recreationalist*)

I really think that the authorities should be more flexible in allowing landowners to protect their property. It's such a hassle to go through all the steps it takes to put rip-rap on your property.…There has been hundreds and hundreds of acres

> lost here….I feel for the larger landowners that have a lot of river frontage that lose a lot of property every year and really can't do too much about it. (*Yellowstone County Residentialist*)
>
> Make a comprehensive plan as to what is allowable and a process to permit it with ease, rather than fighting every step of the way.…You get it so difficult, people just say, 'It's not worth the energy [to get the permit.] We'll do it anyway,...[even] if they put us in jail.' And I can't blame those people. (*Yellowstone County Residentialist*)

Any number of other conversations can be found within and across the four interest group analyses included in the next sections of this report. This summary addressed only the three dominant themes in hopes that the readers would be encouraged to further delve into the details of each interest groups' concerns.

Big Horn River to Laurel: Agricultural Interest Group Overview

Sixteen interviews were conducted with individuals representing agricultural interests, including farmers and ranchers. Participants were recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of Natural Resources Conservation Service.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Big Horn River to Laurel: Agricultural Interest Group Analysis

I. Specifics of an Agricultural Perspective

A. Lifestyle and Way-of-Life

It's peaceful. It is just someplace that we have always wanted to be. We both were raised on acreage. We weren't town-oriented at all. (*Yellowstone County Agriculturalist*)

We're out in the country. We have a view of the mountains. The neighbors aren't that close. We have a little open space to breathe. (*Yellowstone County Agriculturalist*)

Everybody's got to be somewhere. I like where I'm at….It's secluded, [yet] it's not a long ways to get somewhere either. I've had some people tell me they couldn't live there because they'd just sit on the porch and watch the river go by. (*Yellowstone County Agriculturalist*)

You have wildlife that swim the river. There's even whitetail hunting right down in here if a person chose to do that. There's pheasants, prairie chickens, a lot of wildlife, badgers, coyotes. (*Yellowstone County Agriculturalist*)

Mink, otter, we have all kinds of squirrels, rock chucks, yellow-bellied marmots. There are quite a few bull snakes. We used to have rattlesnakes. Two years ago we had one, but we don't have many….We never kill a bull snake. They eat a lot of mice. I saw one the other day that was as big as my arm and six or seven feet long. I stepped on a bull snake one evening in the grain field and I must have went about 20 feet in the air. (*Yellowstone County Agriculturalist*)

It is a place to live, I guess. The old homestead. We are not like the people that move every two or three years and change jobs. We are different. A lot of country people are that way—they stay in one spot. (*Yellowstone County Agriculturalist*)

I was supposed to retire this year and I ended up irrigating and putting up 4,500 bales by myself. That is hard work. The neighbor was supposed to take over the hay…and he let me know too late that he couldn't. If you stay on the place, there is always something to do. (*Yellowstone County Agriculturalist*)

We love this property. My wife and I have lived here since 1941. We raised our children here. Three of our four children are college-educated. My wife has never lived anywhere but here, and she tells me, 'I have lived here all my life and I am going to die here.' I've told her, 'I hope that we still own it.' It's getting harder and harder to make ends meet. Machinery costs are prohibitive, our property taxes are atrocious, and our property insurance is out of this world. (*Yellowstone County Agriculturalist*)

Since the fuel prices went up…the people that are in cattle, stay in cattle. They're not switching around. (*Yellowstone County Agriculturalist*)

Want to buy it? Write me a check, I'm gone. I can't afford to leave. (*Yellowstone County Agriculturalist*)

We've just been here for so long. We own it, but somebody else is going to have it someday, and I want to leave it in as good a shape as it was when I got here, if not better. We're real careful that we don't waste a lot of water. (*Yellowstone County Agriculturalist*)

I think it was a good place to raise a family. We have a lot of history here. (*Yellowstone County Agriculturalist*)

Farming is a full-time job. (*Yellowstone County Agriculturalist*)

I guess I'll stay here until the river comes up to the porch. (*Yellowstone County Agriculturalist*)

B. Land Should be Productive

It is a very productive area, producing excellent crops on land irrigated out of the Yellowstone River. If it wasn't for the Yellowstone River, there wouldn't be anything here but desert. (*Yellowstone County Agriculturalist*)

Some of the land we leveled ourselves. We have two scrapers and we leveled quite a bit of the land ourselves. By leveling the land and making the irrigation more efficient, it accomplished two things: the land became more productive and we were able to use much less water. (*Yellowstone County Agriculturalist*)

The upper part I leveled and made a field. It is pretty good productive land. (*Yellowstone County Agriculturalist*)

The gravel that the river washes out of its banks ends up in big gravel bars and islands…that are not productive for anything except for noxious weeds. (*Yellowstone County Agriculturalist*)

Without water you couldn't raise anything. Especially on top. There is so much gravel. That is called cactus flats because that was all that grew. Any moisture just went down in the gravel.…You have to use fertilizer. The nutrients do wear out and are used up. On dry land, where you don't have the moisture and don't produce a heavy crop, they last a lot longer. (*Yellowstone County Agriculturalist*)

Down around Columbus, you start getting into row crops, and corn, and beets, and into a lot more expensive land—a lot more productive land….We've got to protect some of that. Urban sprawl is taking that out. (*Yellowstone County Agriculturalist*)

I thought this farm would be a good place for a subdivision when I retired. I looked for three years for that kind of place. (*Yellowstone County Agriculturalist*)

C. Rural Ideals

I own this property, and the State owns that river. I understand that and I am perfectly fine with it. I can't go out in that river and mess around, because that is the State's. So, I think the State should have to keep that river off of my property, too. If I can't mess with the river, why can the river mess with me? (*Yellowstone County Agriculturalist*)

The biggest problem that I think is going to be faced on the Yellowstone is ignorance of the natural process, and bad practices. They blame everything on the farmer and rancher. Well, there aren't many left….Those guys [still farming] are getting old, and they're selling off. (*Yellowstone County Agriculturalist*)

Farmers are stewards of the land. And until the recreationists become the same stewards, you're going to have problems. The folks in the Greater Yellowstone Coalition, they're not stewards of the land. They don't have any idea what it is to manage that land. (*Yellowstone County Agriculturalist*)

Unless you're raised around livestock, you don't know what you're dealing with. City people are not well educated in hazards. They'll go out and think it's a pretty-looking buffalo in Yellowstone [Park] and get gored….Those are city folk that don't understand that cows and horses and bulls can take exception every now and then from being totally docile. I don't care how fast you are, if a bull's coming at you short distance, he's going to outrun you and then he's going to hurt you big time….An OSHA manual came out in the '60s, [and] the title of it was 'Livestock are Dangerous.' That is true. (*Yellowstone County Agriculturalist*)

There are too many people [who] are too far away from having a little dirt under their fingers from working the soil, and they just don't understand exactly what all of it is. (*Yellowstone County Agriculturalist*)

D. Individual Rights are Important

You've got to allow the owner of the land to do what is in his best interest and the land's best interest. And if you start stepping on that, then you're violating their property rights and their personal rights, and that isn't quite what this country was founded on. (*Yellowstone County Agriculturalist*)

It amazes me the number of people that are not connected to the land and that have no respect for private property issues. (*Yellowstone County Agriculturalist*)

II. Agricultural Descriptions of the River

A. The Yellowstone is Evolving

This river is still evolving. It will evolve for the next 1,000 years. And there will be changes in the river and sedimentation—every time a chunk of bank falls into the river it creates mud. (*Yellowstone County Agriculturalist*)

When we were kids we ice skated on the main channel. It was three-feet thick. My grandfather marked a road on the ice from Huntley to Billings. All of the homesteaders drove to Billings on the river. (*Yellowstone County Agriculturalist*)

Years ago, the Clarks Fork used to run into the Yellowstone right here….Now, the Clarks Fork enters up there by Clark's Camp….If you get real old maps you can see that the channel was right over here….The river is slowly cutting this way, and I guess in another 1,000 years it will cut back that way….You can just look across [at] the old growth timber, the big trees way back and then the young growth out here in the front. (*Yellowstone County Agriculturalist*)

B. Ambivalent Sentiments about the River's Character

Montana is the number one watershed area on the North American continent—number one….A good share of [Montana water] comes down this Yellowstone River. A lot of it will go west into the Snake River. A lot of it will go to Three Forks and will go the other way into the Missouri. But it's all Montana water. (*Yellowstone County Agriculturalist*)

This Yellowstone is a mean, mean river during flood time. I live right on it. I know all about it. It's mean. It runs fast and it runs deep. (*Yellowstone County Agriculturalist*)

It's a floating garbage pit….It washes away the land, and it washes away the trees….There's all kinds of decaying trees in the water. Does that do anything for clean water? (*Yellowstone County Agriculturalist*)

It is a beautiful river to take your family out on. It can be a great experience. (*Yellowstone County Agriculturalist*)

I think the attitudes of people have changed from [the river] being a garbage dump to more of recreation or beauty. [The change] has taken place gradually over the years. Hopefully it will stay that way. (*Yellowstone County Agriculturalist*)

C. Comments on Free-Flowing

People have more respect for the river. Everyone knows that the Yellowstone is the last free-flowing river in the United States. They could have dammed it and made a big lake and then irrigate out of it. (*Yellowstone County Agriculturalist*)

I know they want the Yellowstone River to be a wild and free-flowing river, and in some areas, it is. But wherever we've had to put in rip-rap material, or bank stabilization, or what-not, it really isn't anymore.…It really isn't wild and free-flowing….People have to protect their property, their homes. (*Yellowstone County Agriculturalist*)

I'm no longer in favor of the free-flowing river. You can have a free-flowing river, but you've got to protect some of the assets. One of the assets is this irrigation ditch that waters a lot of farmland in Yellowstone County….I think we've swung too far on the pendulum [toward] the free-flowing river. You can still have a free-flowing river, but protect some of the assets that have been there, like this irrigation ditch [that has been here] since 1890. (*Yellowstone County Agriculturalist*)

You also have a lot of trouble with this river during high water. There's lots of erosion and there's lots of flooding. And, as you're aware, it's the only undammed river on the North American continent. That I don't like. (*Yellowstone County Agriculturalist*)

I understand that the Yellowstone River is the longest free-flowing river in America, and I used to think that was a great deal until I lived on it. Now I don't. (*Yellowstone County Agriculturalist*)

You have to look at it as a free-flowing river, because it's one of the few left. (*Yellowstone County Agriculturalist*)

Of course, the Yellowstone is the last free-flowing river. And it has to stay that way. (*Yellowstone County Agriculturalist*)

D. The River Goes Where it Wants to Go

We tried to change the channel…[but] once the river has made its mind up, it don't make any difference how much limestone you put in there. It's going to go where it wants to go. (*Yellowstone County Agriculturalist*)

The time that the river changed course drastically, and started moving into our property, it was just horrific….There was a big island out there, and it was full of trees….You would hear the trees….It sounded just like bowling pins going down….It literally lifted those trees every which way out into the river….It was just unbelievable. [Then, the fallen trees were] knitted and packed with mud just like somebody had created it by hand, but it was just the force of nature….[The fallen trees] diverted the water,…which brought it into our place.….It just basically changed overnight. (*Yellowstone County Agriculturalist*)

People want to live where it's pretty, but if you're going to build on the river, expect to be flooded. And don't cry to me when you're flooded because, if you're stupid enough to build there, then it's your problem, not mine. (*Yellowstone County Agriculturalist*)

If you ever notice, farmers and ranchers don't have their houses right on the banks of the river. Gosh, I wonder why. But you see the city folk [saying], 'Oh, that's a great place to build, great view. Boy, we can walk out the back door and throw the fishing line in the river; that's fantastic. We can put our jet ski out on the river right out our back door….Oh, my God, now the back door is the front door, the river has changed channels.' I'm not going to cry for those people. Common sense says you don't build in a hazard area. (*Yellowstone County Agriculturalist*)

The '97 flood forced us to become more flexible. Our present day intake, where we have it now, is on the south side of the river and [before] it was on the north side. (*Yellowstone County Agriculturalist*)

The river is constantly changing. The river moves from side-to-side one time or another. (*Yellowstone County Agriculturalist*)

The river moves north and south. [Since we've lived here,] it's moved north….It's washed out 30 acres of our land. What we used to have, we no longer have—it's under the water. Fifty years from now it could move back south and we could regain it….In fact, it's endangering the canal down there that's been there since 1890. (*Yellowstone County Agriculturalist*)

That farm right next to me….I've seen that under six feet of water twice in one year. The big hay bales were floating. Once was at Christmas time, due to an ice jam. A lot of times it will freeze up early then it will break out around Christmas. We got a warm spell and [the water] went right through the house. (*Yellowstone County Agriculturalist*)

We sat up one night during a rainstorm and heard the river take one of these 60-foot cottonwood trees…..Just CRACK, and KAPLOOSH, and the whole thing went, roots on one end and leaves on the other. If it can do that much damage to these trees,…I don't foresee anything left of this place eventually. (*Yellowstone County Agriculturalist*)

[Our neighbor] had a lot of problems with the dikes washing out. He laced willows on the face of the dike, but if there was a hole started, the river ate it out. (*Yellowstone County Agriculturalist*)

If we don't get some stabilization on that bank, this place, in ten years, is going to be in trouble, and so is everybody else in this valley if this river gets high enough. We've had two neighbors down there that it flooded already. (*Yellowstone County Agriculturalist*)

The loss of agriculture land [due to flooding]…may be critical….You may be out of business, [especially] if you're renting. (*Yellowstone County Agriculturalist*)

III. Controlling the River with Rip-rap

A. Rip-rap Seems to Work in Some Places

I lost eight acres on the one field, but it was also endangering the railroad [so] they came in and rocked it….Yeah, it worked. It was spendy, but it worked. (*Yellowstone County Agriculturalist*)

It worked. The place is still there. The river has changed and actually it has gained because the river went back north. So, I guess [the rip-rap] was a worthwhile project for us. (*Yellowstone County Agriculturalist*)

It should have been rip-rapped many years ago, when I first moved on that place. If I had known then what I know today, I would have rip-rapped. (*Yellowstone County Agriculturalist*)

In '97 we had the highest flood on record….[It] was a 500-year flood....[The] REA was afraid it was going to…flood their new unit….They rip-rapped it perfect [for] a half mile…and there has not been one piece go out of place. There's always a hole or something that may have been done better originally, but if you throw…rip-rap [in the hole] it just makes it better….To do it right, you want [there] to be about 16-foot width at the base, so you have a big strong base for the other to lock with, and then bring it up to about a three-foot width at the top….The weight crushes it down….You've got the dirt walls behind it that are packed and it doesn't seep very well. (*Yellowstone County Agriculturalist*)

Years ago, we did a lot of rock work and that is the only thing that has saved half of the farm. (*Yellowstone County Agriculturalist*)

Farmers and ranchers protect their soil. It takes too long to regenerate an inch of soil to have it wash down the river. In this part of the country, 100 years will build an inch, and, depending on where it's at, it may take 500 years. (*Yellowstone County Agriculturalist*)

The easy thing can be done, but [it's] not allowed to by the Corps of Engineers. You could put in rip-rap, and you could reinforce the banks. They do this world-wide. (*Yellowstone County Agriculturalist*)

B. Rip-rap and the Potential for Shifting the Problem Elsewhere

Rip-rap diverts water into the neighbors' land if you don't do it right. That is something you have to be concerned about. You could subject yourself to a lawsuit. That is something the Corps and the local Conservation District should look at. (*Yellowstone County Agriculturalist*)

Water finds its own level, as you're well aware, and that's what the Yellowstone will do. If you stop it from meandering [in one] place, it's going to meander someplace else. (*Yellowstone County Agriculturalist*)

You…[have to] watch out. If you are rip-rapping on the south side, and somebody's got farm land on the north side, that can create some problems….We were very fortunate because there was no effect to people to the sides of us or across from us….We had no one but ourselves to protect. In fact,…the river was affecting [the neighbor] tremendously, [and]…when we got done, it turned the river away from their property. They now feel safe and secure. (*Yellowstone County Agriculturalist*)

Weirs change the current so that maybe the flow…shoots [across] and starts chewing on [the bank] over there….People might be upset if they don't have rip-rap to protect them. (*Yellowstone County Agriculturalist*)

C. Rip-rap and Difficulties Getting Permits

Often times, before you can get your permit, the damage has been done….All these various approvals…take from three months…to six months, maybe. But the damage is done and over before you can get [the permit]. (*Yellowstone County Agriculturalist*)

I got along with them. They knew the emergency and so they rushed it through so we had it in a couple of days. They did not bitch about the emergency….It had to be done or else it was wrecked. So they allowed them to come in and fill where the hole was leaking…then the permit followed the deal. (*Yellowstone County Agriculturalist*)

The permitting process is difficult and what they require you to do is costly. (*Yellowstone County Agriculturalist*)

I can't do anything now because of the permit system. (*Yellowstone County Agriculturalist*)

I think we ought to reinforce the banks….[Erosion is] endangering the canal that feeds the sugar beet, barley and corn farm area of Yellowstone Valley….You lose that canal system, you have no food. And yet we can't do anything to it. The ditch company couldn't even get permission from the Corps of Engineers to protect the ditch, something that's been there since 1890….They spent over $100,000 trying to protect the ditch, but they can't get permits, can't get in the water, can't do rip-rap, and can't protect it….They used to allow rip-rap on the river, but they've made a decision in the last several years not to do that, so they don't allow anybody to do it. You can't even protect it in Billings. (*Yellowstone County Agriculturalist*)

I think many landowners just don't have the patience, number one, to go through the process. (*Yellowstone County Agriculturalist*)

I have lived here long enough to know that the banks can be stabilized…without bankrupting you. But you can't follow all these stupid regulations….The bulk of our population is so interested in recreation that they overlook the fact that…the river is a resource. It's a resource that should be managed and should be protected. It should not be left to the wiles of flooding and high water. But I don't think [the regulations] will change….There are more of them than there are of us. (*Yellowstone County Agriculturalist*)

I don't expect them to let me put [the dike] out in the river again. I just want to stabilize the bank so that if the water comes over it, it won't cut it away….See, the real bad part about it [is that] the top three foot of this ground is just sand, and as soon as that water hits it, it just sloughs off into the river, and just keeps sloughing off….I don't care if it runs over. We can put up with it running over once a year, you know. But I just don't want it to take any more of my yard. (*Yellowstone County Agriculturalist*)

We didn't have too much trouble with the permits. They went pretty good. Not saying we didn't have little problems once in awhile. Just misunderstandings. We get along pretty good. The only thing was I couldn't get any money to help. To [rip-rap] is awful expensive. (*Yellowstone County Agriculturalist*)

I want to give the Yellowstone County Conservation District credit because I think, by in large, they are very reasonable. It's just that in many cases they are reluctant to have you do anything to the river. (*Yellowstone County Agriculturalist*)

D. Rip-rap is Costly and Few Can Afford it at an Effective Scale

I've put a lot of money into rip-rap…three-eighths of a mile,…[which is] half of my retirement fund….I think it is almost cost prohibitive now….I guess over the years I've put a $100,000 to $200,000 into it. That was when money was worth more than it is now. (*Yellowstone County Agriculturalist*)

The neighbors were wanting to do some rip-rap….At that time, land was only worth $1,000 an acre, so we told them to let the river take it. The very next year, it switched, and we haven't had any trouble since. (*Yellowstone County Agriculturalist*)

I was told, 'We can't approve the using of concrete rubble.' I asked, 'Why not?' I have traveled quite a bit…and I have never been to a city on the Yellowstone where there hasn't been bank stabilization done with concrete rubble….To do what he was proposing you could easily spend a million and a half dollars. You reach a point and ask, 'Is the land worth saving?' (*Yellowstone County Agriculturalist*)

Agencies say the rip-rapping isn't worth the investment. But once a piece of productive land is gone, there's no revenue from it. It isn't just the revenue the farmer [lost]….[Farming] supports a lot of businesses in the community….It's a hard thing to figure. The land might have been worth $1,500 to $2,000 an acre…but when you figure the production over ten, 15, 20 years, it grosses a lot….And it takes hundreds of years to get it back. (*Yellowstone County Agriculturalist*)

We've got the technology to do damn near whatever we want to do; it's whether [or not] we can economically do it. (*Yellowstone County Agriculturalist*)

We've got wasted cement everywhere….We should have it coordinated to where they could take it to a site, dump it on the bank, and, with a backhoe,…get it right. It …would be helping the whole community. (*Yellowstone County Agriculturalist*)

We can get rip-rap for nothing….People are glad to get rid of it because they have to pay to take it to the dump. Whenever [my husband] sees a new project going on…he'll stop and tell them they can come out and dump it here….But we don't put anything in the water that has any steel rebar in it. Absolutely not….That's just plumb outta the question because people come by here in a rubber raft. A three-quarter-inch piece of rebar sticking up—what do you think that would do to a rubber raft? (*Yellowstone County Agriculturalist*)

E. Alternatives to Rip-rap

[I heard about] a new idea and in some places it really works. What they do is build a rock weir on an angle out into the river. The Canyon Creek Irrigation District has put some of those in, and they work very well. (*Yellowstone County Agriculturalist*)

We used Bendway weirs. I think we put in six of those….We have had very good success with the weirs except one… They simply keep the power of the water away from the bank. They don't wash out the side of the river. You don't ruin anything downstream, which is a common belief. They don't seem to be like the hard stuff where you throw the current to the other side. They are gentler….DNRC had some money a few years ago and they funded 75 percent of the weirs for the ditch company. (*Yellowstone County Agriculturalist*)

The Yellowstone is so powerful that we get water behind the weirs and it washes behind them….The placement of the very first one is critical. If you don't get it right, it will wash behind it….That is the hard part….The person designing those spent an entire year on that…[and] the next spring the river washed away 20 feet of river, and we were back at square one….These were the most highly engineered weirs on the Yellowstone. They must have spent 200 hours on the planning, and they had two people on site watching the placement of every rock. So there couldn't have been any more scrutiny on a set of weirs. It is not an exact science, but they work most of the time. (*Yellowstone County Agriculturalist*)

A real easy way to stabilize this river, that would benefit everybody, would be to go to Columbus, put a dredge in it and dredge the river [to] about 12 to 15 feet deep…. Haul that rock out and use that rock in road building, use it in cement, or whatever. Dredge it from Columbus to Huntley. They wouldn't have any problem in this river. It just has to be deeper. It's just got to be deeper, and it would make an excellent fishery for recreation. (*Yellowstone County Agriculturalist*)

F. Rip-rap and the Question of Fish

[Rip-rap] can ruin the fishing habitat. That is the biggest thing. If you have a rip-rapped bank on both sides of the river, there is no place for fish to hide. (*Yellowstone County Agriculturalist*)

G. Rip-rap and the Question of Aesthetics

The rip-rap is unsightly, and, [when] they dump rebar…it is dangerous for the animals. (*Yellowstone County Agriculturalist*)

Rip-rap is an eyesore and takes a tremendous amount of material. And most people can't afford it. (*Yellowstone County Agriculturalist*)

Well, they've tried auto bodies and they're ugly and don't work. (*Yellowstone County Agriculturalist*)

IV. Sharing the River

A. Plenty (?) of Water

If it wasn't for the Yellowstone River the City of Billings wouldn't exist. And one of the things I think that all of us ought to be concerned about is that, with the terrific growth in population that we have, water is going to become a very valuable commodity. We have lots of water, but we make very little effort, if any, to store it. (*Yellowstone County Agriculturalist*)

I think it is too bad we can't divert it somehow, the high water, and put it to use. Once it leaves this state, it is gone. I think we could develop more agriculture if we had some diversion. I'm not sure how'd you do it. Maybe it would take a dam and that would be pretty hard to do anymore. (*Yellowstone County Agriculturalist*)

If we were without the river we would have nothing….We've got to get our irrigating water from the Yellowstone….Most of it is flood irrigation. We don't have any sprinklers….The operation is all we can handle. (*Yellowstone County Agriculturalist*)

I think there will always be plenty of water in the Yellowstone until late in the fall. There will be some shortages that show up in the fall, for irrigation mainly. The river gets so low then that people have to pump and that is expensive. I don't think they will ever put a dam on the Yellowstone. I think there is too much public pressure. The only thing is, if they could divert some of the high water, and use it when the river is low. I don't know anybody that is in favor of a dam. (*Yellowstone County Agriculturalist*)

The canal always is filled to capacity at Laurel. There is always competition. The City of Billings wants water. A lot of ranchers would like to pump [water] up to the dry land and put pivots on. There is always competition but the canal has only so much capacity. (*Yellowstone County Agriculturalist*)

Twenty-five or 30 years ago, a man named Cristafulli spent his own money…and [designed a project for]…pulling water out of the Yellowstone at the high-water time, which would alleviate all this flooding downstream….[A canal would take water out] just this side of Livingston, Montana, it would go down the slopes of the Rockies, and the canal would empty it back into the Yellowstone near Glendive, Montana. There were nine reservoirs that would be filled during high-water time that would put some nine million additional acres under irrigation in Montana….Think of the tax base that would have added to our state, not to mention the recreation and the fishing and the funning that nine big reservoirs would afford everyone….But, no sir-ee. [The Feds] said, 'You don't touch the Yellowstone waters.' (*Yellowstone County Agriculturalist*)

We applied for some reserve water….The way I understand it…[the State] would like to get the water out on land because otherwise it will be claimed downstream in other states. (*Yellowstone County Agriculturalist*)

B. Development

The way Billings is growing, the irrigated farm land is vanishing. I even noticed it in the Worden area. (*Yellowstone County Agriculturalist*)

I think between Billings and Laurel it is going to be pretty well filled in. (*Yellowstone County Agriculturalist*)

It has changed. One of these days, you're going to see a lot of houses out here. (*Yellowstone County Agriculturalist*)

In the last ten years we have four times as many families. There is less irrigation and more subdivision. There is less farming. You get 160 acres and divide it up into five-acre plots and put a horse on each plot….Subdivisions have to be approved by the County Commissioners. (*Yellowstone County Agriculturalist*)

The place right next to me sold to a doctor in Billings. He bought up the land, inflated the prices…[and now a farmer] can't buy land….The outlook hasn't been real good on farming for the last few years….The land is too expensive, and the cost is too high to try to farm. (*Yellowstone County Agriculturalist*)

East of Billings you're not going to see major changes because agriculture is still king. There isn't going to be huge development. There will be some…out by Pompey's Pillar, if it's not all burned up,….[and] some development along the river [in] Park City….[In] Columbus [and] down this way, you're probably going to see…the smaller acreage type of things happening, which is going to take out some productive cropland, and some of it isn't. (*Yellowstone County Agriculturalist*)

For farmland, we could pay $1,800 an acre, but they are getting $18,000 an acre for that stuff. I don't see us continuing to farm in the next generation….Maybe another 20 years, and then it will all go to houses. (*Yellowstone County Agriculturalist*)

Eventually it will be for real estate rather than farming. I only have 500 acres. (*Yellowstone County Agriculturalist*)

All of the ground that you see between Laurel and Billings is dotted with development. Between Laurel and Park City, and Park City to Columbus, it's the same thing….I think in 30 years,…when you come off the Columbus hill, it's going to be all developed, probably to Custer. (*Yellowstone County Agriculturalist*)

When they subdivide the irrigated land, I would like to see the taxes on that land go to pay…to put water on something else. If we have to pump water 20 miles up to the dry land, the cost of that should be attached to the land that has been destroyed [for] a house….How would you do that? Politically, it is unsound. (*Yellowstone County Agriculturalist*)

C. Corridor Might Limit Development, Might Violate Rights

[A corridor is]…where…we aren't going to have any development along the river…[and] keep housing and development out of it. I assume is what they're talking about. That sounds fine. (*Yellowstone County Agriculturalist*)

As I understand it, they want to take land from the landowners along the river and make this river corridor. Let's say they have a corridor of a quarter-of-a-mile wide. That would take a good share of our productive land. I object to that. That's how we make our living. Then let's say the river continues in its wild, untamed fashion and it washes into that corridor….They'll want another quarter-of-a-mile. (*Yellowstone County Agriculturalist*)

We all recognize and value the river, and we all recognize the flood zone area. You're never going to put houses in there….It's only going to be good for cattle grazing or horses, or something like that, and if you end up having horse trails through there, or bicycle paths, no big deal….You could make out some kind of compromise so it could be a win-win for the farmers and ranchers and for the city people. (*Yellowstone County Agriculturalist*)

D. Conservation Easements Can Protect Land from Development

I did this Nature Conservancy thing to protect the land so it could never be developed….My kids would sell it, and there would be all houses built. We don't want that. There is enough of that around here. There is so much traffic. They drive too fast. They almost ruined my second cutting last year because it was so dusty. (*Yellowstone County Agriculturalist*)

We actually looked into creating a river corridor here. We were going to have three miles of riverfront in conservation easement. We had our two neighbors and myself, and between us, depending on how much land they put in, we could have had as much as five miles. Three miles would have been easy to do. And we had the Feds and State both out here several winters ago talking to us over a couple of months. It was a terrible worthless deal that none of us wanted. We were all excited and interested about doing it, [but] the way they put that program together, I don't know why anybody would do it….The tax break is not significant. (*Yellowstone County Agriculturalist*)

With conservation easements I think that either people are afraid that the government is going to do something with the land or they don't trust the people that are issuing the easement. But I think it is a good thing because it protects the land. (*Yellowstone County Agriculturalist*)

They don't give you a break on taxes because it is an easement….I talked to the tax department quite a few years ago and there is no tax advantage. I thought there wouldn't be. (*Yellowstone County Agriculturalist*)

E. Abiding by the "Old School" Rules of Accommodation

You can go to a Montana farmer and rancher, not to the New York boys or the Californians that have bought [land], but go to a Montana farmer or rancher, and you ask permission to go hunting or fishing, and nine times out of ten you're going to get that authorization. (*Yellowstone County Agriculturalist*)

I've been pretty generous with fishermen. All I require is they close the gates and they pick up their trash. If they don't, I throw them out. (*Yellowstone County Agriculturalist*)

We wave and….the dogs go out and bark and greet them. Once in awhile you get some idiots that are all tanked up with beer…and all I ever [ask] is, 'Please, don't tease them'….We haven't had any problem with them. Most of them just wave. (*Yellowstone County Agriculturalist*)

If you want to know where the high water mark is, it's obvious. Yes, it's very obvious. (*Yellowstone County Agriculturalist*)

F. Access and Abuses

Laws keep law-abiding citizens honest. Locks keep law-abiding citizens honest. I don't know what it's going to take.…Providing more access to the river may do some good, but it's doubtful. (*Yellowstone County Agriculturalist*)

I do allow hunters in. Last year it wasn't bad, but [now] I have people call and book a hunt. They were taking about 25 [deer] a year. I think last year they only took about 15….We don't allow any bird hunting. My wife likes the ducks. They raise their young down by the barn in the ditch. (*Yellowstone County Agriculturalist*)

We have pickups that come in from the access up the river, and they drive out through our place…to find a way back to the highway. That gets real old. (*Yellowstone County Agriculturalist*)

A lot of people resent people crossing their land to get to the river. [The State or the County is] going to have to have public access to the river….The problem, now, is [the public] can gain access by boating and…[then] they go on private land. That is the biggest thing I think that is going to come up. (*Yellowstone County Agriculturalist*)

We've had gates left open, cattle and sheep in everybody else's country, trees cut down and campfires on the river shore. (*Yellowstone County Agriculturalist*)

We get people in inner tubes coming down here in May and June. I wouldn't be out there in a boat in May or June….If [only] they saw the trees underneath the water, where they could catch a foot in a 'Y' and just get pulled down. And they'd never get up to breathe. They ought to go out there in August when the river is low and see how many trees they could get caught in. (*Yellowstone County Agriculturalist*)

We go down there and pick up beer cans and stuff from people having beer parties, or whatever. I accept the trash is just a part of the deal. (*Yellowstone County Agriculturalist*)

There are more thieves that come down the river. It is like a highway. My father-in-law had his boat pulled up, and they came along and stole it. You can't leave any equipment along the river. [One man] left his backhoe down there and they stole the copper and broke all the windows. You hear boats every day. You don't have the privacy like you used to. A lot of hunters will come and hunt on the islands. They will hunt on your property too. I think it is bad, [but] because the river belongs to the State, we have no say along the river. (*Yellowstone County Agriculturalist*)

V. Other Difficulties and Concerns

A. Exotic Invasive Plants—Noxious Weeds

The number one problem with the river is weeds. We have more each spring when it floods. (*Yellowstone County Agriculturalist*)

After the flood, we also ended up with a noxious weed problem that you can't believe. We had leafy spurge and knapweed, and we have salt cedar growing on the gravel bars in the river….Where the river channel had been before, it is now a huge gravel bar, a big island….There is so much salt cedar down there. When that stuff is in bloom that island was pink with blooms. (*Yellowstone County Agriculturalist*)

We have knapweed and leafy spurge, and we have more each spring when it floods. We spray and spray, but every time it floods…we have more leafy spurge and more knapweed. (*Yellowstone County Agriculturalist*)

I don't graze it because [the animals would] pick it up and we would have it all over the place. There are hundreds of deer down, and they are bad enough. They spread hound's tongue and they like Russian olives. (*Yellowstone County Agriculturalist*)

It is a constant battle with the weeds….[When] cattle season comes, the [trucks] come down the roads with loads of cattle, and they dump their crap….The rains wash it off the road and it stays there. Then, the next spring, they hire the college kids to kill the same weeds that the bull-haulers just hauled in and planted for you….It's ridiculous. It's stupid. What they could do with those bull-haulers is to make it a $1,000 fine….When I was a kid growing up, it was illegal to ship wet cattle. You had to dry-lot your cattle 24 hours before you could ship them. (*Yellowstone County Agriculturalist*)

I work really hard at taking care of weeds. And you look in the city parks and they are full of white tops….Give us a break. (*Yellowstone County Agriculturalist*)

The disadvantage to flooding is the Russian olive, which is ruining the river valley….The only thing they're good for is a toothpick if you need one. (*Yellowstone County Agriculturalist*)

We could turn the Yellowstone into the ugliest river in the world if the weeds come in and take over. That is a great thing [the Yellowstone River Conservation District Council] has done. They have done a great job on weed control. (*Yellowstone County Agriculturalist*)

B. Cottonwoods

I realized…[that] if you don't have flooding, you don't have new cottonwoods growing. (*Yellowstone County Agriculturalist*)

My place is unusual because a lot of my pastures are covered in high water and…it reseeds all of the cottonwood trees. One year, before I did the diking, the river ran into the field and the cottonwoods grew like grass. I turned the cows in and they ate them like grass. (*Yellowstone County Agriculturalist*)

I am not a supporter of letting the river meander. Why must we destroy an acre of mature cottonwood trees that are 100 years old in order to provide areas for new ones? (*Yellowstone County Agriculturalist*)

We…lost so much land, and this was bottomland that was covered with big cottonwood trees. And we thought, 'Well, with the big, heavy trees there and the roots, we'll never have to worry about it.' In fact, the river ran in the same channel for years and years. And all of a sudden it changed. We've lost at least 42 acres. (*Yellowstone County Agriculturalist*)

The cottonwood and willow river-bottom ecosystem is supposedly an advantage….One of the problems is there's all these beavers down there. They chew up the cottonwood trees—[trees that are] six to eight feet in diameter…that Clark could have used for canoes—but the beavers eat right through them. When they eat through them, they drop that tree…[and] it kills the roots. Guess what? Those roots were holding the soil to kind of keep the river at bay. (*Yellowstone County Agriculturalist*)

A young man came in, and he was soaking wet and freezing cold. He had been on a jet ski [that] washed into a tree and he almost drowned. It sucked the jet ski under. He was able to dislodge himself after a half of an hour and walk to my house….We gave him some warm clothes….What do I do, leave the tree to fall in and it takes someone's life?...If we save a tree, we save a life. The Yellowstone can be so dangerous. (*Yellowstone County Agriculturalist*)

C. Water Quality

There are drainage ditches anymore that you can't find the minnows in….It's due to fertilizers and chemicals that come off the fields. (*Yellowstone County Agriculturalist*)

Some of the nitrogen probably gets in the water table because it goes down pretty fast. Phosphorous hangs with the soil a while. We use the waste water again when it comes through the drains. We use the same water twice. (*Yellowstone County Agriculturalist*)

The refineries [used to] put their waste oil in ponds and it seeped into the river. In the '30s and '40s you could see the colors of the rainbow in the water from the oil. They have really cleaned that river up. It is amazing. It is really clean now. People are pretty careful about dumping stuff now. If they catch you, they will fine you. Years ago they used to dump their garbage in. (*Yellowstone County Agriculturalist*)

D. Threats to Agriculture and to the U.S. Food Supply

There's a huge amount of movement away from food production here in the United States….Our society and our way of life [is moving] into a service industry. The plan is out….We can buy food,…beef and vegetables and sugars and all the rest, from third world countries….And if we do,…we loose our middle class. We will have the very rich and the very poor….The people who work the land are your middle class and we'd lose that. And it'll be the end of the United States as we know it….Then dictatorship takes over usually. (*Yellowstone County Agriculturalist*)

The environmentalist community has a strangle hold on the State of Montana. (*Yellowstone County Agriculturalist*)

VI. Managing for the Future

A. Frustrations with Local, State and Federal Management

Ranchers and farmers are kind of suspicious. A stranger walks in and they are suspicious as to why they are here and what they are after. It has been that way for years. (*Yellowstone County Agriculturalist*)

The most important resource that Montana has is the Yellowstone River, and we're giving it away to downstream interests. We should not be doing that. The Federal government should not be allowed to do that. (*Yellowstone County Agriculturalist*)

My ranches have lost probably 120 acres….I'm paying taxes on several islands out in the middle of the river, and I can't use them. But they're still in my deeded ground, and the government still taxes me for it. (*Yellowstone County Agriculturalist*)

I'm telling you, the Department of Environmental Quality has gotten so out of line….The DEQ is running rough-shod over people that live around these streams and rivers, or that have a pond on their place, or that have some cattails that might be in a flyway….Those cattails, it seems as though it's 'Hallowed be Thy Name.' (*Yellowstone County Agriculturalist*)

The County came out here, and they told us all these things we needed to do [about the weeds,]…or they can come out and spray it and charge me money. I told them, 'You go up to the head of the Yellowstone River and you kill all the knapweed and spurge down to me, and then I will kill mine, and then you can go on down there. Until then, there's nothing we can do about it.' I can…show you every place that river has ever overflowed—it just spreads them weeds, and that is exactly where the knapweed and spurge is. (*Yellowstone County Agriculturalist*)

We were all out on the river bank…and [one man] asked, 'What's the problem with car bodies?' And [an agency man] says, 'It's the oil and the rust.' I said, 'Yeah, I can understand that, but when I go to Billings and this old vehicle in front of me…[is making] a puddle of oil….Where does that go when it rains?' He says, 'It goes in the river'….That kind of tells me that a 100,000 people make it right, and one individual makes it wrong. (*Yellowstone County Agriculturalist*)

Sure they want our water. They need it for commerce downstream. And now we have the environmental sector,…the tree-huggers from back east, and the Fish and Game has gotten involved….And it's almost a sacred word, 'Don't touch our Yellowstone.' Well, wait a minute here. God put that water here for it to be used. (*Yellowstone County Agriculturalist*)

We have not had the best of luck with some of the agencies. They all have to sign-off. The people who are in those roles, some of them, have been less active than others. We have had permits sit on their desk six months, and [we] get it back signed with no comments. (*Yellowstone County Agriculturalist*)

[Near] the population centers…the County and State government people come in and do what they want. They don't need permits [for bridges and roads]. They just do it. That one project on South Billings Boulevard would have more impact on the river than 50 private people. (*Yellowstone County Agriculturalist*)

[We] went to Miles City,…[to] both the State and Federal offices, and they said, 'You don't need any 401 permits for that project'….[So] we've been flood-irrigating through the years [and now] there's a little patch of cattails. Well, that designates it as a water route….[and] Federal gal out of Helena…says, 'Oh, wait a minute….You didn't get the permit'….They wanted to fine me $100,000 ….The [Miles City] offices are still up in an uproar about it because the Federal government out of Helena and Denver superseded them...[and] the fine runs $17,700 a day. Well, this hits up towards the millions, so I finally settled with them. They just use scare tactics on you. (*Yellowstone County Agriculturalist*)

We are not concerned about clean water.…It just makes a lot of people feel good. When you have tons and tons of topsoil going down the river, it doesn't do much to clean the water. (*Yellowstone County Agriculturalist*)

B. Management Priorities

The prime agricultural land that's down along the Yellowstone… should be prioritized for protection. (*Yellowstone County Agriculturalist*)

It's got to be managed for multiple-use. I enjoy seeing the people on the river enjoying the river and the fishing and stuff. (*Yellowstone County Agriculturalist*)

I don't care what anybody says—without that river, there isn't anything….Up and down the line, I don't care what county they're in. Take care of this river and it'll take care of us….That's how we've made our living since '47 is through the water in the

Yellowstone River. Without that we'd be like that dryland burning over there. (*Yellowstone County Agriculturalist*)

They'd better look at the core industries…that are serviced by the Yellowstone River first. Then let's see how we can mesh the rest. I'm just telling you the way it is. (*Yellowstone County Agriculturalist*)

Be conscious of what goes on upstream….[Decisions are made upstream that] impact the downstream people. (*Yellowstone County Agriculturalist*)

People…in Montana who own land, and pay taxes, [and] pay for their water… should not be disallowed to let a natural resource work against them. (*Yellowstone County Agriculturalist*)

C. Comments on Best Management: Who and How

You have to have a goal…[and you have to] see the pieces of the puzzle that you need to produce that goal. Then move forward. If you're so hesitant to move forward that people along the roadside are going to grab you and take you away from your goal, then chances are you have to step back and evaluate because maybe you don't really understand your goal. (*Yellowstone County Agriculturalist*)

You've got to build…the relationship. The relationship has got to be there between the sportsmen groups, the Fish and Game,…the farmers and ranchers, and the landowners. (*Yellowstone County Agriculturalist*)

You have to have a benchmark….[Then] you can look and see if something is having a devastating effect or no real effect. This mapping is the first step. You can't make these decisions without it….[We need to know] what are the cumulative effects, as opposed to…just hot air in the wind….You [need] a firm basis to make your decision. That way they can make intelligent decisions. That is the major role [for management]. Eventually they will be able to make decisions because they know what has happened and they will have evidence to support those decisions. (*Yellowstone County Agriculturalist*)

The [Yellowstone River Conservation District] Council is the only one that can bring all the ideas together. I don't know what's going on in other counties. I would never be privy to any of that information. This group has that unique ability to bring all the thoughts together. I am not sure about the cooperation they get from the County. Maybe one of the roles is get some unifying thoughts [and] summarize what has happened. I don't know if they want to tell people what to do as opposed to maybe cataloging what has been done and the effects. (*Yellowstone County Agriculturalist*)

As far as I'm concerned, that [Yellowstone River Conservation] Council has got to get on the ball to do things for the river—to take care of the river for the future, for the people that are coming along. (*Yellowstone County Agriculturalist*)

This [Yellowstone Conservation District] Council is a must. It's going to do some good someplace, sooner or later. Somebody is going to come up with something….[Don't] get discouraged that there's nothing happening. (*Yellowstone County Agriculturalist*)

Thirty-five or 40 years ago [I heard about] the wise use of water….The 'use it or lose it' type of thing…was a step forward, but they never carried it through to wise use. Now they're getting where they're registering the wells and trying to get into the wise use of it. And that's the right step, to have somebody that knows what they're doing. And I think the [Yellowstone River Conservation District] Council has the expertise in these matters to following through with wise use….[The Council] will come out with a really positive program when it's done….They're knowledgeable people. (*Yellowstone County Agriculturalist*)

Some people aren't aware that they can't [do something]….They are naive of the law. Once they realize they need a permit they are cooperative. (*Yellowstone County Agriculturalist*)

The river is there for everyone. It is there for everybody, and we should try to keep these [extreme] groups…away. (*Yellowstone County Agriculturalist*)

Of course, the Corps has the final say in the direction that river goes. So we try to comply and understand…the big picture. (*Yellowstone County Agriculturalist*)

Big Horn River to Laurel: Local Civic Leaders Overview

Eighteen interviews were conducted with individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and water/wastewater treatment managers. Participants were identified through public records.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Big Horn River to Laurel: Local Civic Leaders Analysis

I. The Transformed Valley

A. The River, The Rims, West Meets East —This is God's Country

It's…a high plains environment situated on the Yellowstone River, the longest free-flowing river in the United States….[Billings] is bordered by the river and the rim rocks; it makes for a real unique character. (*Yellowstone County Local Civic Leader)*

It is one thing to simply look at the river…but you go back further and that is what created our rims….That view was created by the river. (*Yellowstone County Local Civic Leader)*

[This area] is on the verge of the west, and the verge of the east….The mountains aren't very far away, and the prairie's not very far away. We're kind of a mix of both, right here. (*Yellowstone County Local Civic Leader)*

Where the prairie meets the mountains. We are definitely not western Montana. We're really not totally eastern Montana. We are where the two meet. (*Yellowstone County Local Civic Leader)*

[This is] God's country….It's the best place on earth, just like the Crow Indians thought….When Lewis and Clark came here, this was a bread basket. They couldn't wait to get out of the mountains and come back here because there was food. There was food because…ranging animals moved where there was grass….There were lots of deer, there were lots of everything….[The animals] were able to move unconstrained. Humans have changed that. (*Yellowstone County Local Civic Leader)*

There would be no Laurel without that river. Pure and simple there would be no reason for us. The Clarks Fork and the confluence of the Yellowstone made this the perfect place. (*Yellowstone County Local Civic Leader)*

B. Nothing Works Around Here Without Water

[The river] is huge for agriculture, but it is huge for economic development, too. We have three refineries, and…the Montana Power generation plant takes water. Nothing works around here without water. (*Yellowstone County Local Civic Leader)*

My elders always told me, 'Whiskey was for drinking and water was for fighting.' I think it's true….When you have the amount of people…and the amount of land that is good land, the only thing that's going to prevent that from being developed is the use of water….Right now there are opportunities for development that are being held back until you find the proper mix of how you are going to supply water….Water holds the key. (*Yellowstone County Local Civic Leader)*

Of all the natural things that occur…[the river] is the most important thing. It provides water for drinking, flood irrigation, and recreation. It is the lifeblood of our community. (*Yellowstone County Local Civic Leader)*

Without that water, your land values would drop…from $1,500 to $2,000 an acre…to $300 to $500 an acre…[And] not only for agricultural purposes….Your communities…are all centered along those river-ways….The river is important: from domestic water, to irrigation, to recreation. (*Yellowstone County Local Civic Leader)*

If you follow the valleys down, you'll find that throughout eastern Montana…the vast majority of the economy is within the boundaries of that river.…And it's not a whole lot of land….[And] the water that the City of Billings takes from the river…there would be no growth potential if they couldn't do that. (*Yellowstone County Local Civic Leader)*

When the Federal government created that canal it was headquartered in Huntley, hence we have the Huntley Project….[So] the river is of huge importance to us….It's the mainstay of the whole valley. All of the irrigated farms—what would we do without the river? (*Yellowstone County Local Civic Leader)*

I think [the river] is hugely important [to the town of Custer] because we use it for irrigation. This is a largely sugar beet and corn growing area, and, of course, your irrigated lands are going to produce a lot more. (*Yellowstone County Local Civic Leader)*

Because of irrigation in this valley, this valley has changed tremendously from what it was in the 1870s….This whole valley was an alkaline flat….There was a nice riparian area, because the Yellowstone is a wandering river, but it was probably a mile wide at its most. Now it is ten miles wide….Obviously, you need to maintain in-stream flows….There needs to be flowing water to provide for those plants and animals…but there is typically more water than that. (*Yellowstone County Local Civic Leader)*

There was a man named Willard Frasier….He was an old-time mayor [of Billings]….He was a little ahead of his time. He wanted to punch a hole from the City of Billings to Alkali Creek… and he wanted to put a reservoir up on Calamity Jane. If we'd have done that then, yes, I think…we could have had a source of static water that would have allowed us to take off….Plus, you would have had the recreational facilities would have been available for a lot of enterprising businesses. (*Yellowstone County Local Civic Leader)*

There is a about one mile on each side of the river that denotes that drainage, and that is where you typically have irrigated farm ground, and different tree growth and vegetation associated with the river valley. Outside of that, you move in to other types of terrain. (*Yellowstone County Local Civic Leader)*

There are all kinds of ecosystems that have grown dependent on man and are living where they weren't before. (*Yellowstone County Local Civic Leader)*

C. A Big, Big Cowtown with Lots of Jobs

[We] are not really Missoula, by any means. Or Bozeman. But we have a lot more cowboys than Missoula or Bozeman….We're headquarters for eastern Montana's agriculture….You can drive anywhere downtown and you can see a load of cows going down the street and a fancy restaurant. I'm not sure what we are. We're kind of a big, big cowtown that thinks we want to be a city, I guess that's how to put it….I don't know how else you [explain] Billings. (*Yellowstone County Local Civic Leader)*

[This area] has always provided jobs. My grandparents came here with the railroad. My dad met my mother and moved here from Butte….They stayed here [because of work]….With the refineries, the railroads and the medical corridor, there…[are] jobs available, and I think that is what's real distinct. (*Yellowstone County Local Civic Leader)*

You had irrigated farming which in turn brought us the sugar beet factory, which was jobs, and the railroad stopped here, and it became a retail center. I think that is really what the river did for us. It brought the first people, and everyone saw how valuable it was. (*Yellowstone County Local Civic Leader)*

I'm thinking that the industrial base will continue to grow simply because we are the largest metropolitan area between Spokane, and Minneapolis, and Calgary, and Denver, and Salt Lake….Our medical corridor will continue to grow…[because of] that whole bubble of the generations that are retiring [here]….Businesses that need transportation [locate here]….[and] retail businesses [do well because] you've got people. (*Yellowstone County Local Civic Leader)*

When we moved [to Laurel] it was very much a German cultural town. It is not that anymore. It has been a slow change, and not without its grumbles and gripes. It has been a change from a German ethnic community to a bedroom community of Billings. There are still local people, but it is not like it used to be. (*Yellowstone County Local Civic Leader)*

D. Water Cycles, The River and Recharging Aquifers

The river is formed from rain and snow that comes from Yellowstone Park….In different reaches [the river is] recharged by the aquifer system that's around it. In other areas [the river is] recharging the aquifer system. (*Yellowstone County Local Civic Leader)*

It's kind of funny, with all the projects I work in the lower end, we don't really have much water availability issues….The Big Horn dumps into the Yellowstone. They dump enough water, and they keep that fishery in good enough shape, that it pretty much makes the river, all the way down through Sidney, sparkle. (*Yellowstone County Local Civic Leader)*

The Yellowstone, for being a free-flowing river, doesn't experience a lot of shortages….The Yellowstone is definitely the main thing for agriculture in eastern Montana. (*Yellowstone County Local Civic Leader)*

The biggest issue on the west end [of Billings is that]…they're not recharging the aquifer anymore. Eventually, who knows. That's an issue the west end study shows….That's just how it is. It shouldn't be that way, but that's just how it is…[because of] subdividing. (*Yellowstone County Local Civic Leader)*

What's the cumulative effect [of development] on the underground aquifers?...I don't think it is as big an impact as people are trying to make it to be….I think we have plenty of water. It snows like heck every time, and we [have] water coming down the Yellowstone….And if you read in Genesis, God set the whole thing up to where the river comes down, [and] evaporates, and the salt sea is almost a purifier….Now, that's a pretty good ventilation system that He developed. And that's here in Montana. Now we are running through some droughts, and you can get into global warming….But what I see in Montana is, we've got lots of water. We are not going to run out of water unless there is this global shift that changes things. (*Yellowstone County Local Civic Leader*)

II. The River as a Public Asset and a Calling Card

A. Water Rights

Under the state constitution in Montana, you don't own water, you own the right to use water. And [the various users are] aligned by, 'First in line, first in right'.…A full listing [of users] and a full court decree [defines] who is first, and if they're first, how much water can they take. That's what a general stream adjudication is….In the end, if the court ever has to administer the waters of the stream, they have to have the list to do it correctly….But in the older basins history has shown that sometimes you have to [go to court] more than once because they never get it quite right. (*Yellowstone County Local Civic Leader)*

Water rights are very important….One of our subdivisions has junior water rights….[and a few years ago, during] the second year of the drought…Fish, Wildlife and Parks…said, 'You no longer can pull water out of the Yellowstone River…because you guys have junior water rights'….We asked, 'Where we were going to get water [for the subdivision]?' and they said, 'The City of Billings.' Where is the City of Billings getting it? The same river. But, the City of Billings had senior water rights. (*Yellowstone County Local Civic Leader)*

When we subdivide where there are irrigation ditches, [water supply] becomes a real pivotal issue….As we develop in these areas…we're dealing with…downstream users who still rely on the water. But people in subdivisions think they have a little creek going through their property, and that's not the case. I can't say it's gotten any easier, but people are more aware than they used to be. (*Yellowstone County Local Civic Leader)*

Because of the in-stream needs of the fishery, and because of the way that the water laws are set up to reserve water rights, before the Big Horn comes in, in order to develop new irrigation systems, you've got to have a water right and that water is going to be junior to the needs of the fishery. Once you get past the Big Horn, and it reverses, then you can develop senior to the fisheries. (*Yellowstone County Local Civic Leader)*

B. The River as a Calling Card

Those who are interested in the future of this urban area should be interested in the calling cards to the area, one of which is the river. If you allow a few to own it, you've lost that calling card. Would it suffice for the ecosystem if it were a park? Absolutely, it would, because it's a huge area. Riverfront Park is a pretty good example. It needs a lot more extensions. You can go to many cities, Boise is a good example.…and fair amounts of Missoula's Clark Fork are in public ownership….Their urban area is right on top of it….The Yellowstone is a beautiful possibility for an open wildlife corridor. (*Yellowstone County Local Civic Leader)*

I think [water] plays a huge part, especially in the growth of everything. The City of Billings and the City of Laurel both have water rights on the Yellowstone River. That is as good as gold. So that really helps. Each one of the refineries has water rights. That is why they all ended up here. So the river has played a tremendous role in the growth of Billings and Yellowstone County. (*Yellowstone County Local Civic Leader)*

[People] are also looking at the Yellowstone River more as an amenity, which is really different. It's amazing having a subdivision down near the river because for years that's where the industry was going. That's a change. (*Yellowstone County Local Civic Leader)*

It's beautiful down [by the river]. You still got your wildlife down there, and that's what people like….With Riverfront Park, people are utilizing that more. That's great. And then with the new McCall subdivision going in, I think that's going to be good. I think people are looking at it and finally realizing we've got beautiful scenery here, we should use it….Riverfront Park was a beautiful idea ….If we could do that…along different areas of the Yellowstone, I think it would be great. (*Yellowstone County Local Civic Leader)*

Industry [owners] will…be looking for quality communities to live in, and the river can be a tremendous asset for quality of life enhancement. (*Yellowstone County Local Civic Leader)*

There are two things that define Billings: the rims and the river. We've already screwed up the rims because we didn't get them into public ownership, and now [they belong only to those] who have more money than I do….When we tried to buy [some riverfront property for bike trails…one owner] refused….[He doesn't want] to let the bike trails to go through. He’s actively filling the floodway with debris so he can move his trailer park down there. Do I think that’s wrong, personally? Yes. As a public official, there isn’t anything I can do about it….Would I like to see organizations in this urban area recognize the strengths of the river, and allow it to be a wildlife corridor, or allow it to be something as wild and free as possible? Yes….I’m marginally pessimistic [something like that might happen]. (*Yellowstone County Local Civic Leader)*

C. Recreation

I know what the most important aspect now is agriculture, irrigation. But, I think the tourist attraction of [the river] as a natural, scenic resource will become more important over time….[Recreation] should have equal importance to agriculture. It is a tremendously diverse riparian ecosystem along the river. It has historical and cultural significance. It is beautiful. So, people will pay to come and use it, to see it, or they will consider lifestyle changes that involve the fact there is an undammed river nearby that they can appreciate and see. (*Yellowstone County Local Civic Leader)*

The fisheries issues are huge to me…[but] how far do the fisheries [issues] push into the economics? Are we willing to cut our local economy for the Pallid sturgeon? If you’re from Missoula you’ll have a different answer than if you’re from Miles City. The problem is…the sturgeon issues and the fisheries issues are not State [issues]. Even though the state is supposed to manage these streams, the Federal government has to be part of it….It’s a huge issue: State’s rights verses Federal….Something’s going to have to happen….Somebody’s going to have to give in…if they want the sturgeon to recover. (*Yellowstone County Local Civic Leader)*

I think we have seen more recreational use of the Yellowstone River corridor…and probably will see more in the future. I know that the County has been working…[to] increase recreational possibilities. (*Yellowstone County Local Civic Leader)*

[In Huntley] we were going to put some paths in, and we wanted to incorporate the east side of the river….[We wanted to] incorporate Main Street and go around the park. We wanted to tie it all in….There are plenty of places to access [the river], but sometimes they’ve come and gone with ownership. [Some people] get a little wrathy about people crossing their land to get to the river, but I think…it comes down to communication. The people that want to use the river need to…ask [permission]…[and] close the gate when it’s closed. (*Yellowstone County Local Civic Leader)*

With the advent of the four-wheelers, more people are able to get down in those river bottoms….A lot of times you’ll hear people say, ‘I’m going to Huntley to go fishing.’...They’re putting in another access down by the Pompey’s Pillar rock; they’re building that one now. (*Yellowstone County Local Civic Leader)*

I [try to] educate people as to where fishing accesses are [near Custer], what landowners are allowing people to use their river frontage, and which ones aren’t….We have two fishing accesses within eight miles….The hunters have definitely been harder on the landowners than the fishermen. The fishermen work the banks, the hunters work the whole land….Most of our local farmers have shut their land down to hunting….You have rich hunters coming in to buy the farms. (*Yellowstone County Local Civic Leader)*

I don't think agriculture should have priority on the river. I think at best…[agriculture] should…be on par with recreation. Agriculture, you know, feels they have a right to the river, and no matter how hot the water gets, or how low it gets, they figure they got the right to what's left and to hell with the fish, to hell with everybody else, to hell with the whole living system around it. And I don't agree with that….You'll see it later this year, as the heat continuous….It will stress everything along the river…from deer to muskrats. (*Yellowstone County Local Civic Leader)*

III. Municipal Water Use

A. Taking Water, Returning Water: City Uses

[Billings takes] about 24 million gallons a day, peaking at over 50 million in the summer and down to about 15 to 16 million in the winter….We aren't even a pipsqueak compared to irrigators….We return 75 percent of it to the river [and] another 10 to15 percent is returning to the aquifer. Ok, so we've evapotranspirated 15 percent, but we've gained great things from that. (*Yellowstone County Local Civic Leader)*

[Billings has] about 33 millions gallons of total storage in the system. The city uses about 50 million gallons a day in the summer. So, you see, we don't have multiple days of storage….In the winter we do…but then you have a water quality issue. Your potability…[and] the safety component diminishes as its stored….So, we would like to have minimal storage time. (*Yellowstone County Local Civic Leader)*

[Laurel] uses a maximum of seven million gallons of water a day and our intake is designed for 20 million per day. We have good excess capacity. Informally we have talked to the City of Billings about selling them water….[Laurel has] the second water right on the [entire] Yellowstone River, so the chances of us not having water accessibility are very remote. (*Yellowstone County Local Civic Leader)*

[In Billings, we treat on] average [over] 14 million gallons per day….Approximately 20,000 pounds of solids a day come in, and we put out…maybe 400 pounds….We are removing about 95 percent of the total system solids and bio-chemical oxygen demand. The bio-chemical oxygen demand is how much oxygen it takes microbes [to] break down the waste. We want to reduce that as much as possible so it isn't taking oxygen from the river when it is discharged….The water from the wastewater plant is cleaner than [the water the City takes] out. (*Yellowstone County Local Civic Leader)*

[Billings] discharge limits are based on water quality standards of the river. We can't add anything extra to the river that could be considered toxic or detrimental. The fecal coliforms [already] in the river average around 100 colonies per 100 mils, so you wouldn't want to drink that anyway….One of the things we are looking at in the next five to ten years is…the State of Montana further restrict[ing] our effluent limit….They are looking at the TMDL [total maximum daily load]. That is the amount of a pollutant that the river can handle. If that load for ammonia is set at 4,000 pounds a day, and it is determined that the river already has 4,000 pounds per day, then the city would be required to discharge no ammonia. Right now we discharge a lot of ammonia. That would have a big impact….It may be fairly significant. (*Yellowstone County Local Civic Leader)*

B. Safety and Quality of Water Supply

The river is not safe [for human consumption] as it is. We remove all the fine particles, all the bacteria, and the viruses that are harmful….We improve its potability in the sense of its aesthetic quality to users. It's clear, it has a good quality taste….People find it pleasant….There's lots of water that's safe drinking water but not potable. The [Yellowstone River] is a good quality source. It's a bicarbonate water. We're pretty far up the watershed. There's only a minimal amount of interference from man, but enough that it wouldn't be safe for anybody to drink as it comes down the river. (*Yellowstone County Local Civic Leader)*

Using the [river] as a waste-way is a problem….We are still fighting the past in the sense that it is a convenient sewer. That is a principal problem. We've made huge strides since the 1970s in point-source [pollution] control—huge strides. We continue to squeeze…point-sources, but we continue to neglect nonpoint-sources…such as irrigation, agricultural chemicals, suburban use of chemicals, and storm water runoff. We haven't really begun to address storm water as efficiently in urban areas as large as Billings as we should, although that is changing, too. But, we're not treating storm water runoff yet. (*Yellowstone County Local Civic Leader)*

Oil slicks [occurred in] the '60s from spills at the plants….Those don't happen anymore, [since] the Clean Water Act….We've had a water treatment system here since 1915…. [Before 1915] people died every year from cholera and typhoid. They installed a treatment system in 1915 and lo-and-behold there wasn't anybody dying anymore….On the sewage side, they didn't recognize they were the contributors to their own problem. They didn't really build any kind of sewage treatment here, other than direct drains to the river…[until] '46 or '47. (*Yellowstone County Local Civic Leader)*

[In Custer] we are about to redo our whole sewer system….We do not have city water, [but] we should….The business people have to chlorinate [their water]….We've been dumping animal and human waste into this groundwater for 100 years now. These people are kidding themselves if they think it's not in their wells. (*Yellowstone County Local Civic Leader)*

C. Costs of Safe Water and Sewage Disposal

[In Billings] we're adding four filters…and renovating the remaining eight, so it's a very large project. We have to produce water at the same time, so it's a two-and-a-half year project to incrementally bring these online….The biggest local expenditure of money is water and wastewater system. One of the biggest costs are these treatment facilities, production facilities. Just that little addition out there is 18 million dollars. Everything else, roads, that stuff, they get a lot of Federal money for that. This [addition] is right out of the local's pockets. (*Yellowstone County Local Civic Leader)*

The '97 flood forced us [in Laurel] to become more flexible….Our present day intake…is on the south side of the river and it was on the north side….And [now we] have that ability on both sides of the river….I don't know how many different times we tried to change the channel, and once the river has made its mind up, it…[doesn't] make any difference how much limestone you put in there, it's going to go where it wants to go….I believe it was right at…3.2 million to put that intake in there, so it was quite an investment. (*Yellowstone County Local Civic Leader)*

When we [put in the Laurel] water treatment plant…it was more expensive than anybody ever thought, but that is life. Companies that were involved were very understanding, specifically the refinery….We sell them raw water….Some days we had to restrict them, some days they got raw water, some days they got treated water. You can't shut something like that [plant] down very quickly. (*Yellowstone County Local Civic Leader)*

The 303(d) list is the list of impaired streams…[with] a lot of nutrient…or sediment or chlorides. [If the Yellowstone is designated] impaired…[with] ammonia, or nutrients, total nitrogen, or phosphorous, we can treat it, it will just cost more money….My goal is to maximize the tax dollar. (*Yellowstone County Local Civic Leader)*

We pressurize [the Billings water supply for] eleven different pressure zones. In order to have water as you understand it come from your tap, you need about 50 pounds per square inch. Good practice is anywhere from 40 to 80. That is all driven by terrain. There's 600 or so feet of difference across the city and if you were to pressurize the water at the upper 600 foot level to 50 pounds, down at the lower level you'd have about 300 pounds per square inch….It would skin you instead of give you a shower….Do we use a lot of energy? Yes, this [city system] is energy-intensive because we have to lift [the water]….Almost 2 million bucks in electricity a year. (*Yellowstone County Local Civic Leader)*

As that aquifer [west of Billings]…can only become more contaminated as more development sits on top of it…[and] the [irrigation] ditches are shut down because there's no agriculture anymore….If they are annexed they would have to get on the [city system]. So, there's a cost there. (*Yellowstone County Local Civic Leader)*

IV. Urban Growth—Urban Sprawl

A. A $500 Saddle on a $50 Horse

Urban sprawl [occurs] because people wanted to get…cheaper land….It used to be that the city…was able to zone [up to] five miles around the city. Well, the legislature struck that down. Can't do that—can't be zoning, even though these places are going to be in the city someday and they don't meet city standards. The streets aren't the right width, they don't have sidewalks, curb, gutters, sewer, they don't have the same grade of water system piping….Then [later] the city has to annex [those areas] and assume the costs….If you happen to through those subdivisions south of Grand and west of Shiloh, you'll see that the roads have no curbs or gutters….They are very narrow little country lanes with huge homes….They were trying to sell [one home] for $1.4 million, [and] it's got this road that doesn't meet cross sectional design requirements….People will spend $300,000 to $400,000 for their house…[but] their infrastructure is awful. So, it's a $500 saddle on a $50 horse. (*Yellowstone County Local Civic Leader)*

We made a mistake. We should have told [the developers of the subdivision] to put in an additional overlay to their plats. They put in a group of five acre lots and a group of one acre lots and the problem is that if [Laurel] ever annex[es] them it will be so expensive to put in streets and gutters they won't be able to afford it. What we should have required is you put in an additional overlay that says if this area is ever annexed those one acre lots will be divided into four lots. And your homeowner who buys the one acre has the choice of putting his house on one lot and he can sell the other three if it is annexed to pay the SID [Special Improvement District tax]. Or, he can put his house in the middle and pay the whole bill. They know that up front. (*Yellowstone County Local Civic Leader)*

One of the great natural resources that Montana has for growth and development is our air quality, our water quality, and our space. There is room for a lot of people to live in Montana. And in the high tech businesses, the computer businesses you don't have to live in LA, you don't have to be in New York. You can run businesses here. So, what we have I think, is water, air, and space….Montana has the resources to grow and accommodate. We do not have any urban sprawl. There's no such thing as urban sprawl in Montana. (*Yellowstone County Local Civic Leader)*

[Subdivisions are] a common practice in every state in the union. You have a section of land that is divided into quarters, sold off without a property division because it has a legal description. They are further divided and then they are further divided and what you end up with is somewhat piecemeal instead of planned development. However, the opposite of that is [when] government zones and plans for you. (*Yellowstone County Local Civic Leader)*

I have to say, out-of-state developers…come in, and you put a list down that [shows what] they have to do, and…to them, that's it. Our local folks are not used to doing that….We have good developers out there, and we have some that are just getting by on the skin of their teeth. That is a real problem as we deal along the river. (*Yellowstone County Local Civic Leader)*

Here in Montana, we…really don't care if there is a city park next door because we've got a little greenery in our…five-acre-tract…..We are a plains culture. You don't see three story houses with huge oak trees….We have a different look, we have vistas, we are flat and wide. We are not high rise people….They bring planners from the east to tell us how to do things, they want to stack us up downtown and make everybody believe we are all going to give up driving our automobile and move back downtown. It isn't going to happen….The market demand is for a little elbow-room….It is not a Boston, Massachusetts….If you want people to come here to live and work, they've got to have a nice place to live, nice schools, and they have to have a job….That precipitates housing, schools,…paved streets,…and so on. So I think we need to…keep protecting that that makes Montana great. Let's protect our water, protect our air, protect our space…but allow growth….There is no reason that we can't enjoy this same lifestyle with a $250,000 house or 250,000 population. Right now, we are at a 100,000 population. What's the difference? (*Yellowstone County Local Civic Leader*)

B. Building in Flood Zones

It is appropriate to build subdivisions within viewing distance of the river but out of the flood plain….People like to live [near the river], but is also appropriate to keep park land in-between there because then you not only have the chance to enjoy the river but to protect it also. So I think we have come up with a pretty workable balance. (*Yellowstone County Local Civic Leader)*

I like the fact that for the most part [the river] is left open to function naturally, that there is still a lot of flood plain left, realizing that it's heavily armored in places….The flood plain is essentially storage for flows that are above normal flows. Without adequate storage, it would be discharged downstream and have to go somewhere and force itself into places that would probably cause a lot of destruction. So, if you can maintain natural floodplains, then you can pretty much protect property from inundation.
(*Yellowstone County Local Civic Leader)*

It's still a wild running river….We like to enjoy our recreation and use the water, but it is difficult to develop up to the river's edge because it still works around. If you've ever seen an ice jam break loose, you know you wouldn't want a house or something built in the flood plain….We love the river. We use the river. Everybody likes the wildness of the river, but it's a resource that we can't build right [up] to. (*Yellowstone County Local Civic Leader)*

The river changes courses. The river as it exists today is changed significantly as far as meanders and the way it picks its course….I built a cabin on the Yellowstone River bank 60 years ago that is now an island, and this is just from the natural flow of the Yellowstone River….It's a natural thing for the river to do….and it will continue to change. (*Yellowstone County Local Civic Leader)*

There is much of the Yellowstone River from roughly Huntley east…that is in need of official flood plain mapping….Say a subdivision comes in that is near enough to a flood plain that…a 2,000 foot proximity to drainage area kicks in…If it does, then these [flood plain] stipulations enable one to determine the proper setbacks. (*Yellowstone County Local Civic Leader)*

My concern is that people don't take into account what the flood plain and floodway represent….If people build down there, we have minor floods and ice jams [in Laurel] that will potentially flood somebody's property. That is not anybody's responsibility but the homeowner's and they need to understand it….We have people sign waivers around the airport that they will not complain about the airplanes…because they have [bought land] with full knowledge that the airport is there. That is something we maybe need to look at by the river. Have them sign something that they are aware that their house could be destroyed and it is nobody's fault. (*Yellowstone County Local Civic Leader)*

We have to make sure that [people] are not allowed to build within the flood plain and that they wouldn't be putting the land to any use that would pollute the river….[We should] preserve the natural habitat. I mean, keep the man-made uses from having an impact. Sometimes rivers change their channels naturally. So you don't let people get close enough that [a change in the channel] becomes a problem. I would prefer not to use man-made methods to keep something bad from happening or to remedy something that had already happened. I mean, hopefully you can address it before it gets to that point. (*Yellowstone County Local Civic Leader)*

The non-control of sprawl along the river system, in flood zones, [is a problem]. [The river] needs to be protected in my opinion. Number one, it's a wildlife corridor, and number two, it allows the river to act as a living organism. In a sense, it is—it might migrate a little bit. Now, if you're a guy who owns a farm and you see 30 acres of your property move into the river, and your property line…is now across the other side on a sandbar, that irritates you a lot. So, you want to do something about it. But what you're doing is screwing the river downstream for somebody else. To me, that's a problem. (*Yellowstone County Local Civic Leader)*

We have a lot of resources in Yellowstone County to help us make the best decisions. We have an emergency services director and a flood plain administrator, who is the same guy. We have the flood plain all mapped out so we know where the flood area is…[and] we are even expanding that into different drainages that have floodways….First of all, you don't want the people to get flooded, and secondly it creates enormous problems for the future generations. (*Yellowstone County Local Civic Leader)*

We respect private property rights, but we also respect the fact that the river is going to flow where the river deems that it needs to go. And if you build homes in the floodway and the flood fringe, you are probably going to get wet. We saw that a few years ago….We watched Bill Keller's place, over in Custer, as the river chipped away…at the banks and then all of a sudden we watched the building fall right into the river. It is still a free-running river, the Yellowstone, and she has a mind of her own. You have to be respectful of that. You have to understand that we have many, many uses of the river, but we also have to know that if we are going to do subdivisions,…we need to make sure that people are safe and that they don't affect this river. (*Yellowstone County Local Civic Leader)*

The State of Montana has pretty rigid standards for flood plain development. And most, but not all, of the counties along the Yellowstone are active participants in the flood plain management program. That means that [most counties follow] the regulations that the State puts out. The model regulations basically restrict development to generally agricultural purposes, or other uses that don't require permanent structures….For the most part [the model is] making sure that the flood plain isn't altered, not filled or re-graded, or things like that. (*Yellowstone County Local Civic Leader)*

We're lucky that we had a 100-year flood along the Yellowstone back in '97 and '98.… There were photos taken at that time, so the photos help substantiate where the [flood] boundaries were. That is allowable evidence when trying to determine where a flood plain is. You can use historical records…water lines…[and] anecdotal stories about where the flood was. In this case, we've got pretty good evidence of where it was….It's useful to use the photos. Many of the maps were created in the '70s and '80s, and there hadn't been a 100-year flood….Also, the river has shifted quite a bit. The Yellowstone is a typical graded stream, it really is a very dynamic stream [that] can shift quite a bit, and it has. (*Yellowstone County Local Civic Leader)*

I anticipate that the flood plain maps and disaster insurance is going to be a big issue in the next few years. Especially in view of what happened in the last couple of years in the Gulf Coast and Florida. (*Yellowstone County Local Civic Leader)*

Most officials and residents are trying to maintain a corridor on both sides of the river, for the aesthetic value and free-flowing [river]. So you really can't be building down on that flood plain. But we are getting very close….[We try to maintain] a buffer zone to keep commercial and residential development from off the river. The river is a wild river and, if we can maintain a…100-year flood plain without permanent structures or that kind of stuff, we are in good shape. (*Yellowstone County Local Civic Leader)*

C. Septic Systems and Sewage

[Outside of the city water system, we have some areas with septic systems in] pretty shallow gravel….[And] on the bottom is shale, which is not porous. So the water…just moves down the gravitational gradient….You sink in your well…[and your water has] lots of minerals in it.…It tastes like shit. You end up putting in a reverse osmosis system to get the minerals out:…[the] high calcium, high magnesium, high sulfate, and lots of nitrates. Nitrates are causing problems for Blue Baby Syndrome. About 10 mg per liter of nitrates in water is associated with babies [who are] unable to take up oxygen. So, that's a problem if you were to drink water…above 10 mg per liter, and there are areas like that out there. They need to be urbanized; they need to be put on a water system. (*Yellowstone County Local Civic Leader)*

There's a lot of issues with subdivisions….Look at how we look at drain fields on the septic systems. You have places where the groundwater table and the septic system are mixing, but,…mathematically, it doesn't appear to be an issue. See, the problem is this subdivision may not be an issue, but what about [adding] the one above it? Now there's

72 houses above in this aquifer…but the assessment was done here [on one subdivision]….This is decided and this is decided [separately]. We never go like this [and look at all of the subdivisions together]. (*Yellowstone County Local Civic Leader)*

There is more pollution from agricultural animals and fertilizers and nitrates than there ever will be from people. Now, there…[are] a few examples where they put a lot of septic tanks in near an aquifer and we had some problems. Years ago, there used to be a place out in the Heights [and]…I think those people had cess pools….But now with the various systems that we have, the water, if given the proper zone, filters out and doesn't present a health hazard. As long as you have a septic tank in the area of one acre. In other words, if you have room enough for your drain field, I don't anticipate that is going to be a problem. There were some [other] examples in western Montana…[but,] of course, western Montana has a [more] lot…water than we do so it is a lot easier for them to contaminate an aquifer than it is here. Some of our aquifers are down 60 to 70 feet. Your septic just isn't going to contaminate that; it just isn't. (*Yellowstone County Local Civic Leader)*

These guys were here this morning…[concerning] a piece of private property out in Lockwood [near] the river. He received a permit to build a cold storage without a restroom. Now he comes back and says, 'You know I need a restroom.' We are denying it. He is into the flood plain, and his permit was clear. It identified that you're in a flood plain, and you cannot build a sanitary system there. The statutes don't allow that so he is not going to get a variance. (*Yellowstone County Local Civic Leader)*

D. Preserving the River, Local Farms and Public Greenways

Most agricultural operations near the Yellowstone River utilize the river for their livelihood. They depend on it for their water supply. I think there's a link between economic viability of agricultural property and [other] land uses…The tough thing is for our agricultural entity to survive—most likely it will change into some other land use. (*Yellowstone County Local Civic Leader)*

You look at these subdivisions, one on top of the other on the west end. I wish that there…[were] public dollars that could buy out all the development of those farms—just say. 'This is a farm.' And then it's only worth farmland values because you can never develop it. There's programs out there but no funding to speak of. (*Yellowstone County Local Civic Leader)*

When you talk about corridors…it is quality of life issues….I've always…felt like there has to be more to planning than just deciding which subdivision goes where….A good use of public dollars: if there was some very prime irrigated ground…buy that development out of it. [Then,]…if I come in and buy [out] that…development potential,…buy conservation easements on those places. The problem right now [is that] the conservation easements are all dealing with trout streams and elk habitat, not raccoon and whitetail habitat so to speak. It would be great if there were a corridor there and subdivisions weren't in there. (*Yellowstone County Local Civic Leader)*

Riverfront Park is a good example. The area that they developed was kind of the corridor area….There's places along the corridor where it's fairly narrow, but there are places where it's nearly a half a mile wide….I think you look at the wildlife population and the things that are going on there. You look where hayfields have developed and stuff like that. The corridor is generally fairly undisturbed.…It's not a good area to develop….Generally it's the cottonwood area along the Yellowstone and the low lying areas. And in places that's not very wide. [In] other places it's real wide. (*Yellowstone County Local Civic Leader)*

I agree with the [idea of a] corridor….I mean it keeps the quality of life where it is….There's something about walking down the road smelling a fresh cut alfalfa field. I've seen the corn field out there and watched a raccoon go into it, or a deer go by. That's just something that you want your kids to experience, just like you get to. The beet industry up and down the river, the smell of just all that, that's all a part of the quality of life. (*Yellowstone County Local Civic Leader)*

One [problem] is…you don't have to have park dedication if you do a minor subdivision. [So, people would] get that approved take a breath. Do another minor subdivision, take a breath. Pretty soon you have done a major subdivision with no park dedication. You have done a major subdivision as one minor [subdivision] at a time….That was the case in Yellowstone County…but [with] our new subdivision regulations….[a] second minor [subdivision] will be a major. That is a hole that we have found….I hope [the new regulation] sticks, because it will probably be challenged by a land owner. (*Yellowstone County Local Civic Leader)*

We have supported the Yellowstone River and Parks Association and looking at the trail process through Yellowstone County….We recognize the river greenway and how important it is. We are starting to see subdivisions pop up that are using that as selling points….We have Riverfront Park and have worked with the County Parks Association….Our whole trail project of trying to intertwine the city and the trails along the river….We may not have perfected it like Great Falls. (*Yellowstone County Local Civic Leader)*

[According to our] subdivision [rules], you have to do a little bit of park land. It's one of the city/county regulations…like seven or six percent….I think it has to be public of some sort. The problem is that we have all these parks all over the place and nobody maintains it. You go out to Lockwood and look at a subdivision, [and] there's park land authorized….The problem is nobody knows about it and nobody maintains it. So it sits out there, three [or] four acres in the middle of a subdivision….That's how it is. (*Yellowstone County Local Civic Leader)*

[In] that new subdivision…there's a wildlife area [near the river]….It'd be nice to walk from your house and go down there and be able to still have the river intact. And take your kids to walk down there…rather than developing all the way to the edge of the river…[and] it's going to end up…public because it joins other public access. (*Yellowstone County Local Civic Leader)*

I think that you have to be there quite a while before you realize…‘Where’d the deer go? What happened to that hayfield that was down there. Now it’s a car dealer’.…Driving from here to Laurel, it is getting harder to see any farming…and it’s getting to be more things right along the road…more developed. And some of those guys are my friends. (*Yellowstone County Local Civic Leader)*

The experience of floating the river changes dramatically if you have houses on both sides of the river. Right down at the river….How do we encourage understanding that there is the possibility of losing that…[and of losing] the culture of Montana?…If we are not careful, that’s what is going to disappear on us. The reason everybody wants to be here is the thing that is threatened by them wanting to be here. How can we articulate that? (*Yellowstone County Local Civic Leader)*

E. Planning Boards

[As a planning board] we are sitting there looking at the overall growth plan: what would be ideal?…[How should we] use our infrastructure the best? Our water? Sewer?…We…develop a master plan which is for guidance only….Then somebody comes in and says, ‘Okay, I want to build a rural subdivision, and I want to have 50 houses on one or two or three acre tracks.’ We review that....That’s our main role, to be a citizen review board, and then we pass our recommendations on to the city, if it is in their jurisdiction, or the County, if it is in their jurisdiction. The elected officials make the final decision. (*Yellowstone County Local Civic Leader)*

[Landowners] do not have the right to…do anything they want….[In one] situation, where [a fellow wanted] a subdivision,…[there was a] big petroglyph on the site…[and this] conservative planning board…[was] saying, ‘The guy owns the land and he should be able to do what he wants with it.’ Now, wait a minute….This is a cultural resource. It belongs to all of us….[We can] force this guy to do a cultural resource inventory, which would be really expensive….But, [he can also] register this site with the State Historical Society and…put a deed restriction on the lot. (*Yellowstone County Local Civic Leader)*

I’m one of only three non-realtors on the planning board, out of ten. So I come to the table with a whole different idea of what planning should be. You look at the old flood plain maps and there’s a lot of leeway in them….If you’re building an irrigation system, then we should talk….If you’re that young couple, that bought that house and you don’t understand the issues, it’s going to hurt you a lot more than that developer who maybe should have thought about it before he put in that subdivision….The problem [with realtors on the planning board] is that they are out there making a living [by] selling property….I don’t blame them…but I think [the planning process] is more of a public issue. What’s our policy going to be? What do we want to do? Then [the developers have to] follow the policies....I think it’s beyond a realtor. (*Yellowstone County Local Civic Leader)*

V. Pressures on the River Character and Water Quality

A. Rip-rap and Channelization

The natural processes of the river [include] erosion and deposition….I understand why [people who live near the river] would [want to stop erosion], but from a geologic or scientific viewpoint, once someone affects one part of the river it will affect another part of the river. There are consequences….If you put in…rip-rap then that may cause scouring in some places and deposition in others. You may be affecting your neighbors….Those types of things need to be considered….I think it is important to approach this from the scientific point of view. (*Yellowstone County Local Civic Leader)*

I would like to see more of the original river come back. The meanderings, the flooding, the islands, get rid of the rip-rap, that kind of thing. I'd like to see that come back. I don't think that would impinge a lot on industry…but at the same time I realize it is a complex issue trying to tell somebody he can't rip-rap his 100 acres….But this isn't rocket science, but I mean, this stuff can be worked out; some sort of compensation can be set up….You have to do that. That's part of working together to get something done. (*Yellowstone County Local Civic Leader)*

The erosion issue is a tough issue….Are we going to armor the whole [river]?...What's the right thing to do if it's your 100-acre farm that you're going to lose?...If you look at the old maps,…that river moves….If I was a landowner along-side of [the river,] erosion would be a huge issue for me….If you're the City of Billings and it's at your intake for your water system, rip-rapping near that might be a pretty important issue. Where do we go with that?...I'm sure that armoring the whole river is probably not the answer, because if you armor one spot, that force is going somewhere, somebody else is going to deal with that. (*Yellowstone County Local Civic Leader)*

We used to just push cars in the river. I remember along the Milk River….What an ugly sight, but it worked. There were places they'd have half a mile of cars piled up, just push them off into the river for rip-rap. They were allowed to do that at that time. They're all gone now. (*Yellowstone County Local Civic Leader)*

Even in Yellowstone County, we have a lot of extreme bank armoring. You can see it in very site-specific areas where the armoring has caused erosion just right downstream from it. The velocity increases where the bank is armored and you get swirls and eddies downstream that cut into the bank….On a site by site case you can see evidence of how armoring really does change the dynamics downstream. It's not [only] development; it may just be a farmer trying to save his field. It doesn't have to be a subdivision, housing development. (*Yellowstone County Local Civic Leader)*

If you stabilize the bank in one area and…don't really do a good hydraulic evaluation, you're going to erode something downstream. The river has to dissipate energy, and it's going to dissipate it by eroding the next guy's bank. If you graze off all of the riparian plants along the river, you're going to have a whole lot more sediment…than if you had good turf, trees, and all things that attenuate flood flows and that don't allow a channel to migrate as rapidly. (*Yellowstone County Local Civic Leader)*

Channelization is a problem because the river loses its ability to cleanse itself, it increases flooding, it does a lot of things in the long run that could be disadvantageous to a system like this….A river that no longer has any of its own storm controls—oxbows and a nice riparian zone—doesn't attenuate extremes….Rip-rap destroys the river environment, and, from an outdoorsman perspective, it's awful….It channelizes the river, it moves the flood…events down the river. I think there are points on the river where you have to [protect the banks] because of our historical practice of locating facilities that are almost impossible to move. If I had my druthers, would I druther those refineries were away from the river? Yeah. But we can't move them today. (*Yellowstone County Local Civic Leader)*

I've seen a lot of different things. In my mind, the rip-rap is the worst that there is because it just protects the bank at that location. Generally, it gets eroded behind it. You see those old rip-rap trails in the middle of the river eventually. I've seen the river barbs that come out and they're oriented upstream, and basically it diverts the flow away from the bank. These are navigable. You can still go over them in low flows or avoid them in low flows. They don't go across the river. (*Yellowstone County Local Civic Leader)*

[At the Billings water treatment plant] we do have plans to build up the access road and do some rip-rap and get that up higher than the 500-year flood plain. They are looking at…raising the road up a couple of feet. I don't know when or if that will happen….As far as somebody that uses the river a lot, the element of the banks is an issue. It does create some good fishing holes but it also increases the velocity and channelizes the stream….They have [also] channelized the river a lot at the water plant to make it deep enough to get [City] water. They channelize big time to try and keep it deep enough….Laurel has done the same thing. (*Yellowstone County Local Civic Leader)*

B. Billings Turned Its Back on the River

I think Billings is really lucky to have the Yellowstone flow through it. Unfortunately, Billings turned its back on the river and lost sight of its value. Consequently, we get a lot of bad development down by the river. It's almost like throwaway land….In some cases development is good if…it reorients us to understanding the value [of the river]….We've allowed our industries to be along the river….I see a lot of waste and bad development occur along the river….It's almost plighted. (*Yellowstone County Local Civic Leader)*

When I was a little kid,…our landfill dump was down on the other side of Conoco, where Midland packing used to be—that's where our landfill used to be….That's where the garbage went, and….we would bulldoze it to the river. That's why there's so much debris….When people [went] down there and they started the bike path through there, they couldn't believe the junk that was in there. But we bulldozed that for years down there, and that's where all the junk went. (*Yellowstone County Local Civic Leader)*

We…need to take advantage of the aesthetics of the river, because now there is just junk down there…and there's a refinery on one side, and then the treatment plant, and then a trailer court….You would think that would be prime real estate. (*Yellowstone County Local Civic Leader)*

[The river] is kind of an anchor for Billings…that doesn't get seen very often, or appreciated….If you develop it, you try to work with it and try to use it as a natural system rather than trying to control it [or] channel it….[Focus] more on developing compatibility with natural resource systems rather than trying to control them….We've gone beyond that age….Those rivers were here a long time before we were, and they did just fine….We don't…spend enough effort thinking about that end of it….That guy who built those artificial islands, did you see that? Wasn't that cool? Wow, that was a neat deal. (*Yellowstone County Local Civic Leader)*

I'm always looking at things how we should be able to improve our community, and I think utilizing the river to me would be one of them….Down in Santa Fe…[and] in the Laughlin, Nevada, you can walk the river[s]….But in Billings, we seem to shy away from the river….I think we ought to utilize the river because it's so beautiful….I think we should probably be…promoting use along the Yellowstone River….either [with] more bike paths or trails along the Yellowstone….I don't think we would let people build right on top of the river….Basically learning from Santa Fe and Laughlin….If we could do something like that here, I think it would be well worth it if our economic development program [would] look at stuff like that. (*Yellowstone County Local Civic Leader)*

C. Industrial Threats

Thermo-loading back to the river is a problem….That is cooling water that is taken out, like…at the refineries, [for] they're cooling water. That water is returned to the river. It changes the thermal characteristics of the river, so it's thermo-loading. They have some pretty tight controls. (*Yellowstone County Local Civic Leader)*

The further that there is a buffer zone from any other user of any substance, the better off for the city….Industrial facilities right on the bank of the river are an awful thought to me. (*Yellowstone County Local Civic Leader)*

When Midland Packing used to be down there,…they would dump everything down into the river….Nowadays…it's improved….I think we should still pursue that….With the refineries, I think they should be watched more closely. I know with the oil spills that we had four or five months ago, they never did find out where that one came from….Nobody admitted to it….There has been a lot of improvement, [but] I think we can do more. (*Yellowstone County Local Civic Leader)*

There are some…man-made chemicals that are probably added because of ignorant use by people in urban areas, things like…prescriptions [that are] put it in the toilet and flushed down the drain. Worst possible thing you can do. A lot of those things we can't treat, so it goes right into the river system. That needs to go into a landfill or it needs to be disposed of in a hazardous waste landfill. (*Yellowstone County Local Civic Leader)*

The pharmaceuticals and other things are considered emerging contaminants and it is something that is being investigated now. Efficiently run treatment plants remove 99 percent of the pharmaceutical drugs. It is not only what is flushed but what is passed through people. The one percent they [find in streams] they are thinking is still enough to affect aquatic organisms. Not enough to affect humans. It is down below parts per trillion. (*Yellowstone County Local Civic Leader)*

I think we would have to watch so that our rivers are not polluted,…but I think they ought to be utilized, I really do. I think we should be able to develop something, even if it were away from the river. (*Yellowstone County Local Civic Leader)*

D. Noxious Weeds

The only other issue that's the big one is the noxious weeds….There's just about every horrible weed you can find on the Yellowstone….I don't know how it got started, but it definitely goes down the river. If you just go on the riverbanks and look, that salt cedar is just about everywhere now. We can't hardly go anywhere without seeing leafy spurge and…it's a very competitive plant. It'll take a field over….You can't just kill…knapweed and spurge….I can only imagine if we don't get a handle on that how that will look in ten years….Salt cedar is an issue we used to only talk about around Sidney. Now…it's all over the Big Horn. (*Yellowstone County Local Civic Leader)*

It's a big deal, and I think it's in the public interest to fix those sorts of problems. The landowner is important but the [is] public too….We do have some spraying programs [for noxious weeds]…but it's a lot bigger than the little bit of funding we put out there right now. And it's in the public's interest, not just the landowner's interest, to take care of that. Just in Yellowstone County, I can't even imagine to effectively spray those areas, what would that cost. I can't even imagine. Millions and millions of dollars, I'll bet. It's expensive. You don't spray that real easily. You can't just spray it once and control it. You can be years down the road, ten years down the road before you can fix it. (*Yellowstone County Local Civic Leader)*

VI. Comments on Agriculture

A. Agricultural Uses and Water Supplies

Even irrigation is not a consumptive use of water, other than the evapotranspiration….[In the] water cycle your evapotransporting is going up, and raining back down. Water is neither created nor destroyed. (*Yellowstone County Local Civic Leader)*

I've got land and we raise cows…but, you know, I even question sometimes flood irrigating. It isn't the most efficient use of water. They've shown that sprinkler systems are a more efficient use of water, so they have less runoff, and waste and fertilizers…hauled down….In some states, the amount of surface water has been reduced such that you can't afford to keep flood irrigating. There will be some issues like that in Montana, I'm sure. (*Yellowstone County Local Civic Leader)*

Right now we're converting a lot of flood [irrigation systems] to pivots [systems]. So we're reducing the amount of usage, but then again, we are adding acres. So we are spreading water and using it more effectively, but probably not gaining a whole lot to the stream. (*Yellowstone County Local Civic Leader)*

Irrigation, more so than municipal use, has changed the river….The river flows less in the late-spring than it did historically because of irrigation withdrawals. It floods more in the winter because of base load return, because, when irrigation is charging the alluvial aquifers, the aquifers sustain the river in low flows. Without that irrigation, the river would certainly run in greater extremes, both on the top and on the bottom. That is good under some conditions for flushing flows. It is bad in others when it dries up. You hear a lot of rhetoric and a lot of discussion about water uses. A lot of it I believe is totally uninformed. (*Yellowstone County Local Civic Leader)*

Irrigation is a problem if [the river] is over-appropriated and dries up midstream flows. It is not a problem if it creates a larger riparian zone, which it has done. The abundance of life is huge compared to what it was previously. (*Yellowstone County Local Civic Leader)*

Agriculture is clearly a commercial use. Historically, everybody tries to say, you can do anything you want in agriculture as long as it is agriculture related….But if you view it as a commercial use, then when a residence comes in there, you've got [to] look for a compatibility between commercial use and residences….We have a lot of subdivisions on the west end, and out east too, where the people say, 'Well, this isn't commercial use, this is Ag use.' A feed lot is a commercial venture. And it has an effect on the neighborhood. I get a little irritated sometimes with people who get the idea that we have got residential development, commercial development, industrial development. And then they act like agriculture is sitting up there as some sanctimonious outfit that can do anything they want, when in fact,…if you put a hog operation right down on Big Horn River, like they did, you…[get] pollution issues….Agriculture, just like any other business, has to be accountable when it comes to our water. (*Yellowstone County Local Civic Leader)*

B. Agricultural Practices and Water Quality

We are seeing such a change in philosophy even in the farm and ranch community about riparian areas. Everyone used to just perimeter fence their cows; you have a mile square section or half a mile depending on whatever land you own. And now they are starting to fence the riparian areas out so the cows don't trample through the brush and that natural filtering system. That is kind of a farm management thing that is good for the environment. (*Yellowstone County Local Civic Leader)*

Bank erosion today is caused by inappropriate use of the riparian zone, primarily….It's a trade off: do you want to have your cows and calves down in the river under the trees or do you want to take care of them somewhere else? Well, the old-style method was down along the river. Well, they trampled the shit out of everything. The Yellowstone is a big river, so you don't see it as much as you see it on the side channels. The Clarks Fork is awful. It creates nothing but trouble for us because of sediment coming down. It's a very erodeable country….it erodes something fierce. [And] it's got years of that sediment built up right in the flood channel. So, even if you were to correct it today, it will continue to move that stuff forever. (*Yellowstone County Local Civic Leader)*

Irrigation wasteways return sediment to the river, that's a problem for me….Typically, wasteways bring a lot of sediment back. That's where excess water in a canal system can be dumped back into the rivers. When you do a lot of flood irrigation, often that water will collect and drain…back to the river….That's okay, except that it's usually carrying lots of sediment, which is washing away your topsoil and it's also putting sediment in the river, so you're changing the quality of the river ecosystem. The higher sediments change the types of creatures that can live in the water. (*Yellowstone County Local Civic Leader)*

Number one is agricultural chemical runoff…that's a huge use. Chemicals either leach from the soils, and get into the alluvial aquifer….The river is a huge dilution source, relative to the concentration….Aquifers move in inches and feet per year, versus feet per second like a river. So [water] moving back into the river [from the aquifer] is a very slow process. Something you did years ago may [appear] later. (*Yellowstone County Local Civic Leader)*

Something that is really brewing is the run-off from agriculture operations, be it herbicides or animal waste. Getting down into the river this will be treated as a pollutant and you have to have all retained on-site. I don't know how you are going to do that. If I spray my field for aphids and I flood irrigate and some of the herbicides gets into the waterways and ends back into the river. Or my cow craps in the field and it runs off. I mean, there are some problems. (*Yellowstone County Local Civic Leader)*

The agricultural communities are learning about that [run-off] and they are finding out that with flood irrigation and you have a little riparian area that has natural weeds and stuff to filter that wastewater back into the river, you filter most of that stuff out. Not all of it, but there are solutions. (*Yellowstone County Local Civic Leader)*

I've got to credit agriculture....Most people make sure that they [don't] overgraze and,…for the most part the responsible people have tried to be good stewards of the lands as far as grazing and vegetation and the creek beds….The long-time, old-time farmers and ranchers…did a pretty good job. (*Yellowstone County Local Civic Leader)*

C. Agriculture's Potential Allies

A lot of times I don't even understand how agriculture and recreation have any issues with one another. They both want water storage....There are fights and [then] there's a lot of perceived problems....The Pallid sturgeon is a good example of a conflict. It's going to cost somebody a pile of money to pass those fish up and down the river from the different diversion structures….I tried to explain to [the agricultural community] that 'You need to listen to the Feds on this deal….It doesn't cost you anything, and you get your diversion structure rebuilt, which is in horrible shape. The fish get to pass around it, and you still get everything you want. You best be looking that direction. There will come a point where you will pay for that structure and that fish passage issue will be added to your bill. If you don't want that then you need to be at this discussion [and say] that's an appropriate use of Federal dollars.' An environmental community will agree with that. The Ag-recreation deal is just absurd, really….The recreationalists on that river don't really hurt anybody, and the Ag guys…there shouldn't be an issue there. They both, the recreationalist and the environmentalist, want the Ag guy out there. (*Yellowstone County Local Civic Leader)*

Once I explained…'Hey this fishery is the best thing that could happen to you….You're downstream of the need to have 2000 CFS in the [Big Horn River] for the fishery. So, don't cuss at those trout, because that's the best thing you could have. Now you've got the fishery people on your side….They don't care that much whether you're taking the water as long as it gets past Two Leggings [drainage]—the end of the blue ribbon stretch is in there.' And once they figure that out, they liked that idea. (*Yellowstone County Local Civic Leader)*

One of the problems the Yellowstone has, and I struggle with it everyday, is our ideal in the Ag economy….The Yellowstone has a diminishing population base in the rural areas….You go to Sidney, you go to Glendive, [and] the oil industry has helped. But that's a superficial expansion….where the oil industry comes in. They drill some wells and do really well for awhile, and then it goes to heck….My issue is the economy….Not lately, but we've seen a lot of money-guys come in and buy ranches along the Yellowstone. That continues to happen from time to time. It changes the whole dynamic….The rural economy is in tough, tough shape. The ranches are getting bigger, the farms are getting bigger, [and there are] less people….A professor from Harvard came in—this was about 20 years ago—he came in a said…we should…turn Montana back into a buffalo pasture. Made a lot of us mad. But up by Malta they put in one of these buffalo pastures, and there's getting to be a lot of buffalo….He said that's the best use of this country. I hope he's not right. (*Yellowstone County Local Civic Leader)*

VII. Stewardship and Complications in Managing Public Resources

A. Stewardship and Property Rights in Public Policies

I don't feel the river is broken in any way, so I don't see it needing any fixing, as long as communities along the way aren't polluting the dang thing….That's the only way I could see that it would need any more control. (*Yellowstone County Local Civic Leader)*

We all take for granted the Yellowstone River…and we can't do that any more. The value of the river is that…she's kind of a spiritual entity….The whole basis for the existence of life here. If we didn't have that river here, where would we be?…The right of the river to exist in a natural environment is a priority….It benefits us as a place that people want to live, as a place people want to visit. It's a place that enhances our sense of ourselves. It kind of blesses; it enhances. (*Yellowstone County Local Civic Leader)*

A huge percentage of…people are good stewards. Then there's this percentage that aren't….[Good stewards] leave it the way you found it. The next generation needs to use it too….We're not very good at next-generation thinking. I'm not sure we ever were….We haven't made the philosophical change to that thinking yet….I'm a believer in wise use, and I don't think we've defined wise use. It's not merely conservation; its wise use. (*Yellowstone County Local Civic Leader)*

If one takes a look at where we were in the '50s and '60s, and where we are today, one would have to say that there's no need for pessimism….Have we done enough? Probably not. But it would be unbelievable if we hadn't done anything. Even here, it would be unbelievable. If private property rights were totally valid and you could do anything you wanted to do, it would be pretty awful. (*Yellowstone County Local Civic Leader)*

Guess who the property owner is in all of these [public] green ways? You and I. We have property rights and we support those property rights. (*Yellowstone County Local Civic Leader)*

Waterways are public….[Unfortunately,] the closer people are to the river, the more they feel it's theirs and they put up barriers for recreationists….At least in the navigable waters,…setbacks should be required. (*Yellowstone County Local Civic Leader)*

The increase in population pressure never stops….We need to find a way to protect the river assets because there is getting to be more and more and more of us. And we all want a piece of the river for our own private purposes and…you can't do that. I think we need to do some planning on the river before you destroy what you love….By taking a look and starting to appreciate…what a tremendous resource the river is….You have to look at use options and priority settings and water rights. And I think you have to work together with agriculture, and recreation, and industry. I don't like to see the either/or options being thrown around. No one ever benefits by that. I guess that is what I mean about planning. (*Yellowstone County Local Civic Leader)*

They say once you hit [a population of] 100,000 that the next 100,000 comes twice as fast….We'll see. We've had about two to three percent growth a year, which is not like…Bozeman and Belgrade, [and] Kalispell…[where growth is] seven to eight percent [and] you just can't keep up with it….I anticipate that Billings will continue to grow at about three percent and so that will require increased use of the water and, of course, more streets and sewage and sewer and gutter and all that kind of stuff. (*Yellowstone County Local Civic Leader)*

Priorities probably should be in health and safety. But we're…trying to finagle what we have…instead of trying to conserve….Our priorities should shift to a more conservative attitude as far as water usage. And then maybe the question wouldn't be so hard as to whether it's going to be Ag or human consumption….You do that through a variety of means that could support a natural system as well as provide for drinking and agricultural water. We waste so much water through those ditches it just drives me nuts. The leakage of the ditches and evaporation from them—there's got to be a better system than that. Yet, it's contributed to our groundwater and that's something people rely on. (*Yellowstone County Local Civic Leader)*

The river corridor is like the whole valley. In places, the Yellowstone River valley is miles wide. The river is actually maybe 600 to 700 feet wide, but there's from hills to bluffs on both sides; it's pretty extensive….You have to be careful, I think, so wherever little creeks that drain into it, and we need to be careful not to impede those….There's things that could be done towards the outskirts of the corridor that are definitely going to affect the river. (*Yellowstone County Local Civic Leader)*

You can't say, 'That guy is a good guy; he's my buddy. His ranch is right next to mine, and he wants this diversion…,Ok, he can do that.' (*Yellowstone County Local Civic Leader)*

There is a conflict between private ownership and access…[but] somehow the public has to have access….The public should have the right to walk the banks of any stream or river….The conflict that will probably never be resolved in some situations…[but] I wish there was a way that could be ironed out because I think the public, more and more, is being denied access to rivers and streams and mountains. I would be an advocate for the public's right to enter those. (*Yellowstone County Local Civic Leader)*

Bureaucracy is a tool that you can either use to your advantage or a disadvantage. The fellow that [complains] probably doesn't realize the benefit he's getting from these layers of bureaucracy….You have to have a goal…and be able to…see the pieces of the puzzle….Then move forward. If you're too hesitant to move forward, people along the side of the road are going to grab you and take you away from your goal. Then…you have to step back and evaluate because maybe you don't really understand your goal….The general rule, I believe, is that [bureaucracy] serves the purpose for which it was intended—it serves the people. (*Yellowstone County Local Civic Leader)*

B. Tensions Between Agencies' Missions and Governing Entities

Now, we are very fortunate in Montana that those major rivers supply a tremendous amount of water….The State of Montana…owns the water. And the thing that bothers me most…is the Federal government and the Corps of Engineers and their control over our water. They [can] demand water…downstream…[to] float barges in the Mississippi….That is always bothersome to us. (*Yellowstone County Local Civic Leader)*

You have the Fish, Wildlife and Parks with the mission of access….Then you have….the road department that tells the private owner that if you give me a right-a-way, we will fence it and keep the public off your property….Down by Duck Creek…you have a river…a private property owner and…you have a bridge. [The area by the river] is all within the high water mark so [the public] can [be] down there…[but] to get down there, people do what? They drive down,…violating this guy's right….because the State said, 'If you give me my road right-a-way through here, I'll fence it.' So [the State ran the] fence…up to the bridge [and] the public can't get from this public right-a-way to this public right-a-way without climbing over the fence. [So] they cut the fence….There are solutions:…pedestrian gates through there, and better enforcement by Fish, Wildlife and Parks. They often will open an area up but they count on the Sheriff's Department or somebody else to put out the bonfires and the keggers….[This] is a State issue….They sign those agreements for 'highway uses only'.…Quite honestly,…you need to provide adequate access where you can because [the river] is a public resource. (*Yellowstone County Local Civic Leader)*

The cities can annex wherever they damn-well want….We [ended up with a] roadway between two subdivisions and they are in the City of Billings [now]. It was just asinine! So we passed a law that they have to take the roadways along with [the subdivisions] and [the cities] have to maintain them. (*Yellowstone County Local Civic Leader)*

The other thing which Billings hasn't done, but I think it should,…is annex [the land between the City and the river]….The land from Garden Avenue to the river is County, and it's all septic….If you…are trying to get them on to a sewer system, the only way you can do that is annex them. What we're going to try and do is focus a planning effort down along that corridor and talk to the people….Their systems [are old and] will be failing…and they'll need to make that decision: Do they want to annex and get sewer, or do they want to replace [their septic systems]?...So, it's a good time to get in there and show them the benefits of getting on sewer….The City can't force annexation, but we sure would encourage it. It's expensive for people to…get hooked up to sewer [after the fact].…[Where we have annexed] we're playing catch-up,…which is why I say [that area] is plighted. It hasn't really reached its best development potential. (*Yellowstone County Local Civic Leader)*

With regard to development, the State ties your hands in some regards. And the worst regard…is that water issues don't need to be addressed under subdivision….We had a subdivision here and it barely has enough water for itself because it is outside of the City of Laurel. If a sub-divider comes in and says he will build a subdivision right here, and the next one comes in and builds here, at what point can we say, 'You can't do this because then [the people in the first subdivision] don't have water.' We can't do that because the State won't allow it….The link to the Yellowstone River is [that] they will eventually say, 'Please annex this and get us water'.…We let a subdivision build in that same type of situation…[but] we did require them to put in ponds to recharge the ground for the subdivision below them. (*Yellowstone County Local Civic Leader)*

C. The Complications of Setbacks and Corridors

I believe that there needs to be corridors….Not only to protect the river itself but [also] the wildlife systems that are in that river. I would love to see public funding in some of those issues. That is kind of wild for me to say considering I come from a Republican background. (*Yellowstone County Local Civic Leader)*

[In the] last few years people are talking about a numerical setback of, say, 300 feet….In some cases that would be sufficient, in some cases it would not….Those things are best viewed [by] scientific data, elevation data, [and] topographic data that is accurate enough to determine what the 100-year flood plain levels are….[If the scientific data] sets up a duel type of a regulation that [will be] confusing to people….It is important to have those flood plains and floodways delineated so that when the river is at high stages it doesn't do the tremendous amount of damage that it can. (*Yellowstone County Local Civic Leader)*

[With] our zoning regulations, we also have a setback from water courses required. Unfortunately, it's only 50 feet from the center line.…You'd have to study it. I've seen counties that have had up to 300 feet, and that could be severe. I don't know if there is one size that fits all…[but] bigger setbacks are getting to be more common, and those are good practices. (*Yellowstone County Local Civic Leader)*

Do you want me to come in and tell you what you can do with your 160 acres? And what if that is where you put all our resources…and your plan ultimately was to…pay for your retirement. Then along comes the government and says now we are going to make this a riparian area. This is a green space and you can't develop that. I have just wiped out your assets. The government has to be careful that controls don't go overboard…[and] start infringing on private development rights. (*Yellowstone County Local Civic Leader)*

[In] a new set of subdivision releases,…for the first time in Stillwater Country, setbacks from the river are going to be a consideration….[The requirement] didn't say you have to be 50 feet back—it doesn't work. However, if [the subdivision is] in an ecologically sensitive environment, [a setback can be] a requirement, which is a major step forward for a conservative county. So that was cool. (*Yellowstone County Local Civic Leader)*

The opposition will be out there….It's because you don't look beyond the fact it's my property and you can't tell me what to do with it. Public policy can't tell me what to do with it. Now, he might be the same guy that would sell a conservation reserve on that property voluntarily, but if you said, 'We on the Yellowstone are going to make this policy,'…it's just—I don't know what to call it…[It the] It's-my-property-and-you-can't-tell-me-what-to-do-with-it mentality. I don't know what to call it. I know it's out there. I've seen it all the time. (*Yellowstone County Local Civic Leader)*

Politically, whether you can define [a setback] depends on who has the juice and where they're located. We're humans and politics rules sadly sometimes. (*Yellowstone County Local Civic Leader)*

I would be very much in favor of [a] setback.…It's dangerous [to build near the river]….It's an obstruction to a natural river. And what happens when you start building along that river is you've got to protect them. And now you're forced with making decisions that are contrary to the natural flow of the river. So I think that setback should be in effect. I don't know what that number would be, but it needs to be out of the way, that's what I think. And that is regardless of ownership. It's just it should be a building restriction on how close you can get to that river. (*Yellowstone County Local Civic Leader)*

You know, the Constitution of the United States, with its Bill of Rights, as well as the Montana Constitution, absolutely lists as an inalienable right your right to property, both personal and real. And you should be able to develop that to the highest and best use. The biggest problem that we get into then is the responsibility of the property owner….It was absolutely wrong for people to develop their copper at the expense of everybody else's environment. That was wrong. It is wrong today for somebody to build a house that is inappropriate and…destroys other people's values. So the balance between our right to own a piece of property, and to develop that piece of property as we see fit, either for our own aesthetic value or market value,…between all of those bundles of rights and the responsibility of a good citizen, as a neighbor…that's where, I guess, government and rules and regulations and so on comes in….What is responsible in my opinion may different from your opinion….Refereeing the property rights [is important, but]…without a question, we're going to defend private property rights….People should be able to hone that property and invest and make money in it, or sell it, or whatever. But there is a responsibility that goes with that ownership. (*Yellowstone County Local Civic Leader)*

People who want to carve their own niche out of God's country for themselves bring problems….Because of our own history of 'let the other guy do what he wants,' which I believe in too, we have a conundrum….I tend to fall on the side of 'let the guy do what he wants unless it affects me.' And I consider it affecting me….It's restricting access of others for recreational use….[It's] wanting to control [the river] so that it doesn't impact their little niche. (*Yellowstone County Local Civic Leader)*

I think you would have any landowner organization, probably the stock growers [or] any outfit that represented a large landowner base, [oppose the idea of the corridor]. That's just how it is. If you're the NRA and somebody says, 'Let's get rid of bazookas,' you're going to be against it even though the average guy is going, 'Why would I want to own a bazooka?'…When you are a group that's trying to protect landowner's rights, it's the same. (*Yellowstone County Local Civic Leader)*

After the '96 and '97 floods, there [were]…multiple projects….The Corps approved some, didn't approve too many, but as the pressures build, we will have ourselves a canal instead of a river. There's a 404 permit process [and] sometimes it works, sometimes it doesn't. It depends on the Conservation District….They can, depending on who [sits on] the Conservation District board, be very rigorous….I think there ought to be some basic principles that have to be satisfied, and I think that those are conservation of the riparian zone, and conservation of the hydrologic character of the river. (*Yellowstone County Local Civic Leader)*

You don't have to have houses right on the river….It wouldn't hurt them to push it back from the river a little bit, so you couldn't see [the houses from the river]. That is a big step, but I think it's a possibility….We could put homes in [the trees]….It's going to be a long, long time [before people will accept the idea, but] I pushed it and I don't get the opposition that I did. (*Yellowstone County Local Civic Leader)*

It's like everything in life: there's middle ground. And absolutism is a problem. I don't care what it is—religion, land, you name it—absolutism is crazy. There are just a whole lot of people who can't see anything but black and white. The rest of us see grays….It's a struggle. Thankfully, if you look at it in my lifetime, there's a…majority that have seen the grays for periods of time….There's a general consensus that things ought to be better, and that,…collectively, we have a responsibility to the next generation….[But] it costs money. (*Yellowstone County Local Civic Leader)*

VIII. Fulfilling Regulatory Duties

A. Informing and Working with the Public is Difficult and Important

I think that the average person relies on whoever is developing the property….[People] don't think the Yellowstone River can flow 50,000 CFS—it's only running eight CFS [when they look at the property]. They haven't been there that day when it goes from bank to bank. (*Yellowstone County Local Civic Leader)*

The methods…that are based on hysteria methods don't work because they breed the opposite reaction….Credibility is a real problem when you do that….I had a lady call me the other day, 'I just listened to Oprah and somebody on there said the bird flu is coming, and you can expect not to have any water for six weeks.' She was a young mother and was scared enough to think that it was true—that we don't stock any chemicals so we can't treat water…We stock the average supply of chlorine, which is three days in any plant….But even if we didn't have any chlorine and weren't able to treat the water, all you have to do is boil it. (*Yellowstone County Local Civic Leader)*

People have to realize that there are two sides to every story, maybe one good, one bad, but there's two sides. I learned a long time ago when I was working that I had to listen to both sides, and then maybe my side really wasn't right, but maybe the other person was right. And so you learn that…you're always going to have pessimists in whatever you do, but I think…people [need to] understand what you're trying to do…[and] keep them involved. Don't do it behind their back, because you'll lose everything. (*Yellowstone County Local Civic Leader)*

[When] you have people who are talking emotionally, [you can] get caught up in the emotion, rather than the facts. That's why it's important that you have people who can present the facts….Make the decision that's for the betterment of the community. A lot of times, if you get caught up in the emotional decisions,…you walk away and say, 'What did I just do?' (*Yellowstone County Local Civic Leader)*

I think people…have to be educated…that certain times you can swim in the Yellowstone River and certain times…not….The Yellowstone is a treacherous river. People don't' realize that. Sure, everybody thinks it looks nice when it gets hot and you go in there and jump in, but you get such an undercurrent in there, and you don't know what's underneath there. We've lost two or three people already this year alone….I think once people started utilizing this [river,]…we've got to [inform people to]…be careful…And you've got to use a little common sense, especially on the Yellowstone. (*Yellowstone County Local Civic Leader)*

B. Don't Force: Enforce in Ways Best for the River

Bad policy…makes people angry. And the one thing that we found out is that you don't force things down people's throats. You sit and work with them and you work on a solution to get it done. That is what creates the balance….We sit down and work it out….This is really a feather in Commissioner Reno's cap. We are going to actually have a grand opening…for a boat ramp access to a big island down on Pompey's Pillar. And that has been a site where there have been [both] trespassers and legal access to the river off a county right-of-way for the last 150 years. It is a great spot [for access]. (*Yellowstone County Local Civic Leader)*

One of the ways you maintain water quality is by having the river [in its] natural environment [and] it self-cleanses to a certain extent. That does not address man-made chemicals very well, but it does address natural things pretty well….I hate to sound too Republican, because I'm not, but there are plenty of laws on the books for that right now. They need to be enforced…[and] people need to pay consequences for misuse. I'm not sure there are any consequences right now for misuse. (*Yellowstone County Local Civic Leader)*

The Yellowstone River Master Plan….is basically a vision for a [set of] desired outcome[s,]….[such as] maintaining a natural system, and opening it up more to public recreation….Once your goals are established, then you start looking at some ways of achieving it, and those are your strategies. If you do it soon enough, and you do it continually—like, every five years or so—then you'll be able to take advantage of opportunities that arise….Somebody might want to donate land, or there might be land trade you can get into, or funding that suddenly becomes available that you can purchase land. [If] you've already established [areas] you should protect…you [have] the tools to be able to move in an opportunistic way. (*Yellowstone County Local Civic Leader)*

We have to respect people with cattle and animals….We have to respect that people have to have an access on public right-a-way to get to the river—you can't fence anyone of them out. You have to have a balance, but how do you do it? Do we use some fencing to keep the cattle in? Do we use gates to keep the cattle in and let the fishermen or recreationalists [get to the river]? That has been a tough one and not every case is the same. We have been beat up over it. (*Yellowstone County Local Civic Leader)*

Clarks Camp…They built it in the flood plain and we have now gone through five years of fighting with those people to get that removed. It [was] originally…just supposed to be porta-potties….Well, someone is living there now. They have been told to move it and they haven't. We have turned it over to the County and now they have the issue. (*Yellowstone County Local Civic Leader)*

We have been involved in some lawsuits. Clark Camp is a perfect example…we dug our heels in and said it is wrong—you are jeopardizing everyone's flood insurance along the Yellowstone River and you have to remove it. [The owner] put a lot of pressure on us…but we were not the ones who made the investment for him….We couldn't jeopardize everybody along the river. (*Yellowstone County Local Civic Leader)*

Create a balance instead of just putting up roadblocks. I have to say that our Conservation District board here is probably one of the most progressive groups I have ever met. They don't just say, 'Ag is the only thing…and, by God, if we need to put a new ditch onto the river,…[Ag can] just automatically get it.' This group takes painstaking hours to look at [the permit applications] and to see what is best for the river. And these are volunteers. Everybody says, 'Well, you come from the urban county and you could care less.' We have Billings, but if you travel around Yellowstone County we have a lot of rural areas [and] a lot of river. (*Yellowstone County Local Civic Leader)*

Slow is a relative term….If it's a very complex project, [one] that you've never heard of before, and you have to go to the State or some other agency to help make a determination whether this is ok, that takes a while. (*Yellowstone County Local Civic Leader)*

I don't know if we're ever going to be able to come to agreement of what we can do without disturbing the environment. Everybody is going to have to be real understanding….We all have to understand each other's concerns….In order to keep the balance, we have to have people that are genuinely concerned about the river, and they have to meet with the people that want to…make some use of the resources….A lot of people get upset because government moves so slow. Well there's a reason for that. Impulse is not a good thing....I think we just have to sit down and trust each other and work together at it. (*Yellowstone County Local Civic Leader)*

C. Identify Best Practices and New Ideas From Other Places

People will tell you they need the access, but that's usually too late because they realize that their access is being blocked. I think [it helps] bringing in somebody that has some experience in another place…[and make judgments] based on maybe projected population…and characteristics of the river….You might need some outside help. (*Yellowstone County Local Civic Leader)*

As you see the growth of that community on the river [near Laurel,]…you're going to see people who want to have access to the river….Hopefully we'll have guidance….We need people who know what that's all about to come [help] us….We've got some great river frontage. All the people of the City of Laurel own that riverside park. So we have a lot of vested interest in that. (*Yellowstone County Local Civic Leader)*

One of the roles [for the Yellowstone River Conservation District Council] is assembling information so that we can learn and share information with all those other counties who are having similar problems. Once you analyze all the approaches that everybody has taken, you can certainly filter out to the ones that rise to the top….I'm sure there are some spots that we could gain knowledge from what others are doing. (*Yellowstone County Local Civic Leader)*

What is lacking for me in my job is [information about] the state-of-the-art. What is going on in Delaware or Kansas? What is going on in Gallatin County relative to these issues?...If only somebody will bring to me the current trends. I was amazed when Gallatin County…put in a mechanism where voters voted to tax themselves to buy view sheds. [They didn't] want lights on top of Bozeman Mountain so, rather than zone it, [they] are going to buy it. When that was explained, it made me wish I knew some of the current best practices. (*Yellowstone County Local Civic Leader)*

We should be able to develop [information] that would serve all of our counties….To say, here's some of the pros…[and] here's some of the bad ideas we came up with….To make sure every county follows the same sets of rules that we make for everybody. And sometimes maybe one set of rules don't fit everybody, but education would work….If you could think ahead….Education is the biggest thing when trying to educate people to…think out of the box. (*Yellowstone County Local Civic Leader)*

If you want the government officials to get involved, give them some good, simple tools to use that are unbiased and that we can create a real balance. That is really what we need, instead of trying to figure out how can I out-smart these guys….And the other piece is, when you go with something that is just pulled out of the sky and is not affordable, you have started a project that is going to die. Sometimes people do that just to ruin a project. I don't understand that either and we get a lot of that. (*Yellowstone County Local Civic Leader)*

Analyze the information you have from everyone…and identify the best ones—best practices. That is how you come up with one….[But be honest during the process]….You have everybody, and they are nodding their heads, and then someone says, 'No, you can't do that. It is against this blah, blah, blah.' Well, you just shot that [idea] down and you just wasted three hours! Lay your cards on the table and be honest about it, for God's sake. (*Yellowstone County Local Civic Leader)*

Whenever we can make an opportunity to educate…that's one of the most important things [we need in Laurel]….We've grown to this point because of the water, and we're being impacted because…we have to understand what it took to get here and what's the best way to look forward. And that's going to be through discussions….People [need] information….Come forward anytime…[to address] the issues that the people of the City of Laurel want answered….We lack…opportunities to educate our city council…and I'd really like to have [informational] presentations. (*Yellowstone County Local Civic Leader)*

[If we had] a water storage containment system north of Laurel…we could use our excess water intake and pump to a reservoir and feed the whole Yellowstone Valley. Billings pumps their water all the way to 68th Street. It would benefit everybody. There is no way the City of Laurel could afford it, or Yellowstone County. If we have Federal funding it would benefit the whole valley….If that is the kind of thing…[you are considering, we will write] letters of support….That is the stuff we need to know. (*Yellowstone County Local Civic Leader)*

D. Agriculturalists Trust Agriculturalists

With the Yellowstone River Council we actually have Conservation District guys. [They have] buy-in for agriculture….I mean, if you're from Treasure County, you've got Phil Fox—your neighbor. He's on there. So, now all of a sudden, maybe there's a little more to this….Every Conservation District has somebody on the Council. Well, that buys you quite a bit….You take a guy like Kenny Nemitz, who is a personal friend of mine, he's not going to buy into something that's going to hurt a farmer. He just won't do that, I've known him for along time and know exactly how he is. Everybody knows him. If I'm his neighbor, I know…he's not going to go for something that's going to hurt the Ag sector….That's the buy-in. (*Yellowstone County Local Civic Leader)*

Just do an interview with the average person walking on the street in Livingston…and then go over to Sidney or Glendive and [ask] the same questions. You're going to find a world of difference between those two people….Because I grew up over in the east, sometimes I shake my head when I go over west…. I think your buy-in [with the Ag people] is with the Conservation District members—the members have fairly good credibility. (*Yellowstone County Local Civic Leader)*

There is a critical balance….It would be ticklish….Those who are really sensitive to the water [rights] would have some immediate red flags….It is a critical balance that we have right now….It is a real touchy balance. (*Yellowstone County Local Civic Leader)*

The 'family farmer' is barely making it…so, politically, there's a reticence to put any issues under control….All those things would improve water quality, both temperature and sediment control. There's also a belief system among many [Ag people] that there really is not a problem. (*Yellowstone County Local Civic Leader)*

There's a huge fear in the Ag sector about Uncle Sam—what he will and won't do…that Uncle Sam is going to take your livelihood from you—your water….And you've got alarmists in the Ag sector….[who hear about] some ideas out there, and all of a sudden…that's how it's going to be….[Ideas] get turned around….I sat in the coffee shop in Roberts, Montana and listened to two irrigators….They knew just a little bit on the subject of water rights…[but] they got a little piece of information that got turned over. (*Yellowstone County Local Civic Leader)*

You help people understand that they can better manage their resources….[For instance,] if you…fence your property right and manage your fields and your streams and your water resources, you can keep all of the cows out of there, and you can keep all of those filtering areas good and clean. (*Yellowstone County Local Civic Leader)*

It's dollars. [People adopt new riparian practices when they see their] land is of more value and [they] have better livestock if [they] protect that fragile area….[When they see the] land has an increased value. (*Yellowstone County Local Civic Leader)*

We have a lot of armchair quarterbacks out there….They never have the complete story….We give them time to spout off, and then we sit down and explain it to them. (*Yellowstone County Local Civic Leader)*

Big Horn River to Laurel: Recreational Interest Group Overview

Sixteen interviews were conducted with individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity. Participants were recruited from referrals provided by members of the Resource Advisory Committee of the Yellowstone River Conservation District Council. Participants were also identified and recruited by contacting various organizations such as Ducks Unlimited, Trout Unlimited, and the Audubon Society and by contacting local outfitting businesses.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Big Horn River to Laurel: Recreational Interest Group Analysis

I. Valuing the Yellowstone River

A. The Yellowstone "Adds to the Quality of Life"

The Yellowstone River is worth so much to this area and to the state as a beautiful river….It adds to the quality of life in Montana, not to mention a dependable water supply for municipalities and agriculture. (*Yellowstone County Recreationalist*)

The river…puts us in touch with our history….Clark went down the Yellowstone, and they had some steam-wheelers come up the river as far as Billings. And I'm sure that a lot of fur trappers used the river. (*Yellowstone County Recreationalist*)

We're avid touring kayakers. We love to go on the river kayaking and watch the wildlife, the deer the birds, the eagles, hawks, beaver, lot of beaver….It puts you in touch with nature and the cycles of nature….It's just amazing what diversity you see along the river….It's a pretty special place. (*Yellowstone County Recreationalist*)

It is a symbol of nature and a symbol of godliness….It is at the river that I best understand my role as a human being on this planet. I am part of nature, as you are and we all are. When you stand by the river you have a tendency to realize that. (*Yellowstone County Recreationalist*)

[I enjoy] the fast flow of the main channel, and the ripples in the main channel, and the color—it changes with the seasons. I like it when it is greenish and not so brown. I like it when it is flowing fast in June. (*Yellowstone County Recreationalist*)

I am surprised that you use the term river recreationist. It almost belittles the use because it is not just a matter of recreation. Recreation almost trivializes it, like it is something we don't need to do. With the river it is more than a matter of recreation, our very life depends on the Yellowstone. (*Yellowstone County Recreationalist*)

To me, it goes back to mental health….[We] need that ability to be outdoors and enjoy. Our kids…and grandkids are becoming so much more urbanized….Kids don't have the kind of freedom…I had when I was younger. I think we need those opportunities to keep a sane community.…That's why it is so fun to live in Montana because you've got so many opportunities to do that. (*Yellowstone County Recreationalist*)

B. The River as A Refuge

When you go down [to the river] you might see somebody else. But you could be down there all day, or all morning, and probably not see somebody else. I have an eight to five job, where I answer the phone 100 times a day and solve everybody's problems, and when I go out duck hunting or fishing or hiking, the only problem is, 'Should we stop here for lunch or over there?' (*Yellowstone County Recreationalist*)

It's wild. It's untamed. It almost speaks to me. It's a spiritual thing. When I'm on the river, and I just flow with the current, it relaxes me and it kind of de-stresses me. (*Yellowstone County Recreationalist*)

I used to be a big fly fisherman. [I] went up to the Big Horn all the time…but I just got tired of all the people and all the outfitters….For my purposes, and my friends and family, we really love [the Yellowstone] river. This would be our premier river. (*Yellowstone County Recreationalist*)

It [is] neat…to sit on the bridge and put your feet in the water. A lot of people don't get to do that. We're lucky compared to growing up back east where it's crowded. (*Yellowstone County Recreationalist*)

A retired teacher told me he thought [fishing] was just an excuse for doing nothing, so he never fished. I thought he missed something in his life. Even if it's a good excuse for doing nothing, it's a great way to do nothing….I'm pastor and I'm involved in a lot of things….I go out there….[and] the pressure's gone. [I like to] watch the river. Something's moving that I don't have to push. (*Yellowstone County Recreationalist*)

C. Free-Flowing and Natural

I would describe it as a wild, natural river. The longest free-flowing river in the country, not counting Alaska. A meandering, muddy river with gravel banks, and trees having fallen in, and a river that reflects the seasons naturally in color and size. (*Yellowstone County Recreationalist*)

[The Yellowstone River] is a meandering river. And you look all over the face of this globe, and see rivers that are in the stage of development that the Yellowstone is, and you'll see that the Yellowstone is doing what it's always done. (*Yellowstone County Recreationalist*)

You know, every other river in the country is dammed, and it is nice to have something that's wild in your backyard. (*Yellowstone County Recreationalist*)

The river will do what God wants it to do. It's going to change in whatever way it's going to naturally change. (*Yellowstone County Recreationalist*)

In the lower forty-eight, the [Yellowstone provides an] opportunity to float an undammed river [for] 670 miles—there's not any other opportunities like that. You can do it in Alaska, but not here, not in the lower forty-eight. So, it's a neat recreation resource. You go from cold water fisheries to warm water fisheries and view all the different terrain and countryside. (*Yellowstone County Recreationalist*)

[A free-flowing river] helps with cottonwood regeneration along the river. Cottonwoods are important for breeding birds….Cottonwoods need sandbars to germinate the seeds, and if you don't have a free-flowing river to help shift the course of the sandbars in the river then cottonwoods can't regenerate. And if you don't have trees along the river, it decreases the [habitat] for the birds. (*Yellowstone County Recreationalist*)

D. The River's Public Resources

I hope we understand that the river is something that belongs to the people of Montana. Just because you own land along it, you can't really own the river. (*Yellowstone County Recreationalist*)

Water being the thread of life, it's the most essential thing we need. (*Yellowstone County Recreationalist*)

[The Yellowstone River is] one of the most important riparian areas in this part of Montana….The riparian zone is a place that is adjacent to the river and it extends from the river back two or three miles….It's important for bird species and animal species…and aquatic [life]….[It] filters out the dangerous things that might filter into the river. It decreases erosion…and aesthetically it's very pleasing….[It is nice] to kayak the river and camp along the shores in the cottonwood groves. (*Yellowstone County Recreationalist*)

I really believe that every species has a place and….if you didn't have one species, it would hurt another species. So, it's very important to keep that…riparian zone….If you don't keep that, [a species] is going to die, or become extinct, and that's going to throw everything off. (*Yellowstone County Recreationalist*)

We're going to need to understand…the biologic resources of the river....What are the parameters we really need people paying attention to?...I don't think we know those things yet. And that's in the face of coalbed methane development….The BLM is looking at thousands of coalbed methane wells, each of which is producing water…with more saline. So the potential, if we don't have good regulations…would be very significant on rivers like the Powder and the Tongue. (*Yellowstone County Recreationalist*)

The river is a multi-use river. It's used for agriculture, it's used for recreation, it's used for generating energy….There's agate hunting, fishing, bird watching…kayaking…water for cities, and towns. I guess that's about it…Oh, [and] mushroom picking. (*Yellowstone County Recreationalist*)

[You have] cottonwoods…great horn owls, and heron rookeries. In fact, a Fish, Wildlife and Parks spokesperson told me that every seven miles along the river there's a bald eagle nest. (*Yellowstone County Recreationalist*)

I think it is an under-utilized resource….There are some great opportunities for enhancement and enjoyment of it….[We should] develop trail systems within the community. You know, with the river so close, as well as the rims, you have two natural resources that…most communities don't have. (*Yellowstone County Recreationalist*)

It seems like we use it, but we don't honor it….We use it for our own industrial interests, but we don't seem to give any of it back to the citizens…in terms of beautifying the many spots [along] the river. Of course, it is beautiful by itself in the more rural areas. But, when it comes through the many cities,…it doesn't seem like we've done much with it. (*Yellowstone County Recreationalist*)

The riparian area should all be restored. We have a lot of restoring on the river that needs to be done….[A natural corridor is] a natural habitat area. It does not mean [a] lawn right down to the river that is sprayed with pesticide to keep it green. It does not mean that. To me, [the riparian area] is a natural, protective thing. Maybe there could be bike trails and walking trails so people can enjoy that. Not storage and parking lots. (*Yellowstone County Recreationalist*)

II. Shifting Scenery: Development Along the Riverbanks

A. Homes on the Riverbank/ Flood Plain

Well, I guess Aldo Leopold probably said it the best, 'The flood plain belongs to the river.' (*Yellowstone County Recreationalist*)

If the realtors had their way, they would fill the flood plain with houses as they have in so many parts of the country. (*Yellowstone County Recreationalist*)

When they…develop in the flood plain…their actions can affect others. We have laws that limit what people can do on their property….Their development in the flood plain is not in the greater public interest and the greater public interest is what really needs to hold sway. (*Yellowstone County Recreationalist*)

I think another problem with people building so close to the river is that, aesthetically, it's not very pleasing….From what I understand they're going to put in some riverside trails….Hopefully [those trails] will keep the areas pristine and wild.…It ought to be just like the rims, [with] easements that set aside that [area]….Don't allow people to [build] right up to the river. (*Yellowstone County Recreationalist*)

The Yellowstone…is free-flowing and it floods a lot. So you better not put a house right on the edge of the river; it might flood and wash away. (*Yellowstone County Recreationalist*)

I think that we've been really lax in our state, county and city government. They've been allowing people to build too close to the river, and then the river rises in the spring, floods them out….Then, first thing you know, the people start rip-rapping and protecting the banks. (*Yellowstone County Recreationalist*)

You want to make sure [developments] are done in a way that they are not destroying the…feeling that you get from being along the river.…Keep your streambed, riverbed…in a more natural state. (*Yellowstone County Recreationalist*)

Keep it pristine and let it flow. It isn't like we don't have enough room to build a little bit back from the river. We haven't run out of room in this state, yet. (*Yellowstone County Recreationalist*)

B. Calls for Stricter Flood Plain Regulations and Stricter Enforcement

One of the most graphic examples of incursion in the river is...up in Paradise Valley, not too far south of Livingston….Five to eight years ago,…somebody came in and bought a chunk of land between the highway and the river, and that's now an RV park….We have RV tailpipes sticking out over the bank of the river….That's the kind of thing that just should never happen....Paradise Valley has been compromised so bad….[It has] been willy-nilly development….Consider the cost, financially as well as the amenities that are lost. (*Yellowstone County Recreationalist*)

I serve on the county zoning commission and [sometimes when] we get a request that is close to the flood plain….we don't even get a map with the request. So I ask, 'Where is this?' and they will say, 'Well, maybe a corner is in the flood plain, but it won't cause much problem.' So, we are changing the flood plain regulations….If I lived downriver from Lockwood, I would worry. (*Yellowstone County Recreationalist*)

[We need to] develop setbacks, like 300 feet back, and prohibit any development in the flood plain….We shouldn't allow any building out to the 500-year flood plain. Unless there is a high cliff, there should be a rigid setback in the planning. (*Yellowstone County Recreationalist*)

Much of the problem is allowing development within the river corridor, by which the natural processes of the river are jeopardized. You can avoid that development. Move it back away from the river, away from the river environment, and emphasize uses within the river environment that…can withstand some flooding. Things like parks or golf courses….Then the need for modifying…and channelizing the river seems to go away. (*Yellowstone County Recreationalist*)

We worked on a project to get together all the flood plain regulations across the state….We put them together and compared them, and we put together kind of a dossier….We started working with Yellowstone County and the flood plain administrator with that array of flood plain regulations and we got a fairly good set of flood plain regulations passed in Yellowstone County….I find it somewhat troubling that more and more it's being altered to accommodate encroachment by development…construction of buildings, homes, and other buildings that are right on the river banks or very close. They're in the flood plain, and then as a result of that, [there's] a lot of …rip-rapping—so called channel stabilization work—that's being used to channelize the river in the interest of protecting those developments. (*Yellowstone County Recreationalist*)

The ranchers and landowners should not build so close to the river, and I think they [should not]…have their cattle graze right next to the river….Cattle go down to the river and drink and they trample all the…shrubbery and grasses. (*Yellowstone County Recreationalist*)

[We need] good, thoughtful flood plain regulations within a county to protect that critical resource….[The Yellowstone River Conservation District Council] has the muscle to do that within State law. Within that flood plain there's quite a bit of authority to do the right thing. (*Yellowstone County Recreationalist*)

I think where [the Yellowstone Conservation District Council] could really play a good role is in supporting good flood plain regulations within our counties. (*Yellowstone County Recreationalist*)

C. Housing Developments Threaten Water Quality

[When] the high water comes, or you have an ice jam, or…the spring run-off [comes], you flood your septic tank or cesspool…[and] that material in that pool goes right into the river. There's a capacity for the Yellowstone….You can exceed that capacity, and then you have a real problem….We need those setbacks. (*Yellowstone County Recreationalist*)

I wouldn't allow septic tanks….If they want to put in a subdivision of 30 cabins along the river, they would have to pipe that water, pump it back, away from the river, away from the river gravels, maybe to a pond and have their own septic system there. (*Yellowstone County Recreationalist*)

With people building homes close to the river, I think there's a danger of fertilizer runoff into the river and that probably would create algae blooms [due to] nitrogen. (*Yellowstone County Recreationalist*)

D. Other Development: Industry and Municipalities

I would hope that the City would learn to respect the river more than they do now. The banks and the industrial development in Lockwood are just terrible. The County Commissioners think everything should be zoned industrial and Lockwood is very close to the river. I would like to see us change all of that so that all along the river it is a natural corridor. (*Yellowstone County Recreationalist*)

The river has to change. As Billings grows, and Laurel grows, and everything else grows, our water supply comes out of the Yellowstone River [and the river has] got to go down….[But, in terms of] habitat, it's essential that the river rise, that floods sub-irrigate [the] ground and create the nesting habitat for…ducks and geese….It has to do its natural flooding. But if we keep drawing more and more water out of it, it's going to change the natural habitat. (*Yellowstone County Recreationalist*)

You do have all the industry, too. There's an awful lot of industry that's down by the river that creates not exactly what you would call pleasing environments….Yet it is part of our culture. I guess we all have to be a little tolerant of everybody else, because we can't have everything our own way. (*Yellowstone County Recreationalist*)

E. Agriculture, Economies and Land Prices

Most of the irrigation projects in Montana were built around…1900 to 1920. They're over 100 years old and they're still operated [today as]…they were when they were built, say in 1910….They're operated very, very inefficiently. There is much more water diverted than is really needed to water the crops. That tends to dewater the river. There's much more water returned to the [river] than needed…and that water is usually laden with silt and Ag chemicals, pesticides, nutrients and so forth….And I'm not anti-agriculture at all. I mean, I don't want to come across as hypocritical at all. I eat the meat and I appreciate it. But I think there are some gross inefficiencies in operation, and that unfortunately degrades the quality of our river. (*Yellowstone County Recreationalist*)

Is it necessary to plow up that land? Is it going to be productive land? So then we plow up a piece of land and pretty soon it's not productive. We decide that we plowed too close to the Yellowstone [River]….It wasn't good quality land to plow because of the way it's sub-irrigated. It had too much alkali in it so they couldn't grow anything in there. Now you've changed the natural grasses that were along that river [by] trying to plant something there, and with the sub-irrigation, the farmer said it's not going to work….That was a pretty stupid idea. Who draws the line? (*Yellowstone County Recreationalist*)

So if that river meanders and goes away all of a sudden, and you're a person that's doing pivot irrigation, and you can't get water out of that river, you've got a real problem. I mean it's a critical problem and you don't have a year or two to sort this thing out. You need to figure out how to make some provisions where you can get that water, whether it's for livestock or whatever. So,…there's a lot of ongoing problems and that will probably continue forever. (*Yellowstone County Recreationalist*)

But it's my understanding that there are some tax benefits [with conservation easements] that are attractive, maybe not to everyone, but to some people. But the easements are sold. They receive a part of the value of the land right now when they issue the easement or when they grant the easement. They're paid for that. Then when they sell that property, they have to sell it with that encumbrance, so maybe they get a little less for it then. But they've gotten that value up front. Now, if they manage that money that they've got up front, invest it, or whatever, [it] could be that it will be worth as much or more of that selling price [than] if it didn't have that encumbrance. (*Yellowstone County Recreationalist*)

III. Access Dilemmas: Demands, Limits and Controls

A. The Importance of Public Access Laws and Public Lands

The Department of Fish, Wildlife and Parks was proposing a fishing access site near the Duck Creek Bridge….A few of the people that built homes right on the river [near the bridge] were at this public meeting. Their big argument was, ‘We don’t want recreationists on the river. We bought a piece of the river to have it for ourselves, and we don’t want the public out there.’ And really that’s the kind of attitude that just can’t be tolerated by our public managers….The Conservation Districts and the County Commissions [have to protect] the greater public interest,...not those few individuals that bought their little stretch of the river front….They really need to look at the long-term public interest and the real values that that river has for the greater public into the future. (*Yellowstone County Recreationalist*)

The private property lobby has tried half a dozen times to turn over our stream access law in both State and Federal court and [the lobby] lost every time. They’re afraid of…the setback strips [and] controlling the kind of thing they do in the flood plain….They are worried…that [the river] is such an important public resource that there will be some kind of limitations on what they can do on their land. And there probably will be. (*Yellowstone County Recreationalist*)

[I heard it] said our society has a bundle of sticks and society…controls those sticks. They issue them out one at a time to private landowners, and they can take them back to depending on the situation. I think most of us don’t want to do away with private property. We all live, or were raised, on private property, for heaven’s sake….But there comes a time when private property might be impacting [the] public resources of our society….There has always been some limitations….As an example, you can’t sell your topsoil to the Saudi Arabians…But that doesn’t mean that’s the end of private property. It means that society is going to take back a few sticks. (*Yellowstone County Recreationalist*)

So, we decided, ‘All right, there’s an island here. Let’s find out who owns that island and maybe we could get an access’.…Well, we started looking, and nobody was paying taxes on that island, so we said wait a minute whose is this? So, through a series of actions, the BLM finally said we own it. We manage that island. It’s been a public island for 100 years and nobody knew it. (*Yellowstone County Recreationalist*)

If you look back at the history of the United States, the public land and the public water have been enormously important. Our champions are people like Theodore Roosevelt and the national forest, the national park, the national wildlife refuge, the national monuments. All of those are part of the public estate, and we think the public estate is very, very important to our society—equally as important as private property….Our position is, what’s private is private, but what’s public is public and it should be treated with the same level of respect....You can’t have private water where the Constitution says it’s public, anymore than you can have public water if the Constitution said it was private. And we don't just sue every time we turn around. We talk to people. We try to convince them it's wrong, that they shouldn't do it, but we have a hammer and we'll use it. (*Yellowstone County Recreationalist*)

We have to determine exactly what is public and what is private…. Here's an example: the meander surveys. When the general land surveyors came through here around the turn of the century,…they didn't try to run a chain across the river….They went up and down stream with a series of meander surveys, meaning they shot bearings and distances following pretty much the high water mark. And this is how they define [the high water mark]…. Public land, all navigable bodies of water, and other important rivers and lakes below the line of the mean high water mark, are segregated…from lands open to private ownership….Once the State was established, the lands within that meander survey were turned over to the State of Montana, including the islands. Who owns the islands now? That has never been completely cleared up. There are some islands that have been identified. (*Yellowstone County Recreationalist*)

A guy from Florida bought a piece of land and [across a corner] there is a little…road that's been used for many, many years. [The road] accesses the national forest….He closed it off; he gated it….You just simply can't let that stand….You can't depend on the County to fight them because they don't have the money. We're disappointed in some of the Federal agencies. They should be fighting these problems….Part of the idea of the public resources—like BLM, Forest Service, and land management agencies—is that people can get to their [public] land. They have to….They can't brag about a 'land of many uses' if you don't get there. (*Yellowstone County Recreationalist*)

We have the tension between an urbanizing population and a rural philosophy legislature. And generally governmental bodies…lose opportunities for the parks and access….So the immediate problem is that you have this significant population influx, and subdivision development, and it's bumping into the rural philosophy of …'Leave us alone. this is our land we can do with it what we want.' So, that's having an immediate effect. (*Yellowstone County Recreationalist*)

I think it will change drastically as far as people building along the river….[and how] that relates to access to the river….I think that [as] a whole lot more private access show up…it will detract from [the public use] of those areas of the Yellowstone….If it were mine, I would do the same thing. I think that is the way it should be as far as landowners' rights….I don't feel encumbered by houses on top of me. I might when the number doubles or triples or multiplies by ten, and it will. (*Yellowstone County Recreationalist*)

Yeah, subdivision law is set by [the] State legislature basically, so counties are very hamstrung in terms of their abilities to really plan and to force some kind of conservation standards. As an example, you can take a big track of land…and you can subdivide it into 20-acre blocks and [then] you sell it as undeveloped 20-acre lots—almost no constraints within counties for that. Then you own a 20-acre block and you come back in and you ask for a process to subdivide that 20-acre block. You divide it into five-acre blocks—almost no constraints on that. And then you come in with a subdivision plan for that five acres, and it's small enough you don't have to provide for any parks or public constraints. So that's what's happening. So the effect…is that all [developments] lack any coherence. And where you have a really important public environmental resource like the Yellowstone River, which is important to so many things, it has impacts…. [The counties] are really handicapped because of the state laws that govern them. (*Yellowstone County Recreationalist*)

If I live along the river, I don't want other people down there.…That seems to be the resistance to trails in general in this area….Any time you have private property, people do not want other people down there. And yet I think the river is a community asset so everyone should be able to at some point to enjoy more parts of it anyway. I am not saying you take away people's private property. But I think...we should still provide some kind of a corridor for the public to be able to access. (*Yellowstone County Recreationalist*)

B. Problems with Access

I think river access is a really important issue. Until they opened up Josephine Park, I used to crawl under the fences and sneak down to the river. The first time I saw that they put the path down to the river and I didn't have to crawl under fences, I actually burst into tears. (*Yellowstone County Recreationalist*)

I don't have access to the river and its islands like I used to.…It used to be anything below the high water mark was legal hunting, but today it's considered private property on the islands and you have to have property owner permit in your possession. (*Yellowstone County Recreationalist*)

When you fish, you meet people in different communities because you go to have lunch afterward….You get to know some of the farmers. It helps to know some of the farmers so that you can get access to the river. (*Yellowstone County Recreationalist*)

Public access is being squeezed….When people…pay tens of thousands of dollars for small acreages up against the river, they don't want a lot of company there. A lot of them don't like it honorary either. The tendency is, and will continue to be, to close off access….Landowners, who own 84 percent of [river access in Montana], say, 'We don't want to have you here. We bought this…for ourselves, and we don't want it where you can go through here.' (*Yellowstone County Recreationalist*)

Achieving more access to the river for the average person, I would have to believe is a good thing…. [For] example, when…someone has a Federal land loan [and] they go bankrupt, [if it] would be a good access spot….Make it [public]….[Make it] as open as you can to the public…I don't have much of a problem because I know some of the private landowners…and [I've] cultivated relationships over the years. (*Yellowstone County Recreationalist*)

You have to separate law enforcement from access. You can't say, 'Well, the public is not entitled to access to public land because they might do something wrong' anymore than you say you can't have access to the public library because someone might tear up a book. (*Yellowstone County Recreationalist*)

If you're going to float the length of [the river], you don't know where you can stop, where it's legal to stop. You're not sure where you might get off to get re-supplied or to have people meet you. There needs to be maps. There are some sections where the access is really poor. (*Yellowstone County Recreationalist*)

Any place where a road would cross [Montana Rail Link's]…property to get to the river, they're in a habit of closing it off. So you can get in if you walk, but you can't drive in. Sometimes that's inconvenient….I carry a big ten gallon cooler that's a minnow aerator. And if I don't bring a small minnow bucket, I'm kind of stuck as far as getting my minnows over to the fishing site. I wish there was more access to the river. (*Yellowstone County Recreationalist*)

[We need] trails [and]…places for people to access [the river,] to enjoy it in whatever sense. We do have some of that with River Front Park…but it is not necessarily the easiest place to get to….It would be better if you could access it from the community. We don't have a real good access point just because of the environment [the Interstate] we have built in between. (*Yellowstone County Recreationalist*)

C. Decorum: Respecting Others and the Resources

When you go camping, you don't leave your beer tops and…paper plates. I just hate litterers. If you leave it cleaner than you found it, the world would be a better place. (*Yellowstone County Recreationalist*)

I think that the usage will go way up. There will be an awful lot more people using the water. And when you have those people using the water, then you have conflicts from those uses. (*Yellowstone County Recreationalist*)

Not everybody that would agree [with me]. I take my little jet boat out there, and I'm going to offend a bunch of people on that bike path because they're going to say, 'Well that makes noise and it puts out a little smoke'….Through education I think we can bring a lot of people around. (*Yellowstone County Recreationalist*)

We see more and more of the big jet boats….Usually, they've been very congenial and I think they watch out for kayakers, but….sometimes they get a little close to you. (*Yellowstone County Recreationalist*)

[There was] a place that had wonderful waterfowl recreation….Now…there are so many kids going in there shooting the ducks…they've absolutely just ruined it to the point where I'm not sure if any of us will go back anymore because there's just so much pressure on it….With waterfowl you can't pressure things too much or pretty soon they'll just go away….I think the only way you could do it is to try to educate [people]. (*Yellowstone County Recreationalist*)

When you actually look at trail systems,…99 percent of the people that use those trail systems are good, family-oriented [people]…just wanting to go out, not wanting to pollute…or do something to their place, but just be able to enjoy the area. And they become eyes and ears…of whatever system is out there. (*Yellowstone County Recreationalist*)

D. Recreationalists At Odds with One Another

One conflict that comes to mind would be between self-propelled, quiet users versus jet boats or jet skis. (*Yellowstone County Recreationalist*)

You have people who like quiet recreation, and you have people who are more into motor sports….You always have these groups that are always at odds with each other. (*Yellowstone County Recreationalist*)

There is a lot of pressure on outfitters and the board to get rid of the outfitters.…Most of the complaints…have to do with the river traffic. What I think is valid is that we prompted it. We get people up here to experience some of these things because we have world-class fishing….[The public] foolishly think that the fishing we have here is available everywhere and,…if there were no outfitters, people wouldn't fish it. Neither of those is true. We do have world-class fishing here and it happens that I guide people one time and they come on an annual trip and they do it themselves. Did I cause that? Maybe. The same way that everybody in town that takes their uncles out and fishes it. The traffic increases because of it….What I think is invalid is [they] think that the number of guides has a negative affect on the fishing or the fish. We generally take great pains to play the fish well and keep them alive and to never keep any unless they completely insist on it. If people can be talked into putting fish back, we do. I don't begrudge the guy who walks down on the bank and catches his limit. I am frustrated about him complaining about me hurting the fishing because I am not. If you take a few out, the food volume stays the same….The rest [of the fish] just get bigger. (*Yellowstone County Recreationalist*)

IV. Ideas About Erosion and Rip-rap

A. Erosion is Not Necessarily a Problem--It is What the River "Wants to Do"

[As] a hydrologist, I studied river mechanics and fluidal geomorphology and from that perspective, the channelization really changes the character of the river. [Channelization] creates…an artificial river system, really. Often times the so-called channel protection work that's done in one place, causes impacts immediately down the stream. The river is not allowed to meander and shift as a mature river like the Yellowstone wants to do. It can cause unnatural artificial areas of degradation and aggradation, or deposition, or erosion of stream materials, or loss of streamside vegetation. We're losing the cottonwood trees and much of the riverine environment is changing as a result of man’s uses and developments. (*Yellowstone County Recreationalist*)

I think erosion is part of the river in terms of the river flow itself. (*Yellowstone County Recreationalist*)

Sometimes it’s heartbreaking to see [erosion]….But, on the other hand, it’s a wild river and it’s expressing itself in such a way that it makes it what it is. It’s a living entity that gobbles up one bank one year and might turn around and gobble up the other bank the next year. That’s what’s uncontrollable and that’s what makes it wild and adventurous for those of us who like to get on that sort of thing. (*Yellowstone County Recreationalist*)

B. Rip-rap and Its Effects

Most of the time, people haven’t taken the time to determine how to go about it properly. They don’t go through the permitting process correctly. Traditionally, what happens is they will do something inappropriately and then it sends the problem farther downstream, to the next guy. (*Yellowstone County Recreationalist*)

Pretty soon you have a ditch, you know, rather than a river. In some cases [rip-rap] is legitimate, in other cases it’s probably overdone. (*Yellowstone County Recreationalist*)

The riparian zone along the river is altered as soon as you channelize the river. You don’t have the over-bank flows…that renew the riparian zone along the river. And that’s habitat for wildlife of all kinds….If left natural it can actually help alleviate flooding problems downstream. So, a lot of the times, the channelization of the stream just creates more problems….[And] there’s a loss of values in terms of recreationists being able to enjoy…a viable fishery. (*Yellowstone County Recreationalist*)

[The river and the riparian areas are] less healthy for two reasons. One, there’s been a lot of development taking place—I’m talking the entire river, not just around Billings. And [two, I see]….miles and miles of channelization of the river…that very seriously compromises the riparian zone. So, sure, it’s gone down hill a lot in the last 30 years. (*Yellowstone County Recreationalist*)

I think that the erosion problem….is a result of stream straightening. You don’t have the cottonwood growth to hold the banks and keep the erosion down. (*Yellowstone County Recreationalist*)

You get a guy with more money than he knows what to do with, and he’s paid tens of thousands of dollars an acre for land along the river, and here comes the damn river and starts washing [his land] away. Now he can afford to do something about that, and he will do it. What he doesn’t understand is that the degree to which he does that, it is going to hammer the guy downstream. So, he has [created] unintended consequences which he’s not responsible for—he should be. (*Yellowstone County Recreationalist*)

I assume [rip-rap] confines the river and screws up the fishing. (*Yellowstone County Recreationalist*)

Rip-rap [is used for erosion], but that's not pleasing as it is so unnatural looking. (*Yellowstone County Recreationalist*)

There's a guy between Laurel and Billings…that…put big rock jetties out into the river to stop the washing. I don't think it's impeded anything. In fact, sometimes some of that stuff gives the fish more cover, more places to go and hide. (*Yellowstone County Recreationalist*)

C. Rip-rap Does Not Work—Maybe

Keeping the river from meandering is like stopping a natural process. The river meanders; rivers do that. Particularly mature rivers, like the Yellowstone, that are not constrained by the geology. In other words, it's not a rock canyon, it's a meandering river. Keeping it like it is means allowing it to perform its natural function. It doesn't mean locking it in, channelizing it, holding it in the same channel forever and ever. That won't work. It simply won't work. (*Yellowstone County Recreationalist*)

I think from the standpoint of silting, I think allowing them to put stones and old broken pieces of cement and stuff along the riverbank is probably not a bad idea. It'll prevent a lot of land being cut away and being dumped into the river. I think they need to be careful. I would imagine some things they could put in there could be toxic….Any places where they've done that in the past, I can't say it's damaged the river or anything. (*Yellowstone County Recreationalist*)

V. Comprehensive River Management

A. Cumulative Impacts

[An example is] the farmer, who has plenty of capacity in his irrigation pump. It's going to be a 100-degree day today, and he knows that if he can get lots of water to those plants on a day like this….So he grinds that pump out full blast and water runs off,…carrying silt off into the stream. And he sees the stream as a little dirtier, but what's the impact of that [little extra]? And the guy upstream does it, and the guy downstream does it, and the guy up-beyond does it. (*Yellowstone County Recreationalist*)

The pressures from industry, agriculture, and urban areas are not benign on the quality of the Yellowstone River. Also, we're beginning to channelize the river and drastically affect the biota, the quality of the water, the quality of the scenery, and the quality of the recreation potential. It has limited capacity to supply all of these things….It's over-adjudicated and it's under-regulated, but there's not a conservation strategy….There's a direct tie [between] how well we manage all these activities and the health of the river. (*Yellowstone County Recreationalist*)

There's more and more users, so we'll probably be losing water….Actually from the Park on down, there's just more and more folks wanting a place on the river. The guys who are farming or ranching, they're selling those home sites. That's going to be an issue someday too….Everybody can't have a place on the river. (*Yellowstone County Recreationalist*)

When you get people living so close to the river,…they place all their various junk…down by the river and then when it floods that all goes into the river and creates hazards, especially for the wildlife. And fishing line is another thing we see….You know it entangles the wildlife, especially birds….Up by Canyon Ferry, they've got these PVC pipe tubes…[for] used fishing line….[You] put it in [t]here, and they have a cap on it….[They are] at all the fishing access sites….Maybe they could start putting them in here. They're very inexpensive to build. (*Yellowstone County Recreationalist*)

[We need] protection of the animal life on and near the river. The bald eagles, the deer, the birds, all the multitude of birds and even fish that are on the river could be harmed with too much growth, too close and everybody wants to be on the river….I wouldn't mind being on the river. But, at the same time, it might impede the success of animal reproduction in those areas and it would be a shame to lose it. (*Yellowstone County Recreationalist*)

The sauger fishery is pretty weak anymore compared to what it was. There were times when you could get four limits of 15 fish in an hour and a half or two hours right at Huntley. And now to catch 15 fish in a day would be pretty good sauger and walleye fishing….I think they've been over-fished….The problem with sauger, of course, is that people have a hard time telling them from walleyes. A lot of the Montana anglers are still coldwater-oriented people….The ling population has dropped right off on the Yellowstone too, and I think that's probably an over-fishing situation too. (*Yellowstone County Recreationalist*)

B. A Need for Balance

Money talks. Sometimes it screams. (*Yellowstone County Recreationalist*)

I believe you have to balance the needs….How many more people can move into the Billings area before it starts affecting the water supply?…So it's balancing that recreation use with that agriculture use…with the whole picture of who gets to decide. (*Yellowstone County Recreationalist*)

I don't think the balance should be for the users. It should be for the river….An ATV-user [might ask,] 'Don't I have a right to ride along the bank and down to the river?' No, [ATVs] cause erosion and they destroy habitat….Jet boats would be a disaster for the wildlife if they covered the river with them. If it is not healthy for the river, they don't have that right. We have to do what is healthy for the river….I am not against property rights, but the river is primary…and it belongs to the people of Montana. The people along the river have to share their property with all the people that own the river. The river is not healthy unless it has good riparian areas, good habitat, and room to move. It is, above all, a meandering river. Our only criterion has to be what is healthy for the river. (*Yellowstone County Recreationalist*)

The big issue we had this last year with our county was trails. County supervisions would not stand up in front of the rural people and say, ‘Guys, here’s what this means….We can change this wording so it’s a little clearer to you.’ No, they didn’t do that. They were willing to throw out all the planning that had been done for trails because the sky is falling, and they wouldn’t stand up and just be honest about what the world is about. Who’s Bill Kennedy? He’s supposed to be a progressive. He’s not. That’s to be put on the record. (*Yellowstone County Recreationalist*)

How do you balance it out?...In the past, when an industry asks nature and those of us who try to protect it [for something], it never compromises in the other direction….I don’t think compromises work when it comes to that because we’re asking nature to give a little more….I know we try to stiffen the laws but there’s so many things grandfathered in that you can’t do anything about. Once it’s taken, it’s gone. Balancing is a difficult issue in an environment that’s worried more about their monetary welfare as opposed to say the bald eagle or those animals that depend on the river all these many centuries. (*Yellowstone County Recreationalist*)

They [houses built on the river] are bad in that they change the feel of being by yourself on the river. It doesn’t have the same feel as it once did….If I owned a place I don’t blame the people. I don’t have the right to tell them not to build there. I don’t want to pretend that my view of the river is more important than their rights as landowners because I disagree with that. It is a tough question but if this were a question about do I have the right to guide on the river, I would want to defend my right to use the river for fishing but at the same time I want to respect the landowners’ rights. I think they can coexist. (*Yellowstone County Recreationalist*)

I think that you have to have some realistic expectations [that] some things will be lost along the way….I’ve heard the word ‘steward’ so much. That word is so trite I hate to even use it anymore, but I guess until a better word comes along….[I hope] that we would be able to hand this thing off and do it in a quality way, but listen to everybody too. (*Yellowstone County Recreationalist*)

C. Management with Vision

[An important step is] getting the cities, the states, all the people coming together and discussing these [tough] issues.…But we have to discuss them, and we have to have a vision. And, number one, we have to say this river is important to us. It’s important that we keep it pristine.…It’s so important for recreation.…It’s important to have the wildlife. It’s important to have this sanctuary. So, we need to value it, and we need to really get in there and discuss it. (*Yellowstone County Recreationalist*)

I'm optimistic and pessimistic. I think, within the next ten years, it's going to take people with a lot of vision to protect the river. Vision and foresight. And willingness to go out on a limb and develop some green-ways, and cut down on things that could damage the river such as straightening the channel….Hopefully there will be people to step up to the plate and protect the river and voice their concerns. (*Yellowstone County Recreationalist*)

There are some good things happening in the state that they can also look at, and the Madison valley is one of them. Now there's been some encroachment on that river. But there's also a strong move afoot to conserve that valley and to put conservation easements on a lot of the ranches, and to try to prevent us from losing that wonderful Madison Valley….I think there's some real forward-thinking people behind that. (*Yellowstone County Recreationalist*)

My suspicion is that there are a lot more problems along the Billings area. I think the people in the upper Yellowstone are more conservation-minded than here and in the eastern counties….I don't think we pay enough attention to the preservation of the Yellowstone River and the wildlife habitat along it….I hope we get more conservation-minded in our attitude toward the river. Otherwise it will be a disaster. I think it should be in better shape even than it is now. (*Yellowstone County Recreationalist*)

The conflict can be huge, and will be huge if we don't think about a long-term strategy for the river….You have 18 Federal and State agencies that have some responsibility [for the river], and that doesn't count all the cities…[or] all the counties….So who's managing it? Who's thinking about the overall quality of the river?...The river is tremendously threatened…because of lack of focus, lack of attention, lack of thought. It's about [protecting]…the qualities of this river that are important to our society. (*Yellowstone County Recreationalist*)

This is difficult for county supervisors because…it plays against that rural philosophy which they see as representing their constituents. But in Yellowstone County who are the constituents of Yellowstone County board of supervisors? Well, it's Billings, too, but that's not the way they look at it. You can [have] a 1,000 Billings-ites whining, but [if] you get a dozen of these rural people out here whining, that's…the squeaky wheel that will get attention. So, [as far as] stronger subdivision regulations…[or] stronger planning regulations,…most of these rural communities are not going to be enthusiastic about that [and] it pits [the townspeople] against these rural people. (*Yellowstone County Recreationalist*)

[The Yellowstone River Conservation District Council] has roots in those local counties…if they're armed with good knowledge about this river, and all aspects—the social economic importance of it, the biologic importance of it, the industrial, agricultural benefits of it, and what it is that has to happen to preserve that for future generations—they will be in a stronger position to have real effect on it. (*Yellowstone County Recreationalist*)

I hope that…there are some people that will step up and protect the river, and become river-keepers….A river-keeper is basically someone or a group of people who will watch out for the river and…keep it pristine and keep the wildlife….They are kind of like watch dogs. (*Yellowstone County Recreationalist*)

D. Collaboration

The Conservation Districts have done a very wise job in establishing this [Yellowstone River Conservation District] Council and [in]…taking a look at the river comprehensively….[The Yellowstone River Conservation Forum and the Yellowstone River Conservation District Council] did put goals together,…pretty darn good ones, and they are still good ones. We didn't get everything in them we would have liked to have seen. For instance, it didn't have anything in there about access and it didn't have anything about recreation, but it did have goals for clean water, sustained flows, wildlife conservation, protecting endangered species, and some really worthwhile goals. (*Yellowstone County Recreationalist*)

[Regarding a possible alliance between agriculturalists and the Audubon Society]…Sure. Probably the "Z" word, zoning, could be a potential point of discussion. My impression is [that] in most of Montana that's a four-letter word. I've got to think those people [agriculturalists] are shaking their heads, too, when they see…houses down below [in the flood plain]. (*Yellowstone County Recreationalist*)

We had just had two big heavy flood years. And the response to that was the Corps of Engineers was issuing rip-rapping permits like mad and the conservations groups were beginning to get concerned….So I pulled together a number of conservation leaders and we talked about the idea of a Commission and they said no, we ought to focus on the Yellowstone River. So that led to establishing the Yellowstone River Conservation Forum. (*Yellowstone County Recreationalist*)

The Audubon Society, Trout Unlimited, the Greater Yellowstone River Coalition were suing Corps of Engineers for their lack of doing environmental reviews for all of these projects [that] they were doing….The Corps of Engineers lost the judgment and a judge directed them to do the work, which they have not really done yet. (*Yellowstone County Recreationalist*)

We jointly sponsored a two-day seminar and invited all the agencies in, all the agencies being 18 of them, they all came. I think everybody but the BIA. And they all pledged [at] the end of the conference to cooperate in a cooperative approach. And the state of Montana has been a great supporter of this whole effort, particularly in terms of DNRC. The NRCS has also been a good cooperator for this effort….The Corps of Engineers… they're hard to work with, but more recently they've been pretty cooperative. It's a wretched bureaucracy and they do it the best they can under that bureaucracy that they've got. (*Yellowstone County Recreationalist*)

If we made it easier for the public to experience and enjoy the river and you got more people involved in the uses of the river for all the right reasons, you would have more people on the side of the right direction as opposed to the industry and those people who use it for better or worse. I'm thinking that the more things you can do to the river to provide recreation for the community,…the more people that you'll have drawn to the attention of its needs to combat the industries that don't really care. That would make them a stronger ally. (*Yellowstone County Recreationalist*)

E. Management Agencies

A lot of people…[are] not too excited about any kind of a survey to know what's going on. They're not sure if it's going to affect them, pro and con…All these avian studies, there [are] people that have expressed concern because they're not so sure they want people on their property talking about birds….They're not sure if they're going to have to deal with some endangered species or Big Brother coming in and saying, 'Oh, I noticed that you got a couple bald eagle less than you got last time and now you're going to have to do this'….So, communicating…in a way the people can understand and be honest about the whole thing, there's a tremendous need for that. (*Yellowstone County Recreationalist*)

There [has] to be some more enforcement regarding the use of the river, from a recreation standpoint, as well as agriculture….In order to do that, we need to have knowledgeable, sincere people in management positions. And you can't do that without money….We are going to have to fund the necessary people and enforcement policies that you have on this river to protect it. The public estate is too valuable to trivialize or to fall victim to those who say we shouldn't be paying any taxes. (*Yellowstone County Recreationalist*)

The State will cap the number of users at some point. There is too much public support for that not to happen. Our outfitter association has been able to fight it and there are a number of expensive steps that the state would have to take to implement a moratorium on user days. I am torn as far as what should happen. (*Yellowstone County Recreationalist*)

F. Education

[The Yellowstone River Conservation Forum and the Yellowstone River Conservation District Council]…agreed that we ought to start getting fundamental knowledge on the Yellowstone River. And, that that fundamental knowledge, that science should be brought to bear in developing Best Management Practices for the river. (*Yellowstone County Recreationalist*)

[For example,] I think sometimes people that own [boats] and have never kayaked …don't even realize…that the noise or possibly coming so close to kayakers, that it bothers them….You'd get together and say, 'Let's try to ease this, and be more aware that there's kayakers on the river.' (*Yellowstone County Recreationalist*)

We just have to find the language so that you really can communicate. Montana has a history of trying to deal with the commons. Back in the early grazing days, most of these rural people understand that you just can't turn unlimited numbers of cattle loose on the range and have everybody using it as a commons. You'll find that a lot of the rural people kind of understand that….So Montana was really one of the first states to…deal with…the abuse of the commons….It's certainly the kind of issue that we're dealing with here…if you're going to have Best Management Practices, a cooperative approach, and an education approach, we really have to find the language that communicates between kind of these urbanized people, the rural people, and these other people who are itinerant rich people coming in. (*Yellowstone County Recreationalist*)

There were a couple of fellows from the Audubon group that took an interest and started going to their [Yellowstone County Conservation District Council] meetings and were greeted with kind of suspicion and alarm at the beginning….I think that's gradually changed to an acceptance. I think it's positive to get more than just agriculture interests involved in the Yellowstone River issues of the Conservation District business really, and it sounds like maybe they think that too, if they've gone to the trouble to commission this survey. (*Yellowstone County Recreationalist*)

I think where [the Yellowstone Conservation District Council]…can be helpful is…with an education program. People understand how important this river is to everything we are about in this part of the state: our culture, our society, our production base….Everything we do here is dependent on it, almost everything….I think that the Council really has an opportunity there for an educational program. (*Yellowstone County Recreationalist*)

You [outfitter or guide] are constantly showing by example. When we come into a crowded area, I tell them to reel in and we will dodge fishermen and get through here fast….I feel like because of the things that I do to teach ethics and etiquette that these people, when they do come back, they will be a friendlier user of the resource than you would have otherwise. (*Yellowstone County Recreationalist*)

VI. Concerns

A. Concern: Agricultural Run-Off

One of the things we hope to see happen…is modernized irrigation practices….Most of the farmers are using 1,000-year old irrigation [methods]….In this hot weather, [they] put as much water on those crops as they can, and they over irrigate in spots and so it carries away silt [and] chemicals back into the river. (*Yellowstone County Recreationalist*)

[A farmer] certainly has a right to earn a living. But he doesn't have the right to pollute the river with contaminants and pesticides to do that. He has to figure a way to do it without damaging the river because the health of the river should be our primary focus. (*Yellowstone County Recreationalist*)

Irrigation return flows is the single biggest pollutant on the Yellowstone River, carrying sediments, agricultural chemicals nutrients off the land. The most graphic of that would be at the Clarks Fork. (*Yellowstone County Recreationalist*)

Regrettably the water quality particularly below Laurel has been compromised in places primarily as a result of agricultural use along the tributaries. And stream flows have been reduced to undesirably low levels during the summer. That's a result of large diversions on the river. (*Yellowstone County Recreationalist*)

Some of the rivers tend to put a lot of mud and silt in [the Yellowstone River]. I'm not sure why that is. I'm not sure if you can blame it on fields that are washing into the river or whatever the case is. (*Yellowstone County Recreationalist*)

B. Concern: Water Quality

We need to conserve as much land as we can for habitat and [make] sure…that the river stays as clean as possible. We can conserve all the land in the world, but if the river goes to hell as far as the quality of the water,…then we've accomplished nothing. It won't be good for anybody, man or beast. (*Yellowstone County Recreationalist*)

For example, we have a PCP plume coming from a cleaning place on Central Avenue that is heading toward the river all under the ground. PCP doesn't disappear. Eventually, it has to get to the river. It affects the ground water. (*Yellowstone County Recreationalist*)

You know, other little things, like mercury, for crying out loud, coming off of our power plants, coming into the Yellowstone River. Right now women aren't supposed to eat too many of those fish….And nobody's at fault and nobody's responsible, you know, as a community. (*Yellowstone County Recreationalist*)

Our Governor's got to play hard ball with Wyoming.…I don't know if you've seen any of that coalbed methane development over there, but their getting better, but they are not good. (*Yellowstone County Recreationalist*)

Obviously we have…the legal laws on septic systems that would be such a pollutant to a river….You can legislate all you want, but if you don't have somebody to enforce the rules that you legislate, enforcement is more difficult than the legislation part. (*Yellowstone County Recreationalist*)

[The water treatment plant] is absolutely essential, but I don't think the city should be buying property down there….And I don't think they should have their storage and washing and storing their trucks there…right on the bank of the river. (*Yellowstone County Recreationalist*)

A few years ago, in Laurel, we did have problems [with pollution]. I think it's been taken care of, but the Cenex refinery had a pipe running into the river that was pumping raw gas into the river….The Department of Environmental Quality [was contacted], and they got in there and got that thing shut off. I caught a trout out of that spot and that thing just smelled like gasoline. (*Yellowstone County Recreationalist*)

I know agriculture has probably polluted it to a great degree. Sewage plants like the one in Billings has got to have some affect on it. The power plant, we've got a couple of refineries.…It worries me that they could ruin the river for longer than I live.…That bothers me. (*Yellowstone County Recreationalist*)

Warm water has got to be tough on everything, low water. Something else I'm kind of concerned about is the turbidity of the water that comes in from the Clarks Fork. I realize that those boys have got to irrigate, but when they turn their wastewater back in, it's just a mudhole. (*Yellowstone County Recreationalist*)

C. Concern: Warmer Winters

In an ice jam, which we had a severe ice jam here seven to eight years ago, it really changed how the river flows. (*Yellowstone County Recreationalist*)

A lot of summers, we have less water and the streams and creeks are dried up. We are becoming more arid. I would think the biggest changes in the river are due to the climate change. Some of that is man-made. We are changing the water cycle and are changing the quantity of water on this planet. You don't see huge chunks of ice on the river anymore. Most years it doesn't even freeze up. We have already done damage to the planet [and] the river. That is why we need to take such good care of it now. (*Yellowstone County Recreationalist*)

D. Concern: Water Rights

We have to stop wasting water. I see my neighbor running the sprinkler in the middle of the day and 90 percent of the water is just evaporating and not getting into the ground. We are so extravagant in so many ways. We are extravagant in the way we live and the way we use water. We have to be more a lot more conservation [minded] if we are to survive as a people. (*Yellowstone County Recreationalist*)

I hate to see us paying money to pump the water clear out to the middle of nowhere and not charging for that. I think we need tiered costs of services in our planning.…People who get their water pumped clear out to Ironwood need to be paying more for their services,…instead of everybody paying the same rate. [Ironwood is] a long way from the river….We need to be more conservationist in our development. (*Yellowstone County Recreationalist*)

E. Concern: Dams and Diversions

Another conflict would be between power generation and wanting to use more of the water for power generation and also for cities…and agricultural diversion dams….It's not too much of an issue right now, but in ten years…, I think it might be. I think there will be conflicts of development versus leaving the river in its pristine character. (*Yellowstone County Recreationalist*)

I don't think that the river should be dammed….Most of the damming we have done hasn't helped. We dammed up the Colorado so we could irrigate California and they paved it over and built houses. I am opposed to a dam. (*Yellowstone County Recreationalist*)

Every 15 to 20 years, you hear somebody talking about maybe they ought to dam the Yellowstone, but that's not an option ever. (*Yellowstone County Recreationalist*)

I hope it continues to be the same. I can't imagine that they're going to dam it because it is the last major, longest free-flowing river in the United States. Hopefully, they are not going to impede the way it works its magic around here. (*Yellowstone County Recreationalist*)

Big Horn River to Laurel: Residential Interest Group Overview

Sixteen interviews were conducted with property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank. Names were obtained through a GIS search of public land ownership records. These names were randomized within counties. Other people living very near the river and whose primary incomes are not generated by agriculture were also recruited.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Big Horn River to Laurel: Residential Interest Group Analysis

I. Living Near the River

A. Appreciating Scenery, Wildlife, Serenity and Play

But in Montana—hunting, fishing—we ride in the mountains a lot. We are horse back riders….We like outdoors. All our recreation is outdoor stuffs. (*Yellowstone County Residentialist*)

I've always gravitated towards it because it's always relaxed me….My church is the river….The fog comes up off the water….The sun pops up and your line is singing out there and you look down and see the little crystals on it, then I look down and see a herd of elk crossing a couple hundred yards from me. It gives you.…It's what drug addicts are, the reason they're drug addicts.…It gives you that feeling…with no side effects,…other than you're hooked.…I'm not leaving here….This is a place to keep forever. (*Yellowstone County Residentialist*)

[We see]…eagles, ospreys, [and] we wanted to make sure they have places to stay so they can come and entertain us, which they do, constantly. It's just amazing….It's fun to watch them battle the eagles when there's a catch in one of their claws.…I didn't realize that an eagle could actually fly inverted with the fish—you know, roll over on its back in flight to address the threat. It was wild. Oh yeah, I'd have a $100,000 tape if I'd have just had the camera. (*Yellowstone County Residentialist*)

I've floated it, fished in it, ice skated on it, done just a little bit of everything….The Yellowstone is pretty nice, too, especially if you like to float. (*Yellowstone County Residentialist*)

I describe it as pretty….Where we live is within a riparian area, close to the river and next to our alfalfa fields….[There's] a lot of wildlife and [it is] just a pretty area. (*Yellowstone County Residentialist*)

This is good habitat for the deer and stuff; there's a lot of whitetail. I spooked up a little fawn when I was coming in….It helps support an awful lot of the deer and bird and water fowl they come in and out of this area [and there is]…a lot of fishing in this area too. (*Yellowstone County Residentialist*)

[I] absolutely adore the choice of the location….It changes daily….It's alive.…I would say that I'm one of the luckier guys in the world to have this view,…this untamed river that I always brag about….There's two of my [Canadian geese] parents out here going down with 12 of their babies….We see all the ducks, …the muskrats and the snakes….We'll have an eagle fly by and an osprey dive in the river….I'm a happy guy here. I've never worked a day out here, but I've sweat and toiled a bunch, but every bit of it has been so enjoyable. (*Yellowstone County Residentialist*)

We enjoy boating and swimming and doing stuff like that. (*Yellowstone County Residentialist*)

It is beautiful along the river and fun for kids….[It's] peaceful….We sit out on that patio in the evenings and listen to the ducks and the geese and watch the pelicans in the sky….[We see] beavers in the river,…marmots.…The deer like to run through here.…The river islands now have turkeys on them….[We're] seeing the turtles….The river is…unique…and it's free-flowing….It's a beautiful river. (*Yellowstone County Residentialist*)

It's beautiful….It's located on the slope that drops down to the river bottom….Since the house was elevated, we get a great view of the river and the water fowl on the river and the deer in the pasture and the pheasants in the yard and all the other great things that go along with living out in the country….I love to watch the ducks and geese and pelicans and the critters that habitat the river. (*Yellowstone County Residentialist*)

It is just a raw piece of land so it is a recreational piece of property at this point….It is a nice piece of ground on the river.…I love the river….I like to jet boat.…It is scenic….There is a lot of river there. It is a huge asset to this state. There are so many opportunities. It is a great playground. (*Yellowstone County Residentialist*)

[The place is] on the river and close to town. Quiet….There is a lot of wildlife, a lot of birds….We always have geese. They bring the little ones along the bank….There are eagles nesting across the river straight over here….There are a few ospreys up the river. There are a lot of beaver, quite a few pheasants. (*Yellowstone County Residentialist*)

I like the river a lot. I like to fish and float and the wildlife. Ever since we've lived here we've always done things in the river. I mean, it's been a part of living here since we moved….Deer, owls, eagles, beavers—we had a beaver scare when we were floating a little bit ago—fox, raccoons. (*Yellowstone County Residentialist*)

As far as our livelihood goes, the river doesn't play any part. It's more part recreation and status for my husband. He's lived in Montana all his life and living on the river is something he's always wanted to do. (*Yellowstone County Residentialist*)

I enjoy it for recreational purposes. (*Yellowstone County Residentialist*)

I was going to say recreation, but it's not recreation: it's a refreshment, a rebuilding time. I bought this when I was still working full-time, and working with people and you're uptight, [and] you come out here [to the river] and can renew yourself. Even busy working, irrigating, it's a great way to refresh yourself. (*Yellowstone County Residentialist*)

B. Keep the Yellowstone Natural

The big argument has always been, 'Dam it or let it run free'.…There are always advantages and disadvantages. (*Yellowstone County Residentialist*)

This is a 759 mile-long river, the longest river in the lower forty-eight [states,] untamed by any dam….I would not be opposed to a dam. I'd probably say, 'You're not going to flood my land, are you?' like everybody else would. It would be a great recreation deal…[but] I think the river is somewhat manageable even without a dam….I feel just a little unique saying that I live on this 759-plus stretch with no dam, although it would make a hell of a recreation area if it had one. (*Yellowstone County Residentialist*)

[Keep it] free from dams. I think that's really important. (*Yellowstone County Residentialist*)

I don't know if ever there could be a dam where they use power, and I know this is the only river in the United States that's free-flowing. To take that away….I'm for it at times, and then I'm not because of the free-flowing. (*Yellowstone County Residentialist*)

They should have built a dam at Livingston 100 years ago in Paradise Valley. The whole river would have been beautiful. What a fishery it would make for 500 miles. Plus, they would get hydropower and the reservoir. Now it is just a lot of rich people in Paradise Valley. No way would it ever get done now. (*Yellowstone County Residentialist*)

Put a dam in at the top, [and] that'd be the end of [the river changing course] (*Yellowstone County Residentialist*)

For all the trouble it is, I still like the idea of the Yellowstone just running free. That's more about the aesthetics and the recreation thing….There's a lot of stuff,…the wildlife, the floodplains, the swamps, all those things you have because it runs free. All the changes it has from year to year. It's really important.…I can see the dam….There will be a lot of advantages to control the flow of water. But I think we are back to economics….Irrigation—there needs to be more ditches. No flooding if you have a dam to control it. Plenty water for the growth [for] all these cities. (*Yellowstone County Residentialist*)

C. The River as a Shared Element of Life

It is the lifeblood of the valley….It keeps a lot of farmers in water and able to grow crops and it's a good source of recreation….I have a boat that was made for river use; it's got a jet on it. And I'd rather boat any day on a river than on a lake. It's just so much more fun. It provides a lot of habitat for wildlife that is fun to watch and fun to hunt….Fish are fun to eat and catch. So it's a wonderful thing for this valley. (*Yellowstone County Residentialist*)

In Eastern Montana, water is critical to everybody any more. So, we are well aware of the river. (*Yellowstone County Residentialist*)

We do a lot of recreation, and, of course, the water wells and the irrigation.…You know, we used to see jet boats and some floaters….There's a lot of fisher people….There's a lot of cattle down there. (*Yellowstone County Residentialist*)

Farming, ranching, and recreation. That is basically it….I have to admit there are more people on the river. There is a lot of river there and you can spread a lot of people out and never bump into too many people. (*Yellowstone County Residentialist*)

Everybody [uses the river]. The Yellowstone River feeds Laurel's water system. I believe it feeds Billings' water system, and since that's a necessity of life, I would say everybody [uses it]. I know a lot of the farmers around use it for irrigation, and I would like to figure out how to do that as well. We have an irrigation ditch….[And] recreation—…there are so many people out there who fish and boat. I think there isn't anybody that doesn't depend on it. (*Yellowstone County Residentialist*)

D. Ruralness

I have lived in town down here for years. And I just wanted to get out of town and have some cows and horses. I always kind of liked that. (*Yellowstone County Residentialist*)

We're right along side the river….We just love the area out here. We didn't want to be in Billings…We do a lot of fishing and hunting and floating and, you know, that kind of thing, and rafting….Just the trees, and that there's nobody between us and [the river] so it's quiet. Solitude. (*Yellowstone County Residentialist*)

We just love the bedroom community.…I mean, it's very quiet we don't have any noisy neighbors. We don't have to worry about any of that. And we have an ideal spot right here. We are next to the river. It's great, you know. (*Yellowstone County Residentialist*)

It's more private, because we're surrounded by our land, and quiet: we're not by traffic. And it's by the river. (*Yellowstone County Residentialist*)

Privacy: Even though we're right here on the road, when you get back behind the house, nobody can see, and all you can hear is the water, and it's very private. (*Yellowstone County Residentialist*)

I think we've got a pretty nice place. The location is good. We're into Billings in 15 to 20 minutes, [on] paved roads….We are out of town, yeah, it is pretty nice….We…plan on living here, [and] dying here, basically. (*Yellowstone County Residentialist*)

E. Development

We're losing more farm ground every year for people to build on….It's going to grow. If they get a sewer system in here, it'll grow. It's grown a lot now, all these houses down here are new. There's a block over here, there's three new houses on it. (*Yellowstone County Residentialist*)

We're seeing some development with the golf course; that's bringing in quite a few more houses. And we get a lot of people out here that are bedroom community. You know, it's a bedroom community so we get a lot of people that don't want to be in Billings. It's cheaper out here. You don't have to pay the city taxes, so I expect that we'll see some development. (*Yellowstone County Residentialist*)

This has been recently zoned where they can cut it to five acre lots. I think that will happen, not only at our place….I think when the kids inherit things, they may not want to live here, they got their own lives, so they'll sell. Whether they sell it all in one piece or not…..Some of those places will start to get broke up. It will all be residential. (*Yellowstone County Residentialist*)

II. The River as a Physical Element

A. Living with the River

It's a vigil every year to keep up with the river, to see if it's going to take out some more of the property. It's a living creature, that Yellowstone. (*Yellowstone County Residentialist*)

The power of that river….The water come up over that bank, and it just rolled. It was like a big roller coming at you, and it was the water coming over the banks, and the force of it, when it moved that huge ice up on the land, and it came around there, and it went all the way up to the neighbor's house before it broke. And it broke fairly fast. (*Yellowstone County Residentialist*)

I wouldn't say it is any abnormal erosion….It is the natural way. It needs to change and move where it wants to move like it does. (*Yellowstone County Residentialist*)

Everything that we've built down there had a three-and-a-half to four foot high level in preparation for the next flood, which isn't a question of *if* it's going to happen—it will happen. We're prepared. (*Yellowstone County Residentialist*)

[We're] just worried about floods every year, because we are right on the water. (*Yellowstone County Residentialist*)

Ice jams are actually the worst for us. They don't last long, but, boy they are quick….Three or four years ago, [our neighbor] had his horses in there. The river is pretty close down there….I went home to get something….I see him running back and forth, he is trying to get his horses out. He is in waist-deep water just like that. Big chunks of ice…[and] your spring floods, you know they are coming. You don't know how high or anything, but you know so you can be prepared for that. (*Yellowstone County Residentialist*)

The ice does clean the river up.…It gets the moss off the bottom, cleans the dead trunks out, does everything….So if you stop the ice flows, the river's not going to be as clean….[It's] Mother Nature's way of cleaning the stream. (*Yellowstone County Residentialist*)

B. Stories of Destruction

My dad grew up fighting the river because it eroded so much….So the river was always a pain in the butt because his farm land the river was taking away.…[In] '98, or '97…[there] was one of the biggest ice jams this place had ever seen because the ice jammed totally the river off around the bend. And all that water and ice came through here and we had eight inches of water in our house….We went up to the neighbor's and watched the water come higher and higher and watch it get to the top of the porch. (*Yellowstone County Residentialist*)

It was a combination of a lot of snow melt and heavy rains that caused the flooding. Our neighbor did get water into their pasture, but it never got into ours. But it took a lot of the bank away between our ditch and the river. Now, each year, the river every time it goes up, it erodes more away and it's caused some real problems. In fact, at that same time it …washed out…our irrigation system. (*Yellowstone County Residentialist*)

This house used to sit down there where the pile of dirt is. I had to move it…. High water came and washed the bank away….That was the 200-year high. There used to be an island down there about 100 yards and the 200-year high took it out. The next year we had a 500-year high and it went right by me because the island wasn't blocking me….[That second year it washed away 100 feet of bank and] the river was running right by the whole south foundation…. It cost probably upwards of $40,000 [to move the house]. (*Yellowstone County Residentialist*)

You can get an ice jam up there…[and] so the river just takes off and it's running 13,000 cubic feet a second. It is a great digger and carver. (*Yellowstone County Residentialist*)

I couldn't even say [what was lost to the river], not in acreage….I lost a huge tree,…no roots or anything, and it probably took 20 feet of our fence. (*Yellowstone County Residentialist*)

When it starts cutting in it,…water is relentless. (*Yellowstone County Residentialist*)

When they start having big ice flows again,…this entire thing will be eight to ten feet thick in ice that will be exploding and cracking, and it can crush a car in a heartbeat. It breaks rocks….And that water doesn't stop....There will be ice 15-, 16-, 18-feet out from the bank, just packed in against the banks. And all that ice then cuts loose and just slops into the river, and it comes down the size of buses….You've got something that's moving five, six miles an hour by water, and it slams into stuff, it changes a lot of things. (*Yellowstone County Residentialist*)

C. The River Changes

And then the river decided for some reason [to] move across—up against the bluff—and so now the river has become a smaller channel here.…I think it had to do with maybe the ice jam. (*Yellowstone County Residentialist*)

As the river changes, the fishing holes change, and the river changes about every year. (*Yellowstone County Residentialist*)

And, you know, it widened out the river so much with that flood the last time, there was so many trees and stuff that went. (*Yellowstone County Residentialist*)

Lots of changes. There used to be just a small channel that…would get water in it during high water and then, when the water went down, you could actually drive out on an island. It was pretty large. And I used to be able to launch my boat down there….It was one of those years when we virtually had a 100-year flood. (*Yellowstone County Residentialist*)

Ice jams are a big factor. They probably change the river more than anything. (*Yellowstone County Residentialist*)

My next door neighbor…tells me he used to drive their old Ford truck over to the island. The deepest [the river would be] in the fall would be two and half or three feet deep. We've sounded that and we know it's eight, ten, 12 feet deep with some deeper holes….Somewhere back in late-'80s, early-'90s the river took a turn, and, instead of going on the other side of the island, ice jams and blockages of one form or another carved the river over here. And we know it's been here because everything here is a product of river sediment over the last million years, and it goes back and it goes forth. (*Yellowstone County Residentialist*)

I figure things change when the ice comes. Ice in the middle of winter—that's what happened here. There was a big ice jam here….And it changed the channel. [It] used to just make a big sleeper here, then it turned it and it came 90 degrees right above this guys house right above into our bank….Now, guess where it's going again? Wrapping around, so it's changing back. (*Yellowstone County Residentialist*)

There's always gradual change, but in a high water year, it could happen in one year, in one season….The boat ramp was carved out a little bit more this year. So there's more water over there this year in that channel, whereas it was one the other side last year. So, it can happen,…like I said, in a season. And it's always happening gradually. (*Yellowstone County Residentialist*)

Although that channel has changed over the years, it's gotten deeper and wider in my estimation, just natural….The main channel used to come down and hit down here and then go out. That has changed. (*Yellowstone County Residentialist*)

Yeah, there's a lot of water there….The main channel is on the other side of that. This is all filling in….What will happen is…they'll have another major ice flow and it will hit the back end of this island and it will start shooting it into this thing here and this will all just get washed away and then it will be going that way. (*Yellowstone County Residentialist*)

I think that the ice flows that will happen…are going to change the direction…and the entire ecosystem….They've done it before, and they're going to continue to do it. And every 20 to 30 years, something major happens. (*Yellowstone County Residentialist*)

D. Building in the Flood Plain is Foolish

People…call it a flood plain for a reason, and if people want to build in the flood plain, then that would tell me that you're going to get flooded. (*Yellowstone County Residentialist*)

We were smarter than the people [building] across the way. You can't tell what the river [will do]. (*Yellowstone County Residentialist*)

I'll tell you where the water was one time. Remember when you drove by here? It was right up to the highway. I was here with my fins on….This road in here is new. They built it up higher, thank God. It saved us there, but here, coming around the corner, there's nothing there. The river…[doesn't] have to rise very much to get over and flood. (*Yellowstone County Residentialist*)

If somebody's going to build in the flood plain, they should sign something, 'I'm building in the flood plain. I'm willing to take the risk. I know what the implications are and I don't expect the government or my fellow Montanans or anybody else to bail me out if things go wrong.' (*Yellowstone County Residentialist*)

The house sits on a .97-acre tract and it is in the 100-year flood plain. The three and a half acres that surrounds it is in the flood plain…and the 30 acres down below is in the flood plain…We've seen a lot of water come through the overflow channel which according to the Army Corps of Engineers is telling me is what's keeping from flooding my place. (*Yellowstone County Residentialist*)

[When building near the river,] be careful. Come and see me. I am not in the flood plain. That river is 30 feet below the deck. When the water comes up above the gravel line, the dirt just tumbles off in the river. (*Yellowstone County Residentialist*)

That's basically is a flood plain, and I'm not sure what the flood frequency is here, whether it's 100 or 500. In the 30 years I've been here, I've never been flooded, but the lower piece down by the river is the one that's been flooded. (*Yellowstone County Residentialist*)

Zoning [is a problem]…because they think we are in a flood plain….[And] because you have all the rules with a flood plain. Cripes, this house was built…after World War II….Water's never, ever come within 20 to 30 feet to be raising high enough to flood us, but we live with all the rules of being in a flood plain….And, actually…in certain areas here, you can't even build a house because of being in the flood plain. These restrictions are due to all of that. (*Yellowstone County Residentialist*)

I think there's a lot of guess work that goes into those flood plain maps, frankly….I think there are probably better ways now through GPS technology that they could very closely identify whether it is in the flood plain. (*Yellowstone County Residentialist*)

The photos are of great value to see [past flooding], but I think since that flood in '97 the river has actually changed course and you can see that in the photos from year to year. Historically, the water hasn't come up that far, but since the river channel has changed a little bit in that area and we have lost some land, even last year we lost a big chunk….I can't say what would happen in the future. (*Yellowstone County Residentialist*)

E. Rip-Rap is a Known Solution

[Regarding rip-rap]…it would take a whole heck of a structure to hold up against an ice flow when the ice flow comes down. (*Yellowstone County Residentialist*)

The river's the banks. I mean people do raft on these all the time, and you know there's nothing worse than going by old car bodies. (*Yellowstone County Residentialist*)

I know they don't let you put concrete in the river anymore. I don't really understand that and nobody has explained it to me, so I guess I'll have to figure that out. (*Yellowstone County Residentialist*)

I've been thinking about getting some huge landscape rocks and putting them down there along the bank, just on top of the bank. I understand that concrete blocks and concrete rip-rap are out now because of the lime and all of that other stuff. So you got to come up with some kind of alternative. (*Yellowstone County Residentialist*)

Rip-rap in key locations in the river is really important for landowners. If they're not able to rip-rap, they're going to lose land. (*Yellowstone County Residentialist*)

I don't know where he got those boulders from. He put some money into it, [and] he was able to get a pretty good tax break when he put those big boulders in the river down there….You've got to use rocks big enough to withstand heaving force of water, especially ice….[The rocks are] aesthetically pleasing….In fact, you'll hardly see them because the vegetation has covered them up now….If it hadn't been for that rip-rap, I wouldn't own the land that I own now,…because the river would be in the middle of this field down next to the river. (*Yellowstone County Residentialist*)

We converted it all to grass and in order to conserve the banks. We've let [the] creek grow wild and planted trees along there and planted shrubs and bushes to hold [the bank]….Those [cottonwoods] are just seven years old….And these guys are 70 years old, these big ones here….They just do so well down there and anything that grows on the bank I just encourage it's growth because it holds the bank. (*Yellowstone County Residentialist*)

I guess if I had problems I would want the opportunity to save my investment. [Rip-rap] makes for some good fishing. You have rocks and boulders that give the small fish a place to hide out….It is a hiding spot for the littler fish and a resting spot for the bigger fish if they can squeeze in between the rocks. (*Yellowstone County Residentialist*)

[Rip-rap is] the only way they can save their land, you know. A lot of them dump rocks in there. When they first started, they'd dump cars in there, but that was outlawed so they couldn't do that. (*Yellowstone County Residentialist*)

I don't think [rip-rap] would be effective—not on a curve like that ,because I think eventually it just…gets behind the rip-rap, [and] you end up doing it again. So I don't believe rip-rap is the answer. (*Yellowstone County Residentialist*)

He stopped it [with rip-rap] from coming any closer. It probably got,…I'd say, about 40 feet from our barn. And he kept it away that long and kept it from getting to the dairy farm. And when my husband and I moved back it was still dangerous and then all the laws of the environment that you couldn't do nothing but just watch it. So, it was kind of scary for a few years. (*Yellowstone County Residentialist*)

When they came in and put…those rip-rap fingers,…in…I think they did a pretty good job with that….They called them fingers at the time, but they're like little levies or dikes. (*Yellowstone County Residentialist*)

F. Weirs as an Alternative to Rip-Rap

We actually looked at using rip-rap. We used to do a lot of rip-rap work.…And it was just lining the bank…[to] keep the bank from eroding, but you don't…really do anything about that. The weirs…actually slow the water down next to the bank and you don't have to line the entire bank with rock or concrete….So it will fill back in with grass and trees….It looks much better when it's done and matures. And it is less expensive than lining the bank in its entirety. We just felt that was the best option. (*Yellowstone County Residentialist*)

We put weirs in….[They were] incredibly successful….If it is done right, it works very, very well. We spend a lot of money and time and energy enhancing wildlife on a property like this that we are not compensated for. We do it because we like to….I spent hundreds of thousands of dollars doing the project we did on the river, doing the weirs the way we did it, engineered right. (*Yellowstone County Residentialist*)

[Weirs] are a good idea. A guy…just put some in a while ago. They seem to be helping a lot….In some cases, [weirs are preferable to rip-rap]….[Now,] putting a weir in still causes an eddy behind it that I think would cause some erosion when the water gets that high.…You can see some kind of scalloped areas behind it. But it does push, helps push the current out away from the bank. (*Yellowstone County Residentialist*)

Bendway weirs…[can] angle the river 20 degrees and they gently move it across to the other side….It's moving the river….You can just see how it hits the first one….Then it subtly moves it out to the second, third, fourth….My experience has been the weirs create habitat. There's more fish behind the weirs….The weirs…are a blessing that's not intrusive, creates growth, creates fisheries. (*Yellowstone County Residentialist*)

There's weirs all the way around this curve [to protect the bank]….We haven't really had high water yet so can't say [how effective they are]. (*Yellowstone County Residentialist*)

I'm living with the river and coping with it. As long as I can do some weirs, I have enough land and grass….If I left it unchecked, that river will be in this creek in less than 50 years. (*Yellowstone County Residentialist*)

G. Rip-Rap and the Potential For Unexpected Consequences

There [are] guys that put in little rows of rocks and stuff to push the river away from their bank, so it's going down like this. This guy does it, this guy does it on this side, so it kicks up more that way from them doing that….It pushed the river that way, so then those guys over there pushed it back this way. (*Yellowstone County Residentialist*)

I don't agree with people messing with [the river] so much to the point [that] when they filled it in over there and the river drastically came over here. I'm just afraid of things like that happening and losing more land. And, maybe not generally just for our land, our neighbors, as well….It changes a lot. A lot of that is because it was natural, but some of it because you know people decide to take it upon themselves to change it. (*Yellowstone County Residentialist*)

III. Frustrations with River Management

A. Agencies Need to be User-Friendly

All he wanted to do was rip-rap to save his bridge….At one time, he had 20 guys standing down there on his bridge, discussing what he should do. Bridge finally washes out and down in the river it goes. The next day, to save the road, they are hauling big boulders, dumping them in…and, of course, in the spring he had to haul his bridge out. That's required….But, there you go. When you're dealing with water, you're dealing with a lot of different people. (*Yellowstone County Residentialist*)

The only problem we had was the reluctance on the Army Corps of Engineers and the DEQ to get [the weirs] done. It took us two years….We probably lost 30 acres and an eagle's nest. To me, that is very disappointing. The lack of vision on the part of people that think the river has to be natural and nothing else works….The length of time and meetings it takes and attitude of, particularly, the DEQ was very difficult. Some of the people in the Corps were very reasonable; some were not that reasonable. The DNRC in town was very good as far as helping us. But their hands are pretty-well tied. They wait for all of the bigger agencies to deal with it. I think they make it so difficult that people just don't want to do it right, frankly. (*Yellowstone County Residentialist*)

My husband wants to build a pond out front and he would like to put a boat ramp in the back, right on the river….We haven't really seen a lot of requirements, other than they want to know what we're doing, exactly how we're going to do it, and what we're going to use when we do it, which I can completely understand. They don't want us messing stuff up. They're pretty particular about what's going to be used and what's going to be done….They even want to know how we're going to restore vegetation after we're done working. (*Yellowstone County Residentialist*)

I petitioned every agency that you have to…to build in four weirs...[in a] series, [which] is what works them gently out….We went through four or five agencies to get this done, and write this down. The Corps of Engineers was the slowest moving, hardest to….just follow up. I tried to do everything,…[to] get engineering drawings, pictures, whatever. It took forever for the Army Corps of Engineers to move. Bless their heart, they did. I was good friends with the gal that ran this deal out of Nebraska, and I certainly knew her on a first name basis and her birthday, because I talked to her every other day. I asked her where it was and she said it was sitting on somebody's desk. (*Yellowstone County Residentialist*)

It took us two years to get it permitted to do it right….We lost 20 to 40 acres. Had we…done it without the permit, we'd have saved that land….We stood down on the river bank looking at the project after we did it…[and] DEQ guy was complaining about a couple of inches variation in elevation….Yet we looked across the river where they had dumped in car bodies and concrete without permits. I said, 'How can you give me a bad time about doing it right, but being off a few inches in elevation, when you can stand here and look across the river and not do anything about what everybody else is doing?'….If I've got a permit…he's going to make it miserable for me. (*Yellowstone County Residentialist*)

That flood, it took probably three or four acres of ground where our irrigation system was and just completely wiped out our source of water. And we had to go through a quite a lengthy process of going through the Extension Service and the Conservation District and State of Montana…Corps of Engineers…to get permission to…lay an underground culvert farther up the hillside and tie it into that system at another point and rebuild our irrigation system. (*Yellowstone County Residentialist*)

I really think that the authorities should be more flexible in allowing landowners to protect their property. It's such a hassle to go through all the steps it takes to put rip-rap on your property.…There has been hundreds and hundreds of acres lost here….I feel for the larger landowners that have a lot of river frontage that lose a lot of property every year and really can't do too much about it. (*Yellowstone County Residentialist*)

Make a comprehensive plan as to what is allowable and a process to permit it with ease, rather than fighting every step of the way.…You get it so difficult, people just say, 'It's not worth the energy [to get the permit.] We'll do it anyway,...[even] if they put us in jail.' And I can't blame those people. (*Yellowstone County Residentialist*)

Make the rules a little simpler, and let the people save the land [with rip-rap]. I mean, it is such a headache. I don't know if they straightened it out, but it used to be a dozen different government agencies you have to deal with. (*Yellowstone County Residentialist*)

I know you have to jump through a lot of hoops [for the permits]. The Corps of Engineers is one, the County is one, [and] Fish and Game. (*Yellowstone County Residentialist*)

The only problem I have with the river here is there is no protection for us that live here in town. This is just a small bank here that goes around a corner. We tried to get them to do something, but they never have.….They'd have to put in a dike there. There's no way out of it. There was talk about doing that. In fact, the county commissioners were going to do it one year, then I don't know what happened. The bottom fell out of it. But there does need to be something done. (*Yellowstone County Residentialist*)

B. Rules Should Be Fair and Enforced

And then you get people across the river or downstream that just throw concrete on the edge of the bank, let the river bank wash out, the concrete falls in and looks like hell and they don't have any problems and yet I got hassled the whole way trying to do it [bank stabilization] right. And that is very disappointing to me. (*Yellowstone County Residentialist*)

I think the restrictions of what you can put on the riverbank has gone a little too strict. I know that you don't want to make it yucky looking, but it seems like…they're getting too touchy on it. (*Yellowstone County Residentialist*)

I don't think you can ever stop them [from littering] because you can't get enough cops to enforce it just like you can't get enough to watch the river. You have to change people's attitude if that's even possible. (*Yellowstone County Residentialist*)

Some people over here a couple years before took a CAT and put up a big berm over there and it pushed all the water over here. I contacted some people and nobody would do anything about it. (*Yellowstone County Residentialist*)

They change the rules. Like if we want to do something in the river, we have to go through six agencies to do all this crap. Laurel was having trouble getting water. They just take bulldozers and drop them in the water and do whatever the hell they want. If I did that I would have been fined quite seriously. So they don't enforce the laws equally either that do exist. (*Yellowstone County Residentialist*)

When that old boy started moving dirt around down there, someone should have done something about that. I called and nobody would do anything. This happens a lot….I have been up and down that river a million times and you can see where people have moved the bank around. (*Yellowstone County Residentialist*)

C. Management Practices Should Meet Residential Needs

I appreciate the chance to talk to you. Hope it will do some good. If they can understand our needs down here, that would be great. (*Yellowstone County Residentialist*)

[The] best manager that I've ever seen—it's been the common farmer. (*Yellowstone County Residentialist*)

I guess they can put the ear muffs on [if they don't like the boat noise]. We have been running the river forever. Now they build a house there and want us to change….The four-stroke motors are coming into play now due to new laws. There are two-strokes that are louder, but they have them running pretty clean. Give it ten years and it will be predominately four-strokes and at that point it will be quieter.…If I build on the river, I am not going to complain because I chose that and I know it could be an issue. (*Yellowstone County Residentialist*)

I just disagree with that whole concept of habitat management. I don't think it needs managing. I think it needs maintenance….Managing the river itself… would sure be nice rather than spend money trying to figure out which way to make the river go. It would be really nice to get the dead stuff out of here, because it is…a fire hazard. (*Yellowstone County Residentialist*)

Co-op funding from the Federal government or the State government…would certainly help. Even if you are not getting reimbursed for all of [the cost to stabilize the banks, we need,]…participation and encouragement to help you do it, rather than no participation and discouragement. I think maybe a lot more people that live along the river would do it knowing they could save land from being washed away. (*Yellowstone County Residentialist*)

[River management is] huge….[It should come from] someone that doesn't profit from the management itself, or someone who doesn't garner any kind of political votes….You've got to start somewhere,…[but] you're going to be infringing on people's rights. Especially Montanans. Out here, we're kind of out-laws….We'll do what we want within the parameters of the law. And, you start putting more rules and regulations on [Montanans] it's not going to work. (*Yellowstone County Residentialist*)

We hear a lot of complaints from fellow boaters and fishermen concerning the dams….There are not any very technical systems for those fish to be able to travel like they would normally. I think it has really affected the fishery. They could make it better….You could have a canal around there where the fish could get through. As far as boaters go,….if they could make a spot in the middle that would stay deep enough to pop over. I don't know. A lot of them have a cement pad and underneath giant boulders. (*Yellowstone County Residentialist*)

I think [the access] should just be a day use, because at night there's no way you can get boats in. And it's just the kids then and the people that take advantage of the land and aren't really fisherman that would enjoy it. (*Yellowstone County Residentialist*)

I don't think it's the right river to dam up. But I think the State and Federal government should work more closely with the landowners….And I'm not talking about making the river a straight channel all the way from Yellowstone park to the border, but give them a better chance to protect their land…and keep their irrigation systems in tact….I think there should be a little bit of Federal or State help for people that get in that kind of situation. (*Yellowstone County Residentialist*)

I would hate to see it come to a deal where you couldn't make use of [the river] with a motor. It would be a shame. It is such a great resource. It is big enough and if you keep [the boat] full speed and go by you don't leave a wake. If you slow down you really put out a wake. I know I went past a few that probably thought I was going too fast, but if I were to slow down it would be a big wave. I would get as far as I could away from them or shut down and let them go by. (*Yellowstone County Residentialist*)

I guess my biggest concern would be to lose any [boating] privileges that we currently have….If you get enough canoers and kayakers together to get the river to themselves, that would be a big deal to me. (*Yellowstone County Residentialist*)

They need to choose areas [for public accesses] that you can really move up and down. It's a waste of money to have them in the wrong spot.…Because the high water mark is right to the edge…[and you have] the concrete down there that's really unsafe to walk on or you've got a 12-foot bank….You have to get up and over the high water mark to get around and that's illegal. So if they did choose any kind of more accesses, they need to find the spot where they can actually get around a little bit. (*Yellowstone County Residentialist*)

I like [the high water mark] because it allows you on the river and then it also allows the landowners…to get nasty if you get out of it or above it….So, as long as you pay attention, you're fine. (*Yellowstone County Residentialist*)

IV. Other Problems

A. Water Quantity

I imagine the day could come, but it seems like we have sufficient amount of water, even with the drought. (*Yellowstone County Residentialist*)

The big thing for me is the low water, the low water levels, but I'm not sure at this point what you can do. There's not a lot upstream that you guys can do to force it down stream. You know we rely too much on the snowfall. (*Yellowstone County Residentialist*)

If you believe in global warning, I think [lack of water] will be a problem everywhere….There is apparently some evidence that there is getting to be too many people. (*Yellowstone County Residentialist*)

We have had some really dry years. That river right now is flowing half of what it should be. (*Yellowstone County Residentialist*)

Maybe [we should be] setting limits on how much water people can use a month….Make it a…law, or vote it on because I think if it came to that…a lot of people, at least I hope they would, understand the problem and want to vote for limited water use….[But, then] everybody's going to look at it for their own interests….It's just not an easy issue.…[The farmers] have water rights, you know….And, that's the law, so unless you change the law, that's how it's going to come out. (*Yellowstone County Residentialist*)

There won't be [enough water] in 100 years. There won't be enough. (*Yellowstone County Residentialist*)

I think the Yellowstone actually moves more water per year than the Missouri does.…Speed is the difference. The Yellowstone flows pretty fast and then in high water it really rips….It'll fool people….I think the Yellowstone has been able to supply so far, although it's gotten low, really low sometimes….[In] August, September,…it drops off substantially. (*Yellowstone County Residentialist*)

There's not a lot of water in Eastern Montana. It's a touchy subject….You get away from the Yellowstone,…up on the rims and stuff. Those people are hauling water to their houses….And we ran into the deal…by Fort Peck….They have to allow so much water to go down stream all the time. That is determined by the Army Corps of Engineers….We don't get to control that. Now, they can't say anything on the Yellowstone, because it runs free…but what you worry about, the next step is they come to Billings and say, 'You can only use so much water, because the rest has to go down stream.' Then the fight is on. (*Yellowstone County Residentialist*)

We are all hobby farmers….We don't have water….But it isn't our livelihood. [There's] a big difference [than]…if I was growing beets, or hay, and that's how I made my living.

I wouldn't be happy if someone was using the water that was rightfully mine. (*Yellowstone County Residentialist*)

The first people that should have the opportunity to use water are those that are fighting things like wildfires….Second are the municipalities, and their water systems, so the public has drinking water….Third are the farmers. You know, that's their lifeblood for…irrigation and stuff. And then you finally get down to the rest of it. (*Yellowstone County Residentialist*)

I'd put the farmers before the cities….I think it's probably more important to have crops than to water your lawn. (*Yellowstone County Residentialist*)

[Here's] a case of [a] city…running out of water.…Their water intake…is by the bridge. [The] channel changed, like for, three or four years, they spent $50,000 to $60,000, got an okay to be out in the river, set up a berm, channeled the water over to the intake. But of course, the powers that be said it was a temporary fix, you are screwing up our river. You can't do that. So we had a big bond issue, it passed….You can't see it, but there are now two intakes. The one that sits up, the cement one, and the one on the south side, which is all under water. (*Yellowstone County Residentialist*)

B. Problems with Public Access

Nine out of ten of those people that…come from a public access are going to trespass….There's four-wheelers all the time that we are constantly reminding them are not to be up on motorized vehicles, even within the high water marks. 'Oh, gee, we didn't see the signs,' 'Oh, really, gee, we are sorry' [they say] after they have been down there tearing up the river bank. (*Yellowstone County Residentialist*)

We need more access so people can get on to fish. People just don't trust people anymore, and we can't blame them….Unless you know somebody, you can't get on ...[so] they fish the bridge down here…[on] both sides, and they fish this corner up here, and they'll walk down the railroad tracks and fish that side, and there's a rancher over here that lets people that he knows on there to fish….[But] it's too close; you've got to get farther away to fish. To catch these here, you've got to go a long ways. (*Yellowstone County Residentialist*)

There's always the high water mark which I really like. As long as you can get on legally, you are legal. I don't believe in the circle the wagon thing neither, buying big blocks and just shut it down. (*Yellowstone County Residentialist*)

[There are] a few hunters that don't understand that you need to ask permission to cross your land to hunt, that's the only problem. Very few people bother me though. I try to get along with everybody. I'll let people come down here if they ask. (*Yellowstone County Residentialist*)

Quite honestly, if they're just pulling off for a few minutes to take a break, I don't really care. (*Yellowstone County Residentialist*)

It's not public access land, but anybody who asks me…I say,…'Tell me when you're coming, and if I say you can fish, don't tell somebody else'….People that I know who like to hunt and fish, they get to know the people. And when they get to know the people, they have lots of places to go. (*Yellowstone County Residentialist*)

I can tell you about the floaters. I've seen them pull up on the edge down there and empty their case of beer and throw the cans. It's just a mess. (*Yellowstone County Residentialist*)

Let me say this [about public access]: If somebody wanted to abuse something on someone's back yard and I'll just clean it up, is that ok? (*Yellowstone County Residentialist*)

The access problem: I would use it more if I had more available access.…[The access] isn't the best….It isn't some place you could go down and launch a boat or something like that, or want to.…There was another one closer, but when the river changed course that year, it left it high and dry. So it isn't even usable anymore. (*Yellowstone County Residentialist*)

We have had [problems] when the kids used to like to party in the park down here.…One time I looked out the window and I saw flames going probably 30 feet up…and it happened to be on my property. And I called the sheriff's department and they got…things under control. But since they've put a lock on the gate into the park, that's pretty much put a stop to that. (*Yellowstone County Residentialist*)

If it was just the fisherman down there, they are no problems. But you get the kids wanting to party on the weekends….That's the people that give you the troubles….[The authorities] check it, but midnight on Friday or Saturday night they're not around when the parties are going and the screaming and the gun shots….We've asked [it to be closed at night], and they won't let that happen. (*Yellowstone County Residentialist*)

There is a recreation area down below here that we get a lot of fisher people in but we've not had any trouble with any of them….If we see somebody down there, we…say, 'I don't care if you have a fire down here….Just put it out. You know you got to be careful what's going on with us up here'.…Kids party down there, but that's typical. (*Yellowstone County Residentialist*)

It is not really heavily used. It must just be a responsible bunch using the river. I have never had any problems whatsoever. (*Yellowstone County Residentialist*)

C. Water Quality

We came here, and there was a guy that used the river as a garbage dump. (*Yellowstone County Residentialist*)

Just polluted, people put so much stuff. It's just really dirty. (*Yellowstone County Residentialist*)

I know there's an awful lot of pollution around….My concern is with the refinery, but I have to be careful about that because they were there before I moved in and I know they were there before I moved in….I would like to see the refinery…closed, but that's wishful thinking. Quite honestly, I don't know what they do to [the river], but I'm sure there's something that goes on, even if they say there isn't. (*Yellowstone County Residentialist*)

I think most people are interested in better water quality, if you are encouraged to do it, rather than forced to do it. (*Yellowstone County Residentialist*)

The Yellowstone River really stinks after Laurel. I mean, not that I want to lose the refinery or anything….I don't know if it's necessarily the refinery or if it's just that it's more populated from Laurel to Billings, that stretch. I don't know really what the problem is. But there's no good fish after Laurel….Keeping it clean is my biggest thing. (*Yellowstone County Residentialist*)

D. Safety: Debris and Undercurrents

I also respect it deeply….It will kill you with no malice or forethought. You can go in a heartbeat. You know it is ignorance and stupidity [that] will get you killed….If you got those two mastered, then you're fine. (*Yellowstone County Residentialist*)

It was scary because the current right along here was deep, really deep and it would just swirl and at nights, it was loud from the current because it was fast moving. (*Yellowstone County Residentialist*)

I have the greatest respect for what the river can do. We lost a neighbor here two years ago. He hated the water, but he wanted to cool off and his family encouraged him to get in the water. He jumped in and never came back. We lost a guy off the bridge up here a little bit ago. The fire trucks and police and Sheriff's Department [all came and] I gave them ropes and life jackets. They came down to the river, and we haven't found the guy yet. I sure hope he doesn't come up here. (*Yellowstone County Residentialist*)

It's really high in the beginning of the summer so I try not to spend too much time around, just because it's pretty scary around the bank. (*Yellowstone County Residentialist*)

If you're going to go on the river, you've got to be able to control your canoe because, if you get close to a tree that's fallen into the water, you get sucked under….You're taking a pretty high risk. (*Yellowstone County Residentialist*)

But, I tell you what, as calm as this looks, and I found this out the hard way, because I fell out of the boat, underneath that water, it's moving and you can't stand up or get up or get out. (*Yellowstone County Residentialist*)

E. Exotic and Invasive Plants

We have…sprayed for and dug every noxious weed we can get after:…leafy spurge,…thistle. (*Yellowstone County Residentialist*)

The islands and the shores along the Yellowstone are rapidly becoming contaminated with noxious weeds, [and] leafy spurge and knapweed [are] the two big ones….I think everybody along the river needs to kill the weeds…[because] weeds contaminates the property owners down the stream. (*Yellowstone County Residentialist*)

There's an insect that will kill [leafy spurge]. A good friend of mine owns a ranch…[and has] some beetles that feed on leafy spurge, and he gave me some, but mine isn't concentrated enough now to give the beetles something to eat, so I don't think the beetles are helping me. But they're helping him. And that could be a good solution along this river where there's heavy concentrations of leafy spurge. Those beetles are species-specific; they feed on just the leafy spurge. That's a great way to control the leafy spurge. (*Yellowstone County Residentialist*)

F. Wildlife and Insects as Nuisances

Mosquitoes are really bad down here…The first case [of West Nile] in Yellowstone County was here…on a horse.…They're so bad.…I was doing work right around the front of the house…and I just couldn't put on enough mosquito spray to keep them off me….I had mosquito netting….I put that on and put a long sleeved shirt on and long pants and my pants tucked in my boots and gloves and that was the only way I could work outside. They were just swarming all around me. (*Yellowstone County Residentialist*)

In fact, the deer are a big problem….I try to grow trees and they have killed some young trees. They killed two last year….They are a nuisance. (*Yellowstone County Residentialist*)

Can we do anything about the mosquitoes?...We have mosquitoes by the jillions. (*Yellowstone County Residentialist*)

All the trees that were probably eight to ten years old were as thick as dog hair down there. So, we thinned them out and I…wanted to keep the biggest and healthiest ones. And as soon as we got half way through that one acre down there, the beavers hit us, and started taking everything….So we had a little on-going battle with the beavers, which I was losing badly….That's what killed the 100-year-old cottonwood out there. (*Yellowstone County Residentialist*)

Yellowstone River Cultural Inventory—2006

Part II: Powder River to Big Horn River

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Preface

The Significance of the Yellowstone River

The Yellowstone River has a long history of serving human needs. Native Americans named it the Elk River because of its importance as a hunting environment. William Clark explored much of the river in the spring of 1806 and found it teaming with beavers. By 1906, the US Bureau of Reclamation was sponsoring diversion projects that tapped the river as a source of irrigation waters. The river then enabled "twentieth-century progress" and today it supports many nearby agricultural, recreational and industrial activities, as well as many activities on the Missouri River.

Management of the shared resources of the Yellowstone River is complicated work. Federal and state interests compete with one another, and they compete with local and private endeavors. Legal rights to the water are sometimes in conflict with newly defined needs, and, by Montana law, the public is guaranteed access to the river even though 84 percent of the riverbank is privately owned.

Interestingly, in spite of the many services it provides, the Yellowstone River in 2006 remains relatively free-flowing. This fact captures the imaginations of many people who consider its free-flowing character an important link between contemporary life and the unspoiled landscapes of the Great American West. As a provider, as a symbol of progress, as a shared resource, as a management challenge, and as a symbol of our American heritage, the Yellowstone River is important.

Purpose

The Yellowstone River Cultural Inventory—2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.

There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants' views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river's resources. Special attention is given to the ways

in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

Identification of Geographic Segments

The Yellowstone River is over 670 miles in length. It flows northerly from Yellowstone Lake near the center of Yellowstone National Park in Wyoming. After exiting the park, the river enters Montana and flows through Paradise Valley toward Livingston, Montana, where it turns eastward. It then follows a northeasterly path across Montana to its confluence with the Missouri River in the northwestern corner of North Dakota.

Five geographic segments along the river are delineated for purposes of organizing the inventory. These five segments capture the length of the river after it exits Yellowstone National Park and as it flows through eleven counties in Montana and one county in North Dakota. The geographic delineations are reflective of collaborations with members of the Yellowstone River Conservation District Council and members of the Technical Advisory Committee and the Resources Advisory Committee.

Working from the confluence with the Missouri River towards the west, the first geographic segment is defined as Missouri River to Powder River. This geographic segment includes some of the least populated regions of the entire United States. This segment is dominated by a broad, relatively slow-moving river that serves an expansive farming community whose interests blend with those folks living along the seventeen miles of the Yellowstone River that traverse North Dakota. Here the Yellowstone River is also important as a habitat for paddlefish and Pallid sturgeon. At the confluence with the Missouri River, the size of the channel, significant flow and substantial sediment carried by the Yellowstone River makes its importance obvious to even the most casual of observers. Prairie, Dawson and Richland Counties of Montana are included in this segment, as well as McKenzie County, North Dakota.

The second geographic segment, Powder River to Big Horn River, is delineated to include the inflows of the Big Horn and Tongue Rivers as major tributaries to the Yellowstone River and to include the characteristics of the warm-water fisheries. This segment is delineated to recognize the significant agricultural activities of the area and the historical significance of the high plains cowboy culture. This segment includes Treasure, Rosebud and Custer Counties.

The third geographic segment, Big Horn River to Laurel, essentially includes only Yellowstone County, but it is a complex area. To begin, important out-takes near Laurel divert water to irrigations projects further east. Additionally, it is the one county along the length of the river with a sizable urban population. Billings is known as a regional center for agriculture, business, healthcare and tourism. This area is notable for its loss of agricultural bottomlands to urban development. Irrigation projects are important east of Billings, especially in the communities of Shepherd, Huntley and Worden. These

communities and Laurel also serve as bedroom communities to Montana's largest city, Billings. It is in Yellowstone County that the river begins its transition to a warm-water fishery.

The fourth segment, Laurel to Springdale, ends at the northeastern edge of Park County, Montana. The river in this area is fast-moving and it supports coldwater fisheries. While there is little urban development in this segment, there are some rather obvious transformations occurring as agricultural lands near the river are being converted to home sites for retirees and vacationers. The geographic segment includes Sweet Grass, Stillwater, and Carbon Counties.

The last geographic segment is defined as Springdale to the boundary with Yellowstone National Park at Gardiner, Montana and is within the boundaries of Park County. The river leaves Yellowstone National Park and enters Montana at Gardiner. It flows in a northerly direction through Paradise Valley and is fast-moving. It supports a cold-water fishery that is well-known for its fly fishing potential. Near Livingston, Montana, the river turns easterly and broadens somewhat thus losing some of its energy. However, severe floods occurred in 1996 and 1997, and local groups have since spent many hours in public debates concerning river management.

Recruitment of Native Americans

Native Americans also have interests in the Yellowstone River. They are active in maintaining the cultural linkages between their histories and the local landscapes. For the purposes of this study a number of Native Americans from the Crow tribe and the Northern Cheyenne tribe were included. Native Americans were recruited by means of professional and personal contacts, either as referrals from state agency personnel, from Resource Advisory Committee members of the Yellowstone River Conservation District Council, or from other project participants.

Recruitment of Geographic Specific Interest Group Participants

The participants represent a volunteer sample of full-time residents of the towns and areas between the confluence of the Yellowstone and Missouri Rivers in North Dakota and the town of Gardiner, Montana at the north entrance to Yellowstone National Park. Participants were recruited from four major interest groups: agriculturalists, local civic leaders, recreationalists, and residentialists living near the river. A database of names, addresses and contact information was constructed for recruitment purposes. Nearly 800 entries were listed in the database, representing a relatively even contribution across the four major interest groups.

Individuals representing agriculture interests, including farmers and ranchers, were identified and recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of the Natural Resources Conservation Service.

Individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and public works managers, were identified and recruited through public records.

Individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity, were identified and recruited from referrals provided by members of the Resource Advisory Committee. Participants were also identified and recruited by contacting various non-governmental organizations such as Ducks Unlimited, Trout Unlimited, the Audubon Society and by contacting local outfitting businesses.

The names of property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank, were obtained through a GIS search of public land ownership records. Twenty acres was used as a screening threshold to separate people who lived along the river corridor but whose incomes were from something other than agricultural practices (residentialists) from those who were predominantly farmers or ranchers (agriculturalists). The names were sorted by county and randomized. Recruitment proceeded from the county lists. Other people living very near the river and whose primary incomes were not generated by agriculture were also recruited. These additional participants may not have had property that technically bordered the river and/or they may have owned more than 20 acres. In all cases, the recruits did not consider agricultural as their main source of income.

Participants were recruited by telephone and individual appointments were scheduled at times and meeting places convenient for them. Many interviews were conducted in the early morning hours and the late evening hours as a means of accommodating the participants' work schedules.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

A total of 313 people participated in the project, including 86 representatives from agriculture, 68 representatives in local civic roles, 76 representatives of recreational interests, 76 residentialists and seven Native Americans. A relatively equal representation was achieved in each geographic segment for each interest group.

Description of Interviews and Collection of Participant Comments

A master protocol was designed from questions provided by the US Army Corps of Engineers and approved by the Office of Management and Budget (OMB approval # 0710-0001; see example in the appendix to this volume). Questions were selected that would encourage participants to describe the local environs, their personal observations of changes in the river, their uses of the river and any concerns they may have had about the future of the river as a shared resource. Open-ended questions were used as a means of encouraging participants to speak conversationally.

The questions were adapted to the participants' interest groups. For instance, interviews with agriculturalists began with the question, "How many years have you been in operation here?" while local civic leaders where asked, "How many years have you lived in this community?" Similarly, agriculturalists were asked, "Are there any problems associated with having property this close to the river?" and local civic leaders were asked, "Are there any problems associated with having private or public properties close to the river?" The overriding objective of the approach was to engage the participants in conversations about the river, its importance and their specific concerns.

Participants were promised confidentiality, and open-ended questions were asked as a means of encouraging the residents to talk about the river, the local environs and their personal observations and concerns in their own words. All respondents were interested in talking about their perspectives, and they represented a variety of views of the river, including: farming, ranching, agricultural science, commercial development, recreation, civic infrastructure, environmental activism, historical views and entrepreneurial interests.

With only three exceptions, the interviews were audio-recorded and verbatim transcripts were produced as records of the interviews. In the other three cases, hand-written notes were taken and later typed into an electronic format. The total resulting interview data totaled approximately 2,700 pages of interview text.

Steps of Data Analysis

The content of the interview texts was distilled by way of analytical steps that would retain geographical and interest group integrity.

Segment-Specific Interest Group Analyses: Taking all audio-recordings, transcripts, and field notes as the complete data set, the research group first set out to determine the primary values and concerns for each geographic segment-specific interest group. The team began with the four interest groups from the segment Springdale to Laurel. Team

members read individual interview transcripts and determined a core set of values and concerns for the individuals represented. As a team, notes were compared and a combined outline of values and concerns was constructed for each interest group in the geographic segment. Quotes were then taken from each transcript in the set to illustrate the particular values and concerns.

Outlines of the interest group analyses for the Springdale to Laurel segment were then used as aids in constructing the interest group analyses in all other geographic segments. Care was taken to adapt the interest group analyses to highlight if, and when, the core values and concerns were different in each geographic segment. The Native American perspective was addressed as an individual analysis with attention to the specifics of those perspectives. Each of the 21 segment-specific interest group analyses was then illustrated with quotes from interviews.

21 Segment-Specific Interest Group Analyses

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Segment-Specific Geographic Summaries: A summary of the values and concerns for each geographic segment was constructed using the sets of four geographic-specific interest group analyses. Geographic summaries were written to reflect the concerns that crossed all interests groups of the segment, either as points of agreement or disagreement, and were illustrated with quotes from the four relevant interest group analyses.

5 Segment-Specific Geographic Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

River-Length Interest Group Summaries: River-length interest group summaries were constructed for each of the four primary interest groups. For example, agricultural concerns from the five geographic segments were compared and quotes were taken from the segment-specific interest group reports to illustrate commonalities and differences. Similar reports were constructed for local civic leaders, recreationalists and residentialists.

4 River-Length Interest Group Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Organization of the Reports

Overall Summary of the Yellowstone River Cultural Inventory—2006: An overall summary of the inventory was written as a means of highlighting the values and concerns that cross interest groups and geographic segments. The segment-specific geographic summaries and the river-length interest group summaries were used as the bases for the overall summary. This report is by no means comprehensive. Rather, it is written to encourage further reading in the reports of each geographic segment and in the interest group reports.

Part I: Missouri River to Powder River: This volume includes the geographic summary for Missouri River to Powder River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part II: Powder River to Big Horn River: This volume includes the geographic summary for Powder River to Big Horn River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part III: Big Horn River to Laurel: This volume includes the geographic summary for Big Horn River to Laurel and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part IV: Laurel to Springdale: This volume includes the geographic summary for Laurel to Springdale and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

***Part V: Springdale to Gardiner*:** This volume includes the geographic summary for Springdale to the boundary with Yellowstone National Park and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Research Team and Support Staff

The project was directed by Dr. Susan J. Gilbertz, Montana State University—Billings. She was aided in data collection and data analyses by Cristi Horton, Tarleton State University and Damon Hall, Texas A&M University. Support staff included: Amanda Skinner, Amber Gamsby, Beth Oswald, Nancy Heald, Beth Quiroz, Jolene Burdge, and John Weikel, all of Billings, Montana.

Powder River to Big Horn River: Geographical Segment Overview

Interviews in the geographic segment Powder River to Big Horn River were conducted June 18-23, 2006. A total of 63 interviews were conducted, including individuals with agricultural, civic, recreational, or residential interests as their primary concern.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
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Powder River to Big Horn River: Geographical Segment Summary

We have to make sure [future generations] have access and have the opportunity to enjoy the same things that previous generations have had with the river….It's going to get tougher because demand is in its infancy. As the pressure gets more…there will be more issues. Right now, it's in the beginning stage. (Rosebud County Local Civic Leader)

Introduction

In the study segment, Powder River to Big Horn River, three conversations emerged across the four interest groups. The first conversation focuses on the "familiar way of life." The conversation exposes a local identity that is tied to agriculture and to traditional forms of recreation, such as hunting and fishing. When asked if the familiar management practices are sufficient in terms of sharing the river's resources, some locals express concerns. The second conversation explicitly acknowledges that the demand for recreational access to the river's resources is in its infancy in terms of representing a problem. The third conversation focuses on controlling the river with rip-rap and dikes.

A Familiar Way of Life

The people of the segment Powder River to Big Horn River reveal an identity that directs their way of life. This identity draws a distinction between Western Montana and Eastern Montana and is especially concerned with agricultural activities as the economic base of these communities and with ease of access to the river's recreational resources. Locals often explain the unique social and geographical features of the area:

> We originally came to Eastern Montana to get experience and then move west, but it kind of grew on us after a while. (*Rosebud County Residentialist)*

> [It's] less populated, thank God….I like it here. Open, Big Sky country—that's us. I don't know how the western part of the state can claim that. [There are] too many mountains and trees. (*Rosebud County Residentialist)*

> It is very scenic. We take it for granted. You come out here and see the badlands….I get so many comments on this picture about the scenery in the background. We don't think about it too much. It is probably one of the nicest places here. We are close to the Interstate. (*Prairie County Agriculturalist*)

> Some people find this area to be very desolate,…[but] it has the beauty of the river and the beauty of the drylands. It's very much a prairie/plains environment.

> The wind always blows, so you [had] better be ready for that. (*Rosebud County Local Civic Leader)*

> It's scenic in its own way. We're kind of in the intermediate stage of the river. It's not a free-style mountain river, but it's not [like] Glendive where it looks like a channel. It's kind of in the middle. It has a lot of character. It's pretty diverse. (*Rosebud County Recreationalist*)

Agriculture is identified as an economical and social contributor to this segment. Also, the agricultural community is seen as a primary provider in terms of access to recreational resources associated with the river:

> It is like having an artery in your body. It is a vital part of this valley. It is the lifeblood of the valley. Our irrigation district was co-founded by our granddad. (*Treasure County Agriculturalist*)

> The agricultural sector of the economy in Custer County contributes anywhere from nine to 13 million dollars per year. Much of that is generated in the Tongue River Valley. There is a great deal of irrigation that is derived strictly out of the Tongue….It is very important for this economy that the quality of the water in the Tongue River and downstream is acceptable to the kinds of crops that have traditionally been grown. If we lose the water quality, we lose a significant contribution economically to this community. The Powder is the same. These are stretches of water that just in normal runoff, that runoff is piling sodium load into the river. If we have additional sodium in the reservoir, we end up with a precarious situation for irrigation. (*Custer County Local Civic Leader)*

> They go hand in hand....I say it's 50-50. I do. Agriculture needs it as much as we need it. It's not a position of 'them' versus 'us.' My interest is recreational, but I also want agriculture to do well because them doing well allows me to recreate….We just don't want any battle. It would be so unnecessary. It's worked before; we can work together. It's good for everybody. (*Treasure County Recreationalist*)

Recreational uses are often connected to the agricultural backdrop and are considered economically important and central to the social ties that bind community members together:

> From our standpoint as commissioners, the [river provides] economic benefits for the local area….[It] provides irrigation for the farmers….It brings…the hunting and fishing people…[and it serves] our own recreational uses. (*Rosebud County Local Civic Leader)*

> We're right at the balance, I think now, between recreation and agriculture. If we switched from one side to another, we would alienate the landowner. That would hurt the access….Then we lose generations of future hunters and we lose those

> dollars into the economy, whether they go buy iPods, cars, or motorcycles, instead of buying fishing poles, and goose decoys, or something. I don't know. People will spend money. (*Treasure County Recreationalist*)

> Rivers are made for such things. People swim in it, [and] people float in it with inner tubes or rafts. A lot of kids in the summer will put in at Meyer's Bridge, which is on the other side of Hysham, and float down and somebody will take them out in Forsyth. That's a great float….Anytime in the summer, you can see adults and kids doing that....People fish on it. People hunt on it during hunting season, particularly [for] geese but certainly ducks. People will walk its banks just to walk the banks of the river. People will walk its banks to collect rocks because the rocks in this river are truly phenomenal….The famous Yellowstone agates, which, at the turn-of-the-century were considered semi-precious gemstones, were sent to New York, London, Paris and Rome to be cut into jewelry. There are two old-time collectors here whose backyards and outbuildings have nothing but these piles of agates that they have collected….The river gets a lot of use….My wife and I spend a lot of time on the river…Seldom are we alone, and we don't go to the easy access places. (*Rosebud County Local Civic Leader)*

Both agriculture and recreation create a way of life that offers a sense of identity and a sense of place to the people of this segment:

> This isn't a Cabela's fantasy….[We've] been making this three-day trip, annually, for 33 years….We build our own homemade canvas-covered boats….[and when] we poked a hole in one, we pulled over and all got to chewing gum and patched it on both sides. (*Custer County Recreationalist*)

> If I sold this ranch, I would lose my identity, I guess. And I would lose my character. That's what would probably happen to me. I would maybe sell this. But I don't think the town of Terry needs another town drunk. That's probably all I would be. When your family has been here for that long of a time period, you just create some sort of identity from the land…My life is based more on the history of the land and a lot of people don't have that. (*Prairie County Agriculturalist*)

> It's the quiet and the peacefulness of being down in that area along with the water. It's kind of a place that you can go,…relax and do the things I like to do. (*Treasure County Recreationalist*)

> It's a seasonal elixir for my obsessive compulsive disorder. I have two things that I might consider to be OCD: one is pheasant hunting and the other is river rafting. (*Treasure County Recreationalist*)

> It was a great place to raise a family. I would still live here if I wasn't farming or working. We are close to anywhere we need….I can't imagine living in a city. *(Treasure County Residentialist)*

I'm a fourth generation Montanan. My great grandparents homesteaded here….Being raised here, I just love it. I go other places, and it just doesn't feel quite right. (*Rosebud County Residentialist)*

Yet, some of the members of these communities recognize that familiar ways of doing things near the river may need to be questioned. Among the topics of concern are questions regarding the forms and functions of regulatory entities. While such questions are not necessarily pervasive, they are found within each interest group, including agriculturalists:

> I know how much fertilizer, and I know how much herbicide, and I know how much insecticide is put on the sugar beets….You fertilize your field, and then you flood irrigate it….It doesn't disappear, it ends back up in the drainage, and it all ends up back in the river….There's no question about it. [For] most of the rivers in this country, the nitrogen rates are far higher than they should be. (*Rosebud County Local Civic Leader)*
>
> There are probably issues out there that are waiting to come up, [that] would be my guess. From a planning board perspective, they rarely come up [here] because so much of the river is Ag. (*Custer County Local Civic Leader)*
>
> Recreation…doesn't use up water….I mean, you're using the water for play but you're not using it up….The growth in the community certainly could use more water, and I worry about agriculture, because I know…people are tending to take a lot more water than they have water rights to. It's a concern….Number one, enforce the water rights that the farmers and ranchers are using….[I know] that's their livelihood, so I'd hate to see that taken away, [yet] we have to have water to drink. *(Custer County Residentialist)*
>
> Ag impacts, or at least…[is] being blamed for, mortality on certain game fish species, such as sauger…down near Sidney at Intake Dam. [The dam] is blamed for killing hundreds of thousands of fish every year. (*Custer County Recreationalist*)
>
> When you start talking about modifying irrigation structures for recreational uses, you have a direct tie to money and the irrigation guys are going to go nuts. You are benefiting someone that [irrigators] don't care about, and that [irrigators] don't think have any reason to be there. I think that's one of the fights. (*Treasure County Recreationalist*)
>
> They're still so afraid of having government involvement….And, I hate to say this, but a lot of those guys, they're in farm programs, and as long as they can take money out of the farm programs, well, then the programs are all right. But then, boy, there better not be any kind of strings attached….I can sit out and bark because, for three generations, we've not taken government handouts, or government programs, or government aid of any sort. And, until you get

> yourself…there, and then stand back and view it, these guys don't have a lot of room to complain about government involvement….I think we can…put [ourselves] in a position that we can protect that river as a resource and it can be there for generations to come….[In terms of accepting regulations] sometimes, along the way, there's some bitter pills that has to be swallowed. (*Prairie County Agriculturalist)*

For the people of the Big Horn River to the Powder River, the local way of life is built around a somewhat desolate but scenic place to live. Most people from this area agree that agricultural and traditional recreational activities contribute to the character of their communities; however, discussions regarding regulations expose complex ideas concerning how to best share and protect the resources of the river. Further complexities are shown in the next section.

Recreational Demand is in its Infancy as a Problem

Nearly without exception, discussions in the Powder River to Big Horn River segment noted that recreational demand is in its infancy in terms of representing a problem. Of particular concern is the need for access to the river and to its recreational access, such as wildlife for hunting. As more and more outsiders discover the local resources, residents of the area are aware that the familiar ways of sharing are not necessarily followed by everyone. The conversations reflect a desire to both embrace the familiar ways of sharing resources and to plan for the eventualities of increasing recreational demands. To begin, most see that recreational demands are growing:

> With more population in Billings, we're seeing more people coming down this way to use the river. (*Treasure County Recreationalist*)

> Last year it was nice, but we saw more people than we have ever seen. (*Custer County Recreationalist*)

> We have been doing it a long time and the traffic anymore….They have big, fancy boats, jet boats….There was one that came by us last year that was as big as a school bus. I thought we were going to sink. It is not rustic anymore. They…[aren't] hunting. (*Custer County Recreationalist*)

Local land values are increasing as agricultural lands are being purchased for recreational uses. This shift causes locals concern as they recognize that such increases may not be appropriate for local agriculturalists, especially as these changes raise taxes:

> But, [putting land into production] does not increase the value anymore. It's recreation….For instance, up here there used to be three big sprinkler systems—three big pivots—, and they…[were] put in there for production of the land, production of crops, [to] feed more cattle….I sold them…and I just irrigate, I just flood irrigate. I could put a sprinkler up there and I could raise a lot of crops. But, where I live here, if I want to sell it, I would have a high value just for recreation

or the opportunity to increase production. What I'm trying to say is, I could go out here and I could buy a big sprinkler that costs, say, $150,000 to irrigate 200 acres, or I could not put it in there, and it's still worth the same amount of money, because some people would buy it for the potential for production versus if it was in production. (*Prairie County Agriculturalist*)

I did get my point across to you, which I think is very important, that…you have to base things on the value of the property, based on what it would sell for, based on its production. Well,…[now] that production is recreation.…People are buying things more for the investment value than production value. (*Prairie County Agriculturalist*)

We'll continue to see more outside ownership. The folks here that want to be in agriculture need to develop long-term leases with the [new] owners….Land sells at higher prices than it will produce in cash flow. So, if you've got to pay for it with the [farm] income, that doesn't work anymore….Folks that come from out of the area, whether it's Billings, or back east, or other states,…[some are] part-time, or they're moving here and retiring….[Maybe] they first came here hunting and [then became] interested in owning some land to hunt on because it's getting harder and harder to find places to hunt. Or [they] just believe it to be a good investment….When the stock markets went lower, and they weren't doing very well with their money, there was a common thought to put it in land. [Land] will always be there. *(Rosebud County Residentialist)*

In this day and age, you don't really base things on production like you used to. You base it more on the assessed value and what it would be if you sold it. That's the way that land along the river is….It's getting less production and more 'what's for sale,'….Now, if a person went to sell this ranch, it would sell more for recreation value than production value…it used to be ten, 15 years ago, and you'd see the productions of the crops would be the value of it. But now when a person comes, like when that real estate agent comes and we looked at it, he put a value of $700on it based on how many whitetail deer ran out of the trees and how many 'coons there were. (*Prairie County Agriculturalist*)

I think if they are buying it as recreation property, it should be taxed that way. Maybe if you tax [it] that way, and you tax mine that way and I am trying to raise three dollar wheat, it is not going to work. Those people don't contribute to the community.…Make them guys live here and when it gets to be 40 [degrees] below [and] maybe they will leave. Everybody wants a piece of Montana. I don't know what the answer is. It is part of a free system where, if you have money, you buy something. You have the right to buy it. You can't compete if you want to buy more Ag land. (*Treasure County Agriculturalist*)

Local people note that hunting access is less easily available. Outfitters, guides, new landowners, and seasonal recreationalists are negatively impacting local access availability:

> I've heard other people saying it is more difficult. I mean, [with the] guides getting in there, tying up areas, paying off the ranchers to keep everybody else out. I think if I lost the ranchers and farmers I know, it would be tougher to get on. (*Rosebud County Recreationalist*)

> Now most private land is being guided. In my opinion, 70 to 80 percent is. What isn't being guided is being bought up by hunters. The hunting and fishing is a commercial venture.…When you get to Bozeman [and] Missoula, if you want to do anything, you fork over 300 bucks. Get a hold of a guide to go fishing. (*Rosebud County Agriculturalist*)

New landowners are not willing to share:

> [We're seeing] primarily out-of-state, big money coming in to buy their little piece of Montana and they don't want to share it with anybody. (*Custer County Recreationalist*)

> [Access]…is getting harder all the time. That has changed. It used to be you could go anywhere pretty much. Now places are getting bought up for the purposes of their own hunting. It is getting tough to find somewhere you can hunt. (*Custer County Recreationalist*)

Disrespectful seasonal recreationalists cause hardships for responsible recreationalists and the landowners:

> [Just] like everybody, out of 100 hunters, one of them is going to do something stupid, and that's the one they remember and makes a bad name for everybody else…It's up to the rest of us to police them and to keep them in line, which we do pretty well, but people are people. Not everybody has the same value system that we do. They just don't care; they're here for months in their life and they're gone. They don't have to live with the repercussions. (*Rosebud County Recreationalist*)

> Everybody comes to hunt on the weekend. I had a guy stop and I told him that I had too many hunters already on and he could come back during the week. He was madder than hell. Last year, we said, 'To hell with it!' and closed it and leased it out to five individuals. You hate to do that. These guys formed a hunting club and leased it and they hunt it. Everybody else is out. That is too bad, but they forced me to do it. I had hunters that would come on drunk. Some would come on without asking. (*Treasure County Agriculturalist*)

> Access—that is complicated….I would like to see just two accesses but…it would be better for the public to have one more….There have been times, especially during deer season, [when] they keep hounding me… to put a boat in. So far, I haven't let anybody use it except my own family. There can be hard feelings over it. It is private property so they should understand that….I am not real comfortable with [them going] right by my house….You are going to have people throwing stuff out and littering. You think they won't, but they will. (*Treasure County Residentialist)*

As landowners charge and/or increase access fees, many locals feel the expenses are limiting access to the wealthy:

> We're getting people from out-of-state. People with a lot of land…that are financially well-off. People that guide hunters and things like that….I've seen the amount of hunters increase quite a bit, and I'm not saying that's bad or anything. It's good for the economy, [and] animals are overpopulated. It's good for the herds, too….[But,] in the old days, you used to be able to just go hunting and now it's going to cost. (*Rosebud County Residentialist)*

> We're seeing that jealousy. The rich people can go hunt on all this prime land, but the guy that lives here and drives the school bus can't get in on the property because he doesn't want to pay to do it. (*Treasure County Recreationalist*)

However, most conversations reveal that Block Management provides affordable access while generating local revenue and game population benefits:

> Fish and Game controls [Block Management], and the landowner gets paid so much per person, per day. And it's trying to keep more of the acres open for the average Joe that can't afford to lay out a few thousand bucks to tie a chunk up so nobody can hunt on it for years. (*Treasure County Residentialist)*

> We have more waterfowl. We have goose hunters from as far as North Carolina. We are in Block Management. We get ten dollars per hunter. It was temporary, but now I think it is permanent. It is strictly voluntary. It has brought a lot of revenue to this neighborhood. Most around here is from $3000 to $5000. (*Prairie County Agriculturalist*)

> Block Management is a wonderful program. It benefits, obviously, the hunter; it benefits the landowner, and it also benefits the game, too, because it disperses them. It's not all crowded into closed-off areas. (*Treasure County Recreationalist*)

> I'm somewhat of a believer in letting the public use your land as long as they're responsible….For instance,…Block Management,...[has] been working real[ly] well for us. And hunters just appreciate it, because, you know, they're having such a tough time getting onto private property to hunt and stuff. As a landowner, I don't mind them hunting, and they appreciated it. As long as they take care of

> the property, I think it's beneficial to us. And, the fact is, they keep our deer population and stuff in sync. So, that's a good program. And…I still have control, because I can tell somebody, 'No, I don't want you on [our place].' We keep a bad list. (*Treasure County Agriculturalist*)

Although there are a few drawbacks, many feel Block Management will gain in popularity:

> The phone starts ringing in mid-August. A lot check and see what it is [Block Management]. We ask them to call in advance. We have room for several, but when it is full, I restrict it. Come mid-January, we are glad it is over. Some of the people are the greatest guys in the world. Great people. (*Treasure County Agriculturalist*)

> It only takes one person to turn you off. It doesn't take much to say, 'Why am I doing this?...What is ten dollars per hunter?' To me, it is birdseed for your trouble,…[and] when the money for Block Management ran out,…[landowners] didn't get paid. That isn't right. If they don't have the funding, they need to let them know. (*Treasure County Agriculturalist*)

> I think if there is ever somebody reported for doing something like that they should be banned for five years. We do Block Management and I had one guy that came down a couple of times. He was rude and obnoxious and a total jerk. He called one time and was rude to my daughter. When I got home that night, I called him at 11:00. The Block Management people called me the next day and I told them what this guy's name was and they put him on the list so he won't draw any special permits for five years. As far as bad hunters go, if there is a way to catch them, they shouldn't be allowed to hunt. (*Treasure County Agriculturalist*)

> I suspect that access will be harder in the next decade, as far as hunting, as far as getting permission to go, whether to go out pheasant hunting, coyote hunting, [or] deer hunting. I envision Block Management to be even a bigger thing out there. I think that is a good program. I would pay more in license fees in order to make sure that big ranches don't close off huge sections of land to the average guy. I am a big supporter of that. [Now it seems like] five or six sections are closed up by someone who has leased it to an outfitter. (*Treasure County Recreationalist*)

As the recreational demands increase, many express a desire to maintain a balance between agriculture and recreation:

> Balance…keeping that relationship that allows agriculture to do well, allows opportunities for recreation and fishing….I just think the balance is important. (*Rosebud County Residentialist)*

> The Yellowstone is in much better shape than the Tongue as far as appropriations, but it concerns me, as we move through time, that more emphasis is placed on

> wildlife at the expense of irrigation. We haven't seen huge issues yet, but they may come. And, [as for] municipalities,…the water is going to go where the votes are, ultimately, and that can be a concern. (*Custer County Local Civic Leader)*
>
> I think more value needs to be put on the recreation values of the river and less on the irrigation uses. Historically, irrigation was the king, [and] whatever they wanted to do, they could do. And we still see that right now. You can't really deny guys who want to put head gates in…for irrigation purposes. (*Treasure County Recreationalist*)
>
> Recreation is important. But it has nothing whatever in value compared to the high yield land and the farm possibilities on that river. And then the power generation, too; that comes from the river. (*Custer County Agriculturalist*)
>
> This particular diversion dam serves 20 miles of agriculture and agriculture producers. That's important to the economy and their livelihood….I don't like hearing the talk about let's knock all the dams out of the river and let things free-flow naturally because that's best for the ecosystem….I think those [dams] serve a great purpose: this one out here for agriculture, the one up there for recreation and agriculture, and to control flooding….I think there…[are] ways to open up around diversion dams so that the ecosystem can stay in balance if that's necessary….I don't want to see agriculture get traded out for the big money, open space, open recreation. (*Rosebud County Residentialist)*

The struggle for general economic viability of these communities adds to the complexity of the situation. In Treasure and Rosebud Counties new businesses are especially needed to draw people to these communities and to encourage youth to remain or return:

> As a city council member [in Forsyth], one of my concerns is to encourage different businesses that would hold [jobs for] our kids, where they could go to [college] and come back and have something to work for. Right now, there's nothing. (*Rosebud County Local Civic Leader)*
>
> People are…[growing] older [and there are] more retirees. I think this would be a fair statement. We've already seen [this happen in] the community of Hysham. (*Treasure County Local Civic Leader)*
>
> The school is in bad shape….When I was going to school there were 70 or 80 [students] in high school, [and it] got up to 100. And now we're at 30…[or so]. (*Treasure County Local Civic Leader)*
>
> Will there be enough jobs that we can keep some of [the kids] home? Or do they have to go farther? We see fewer and fewer opportunities in these small communities. So, there's a migration toward Billings or larger communities. I'm not sure if we can reverse that….[We're] making sure they get a good education

> and…from there [they] go where they can. I hope they have the opportunity to enjoy some of the rural areas in the longer run. *(Rosebud County Residentialist)*

Many of the participants from Custer County regarded energy-related industries as potential new neighbors that would add to the economic base of the community:

> I see it growing because of the energy in the area. There are companies coming in that deal with energy. If it grows, it's going to be because of energy. It's basically right now an agriculture town and hasn't grown a lot at all….There's always the possibility of the Tongue River railroad. They talk about power plants….Energy is becoming more and more important….At some point, it's going to come in and we're going to see the town grow. *(Custer County Residentialist)*

Most discussions support embracing and protecting the familiar way of life while embracing and planning for potential opportunities:

> [We need a] collaborative plan that ensures varied use for all users, whether it be Ag,…[recreationalists] , or homeowners, just so there was adequate planning to address all of the needs fairly for all….It's going to be a shotgun thing….The legislature will be sticking their nose in, the Soil Conservation Boards are already in,…the Fish and Game will be up against issues, and so will the local planning boards. So, it will be a multi-faceted thing. [I don't know] how a person can keep it all organized and not have every entity doing their own thing….That's the way it is, right now. We have never had a collaborative meeting of any kind, with Fish and Game, with Soil Conservation, [or with] county planners. When an issue comes up, we do our part, [and] they do their part. (*Rosebud County Local Civic Leader)*

> As commissioners, you are trying to promote survival of the community, which is economic development and expanding the community. That means jobs….Yes, we want the power plant and those 150 new jobs that pay well. How does that impact the farmers, the users of the resource? How does that impact the recreation? Sit down and give it serious consideration. We don't want to say, 'No, we don't want you here.' But we have to work to minimize the negative impact. As we grow the community, we are impacting that resource for recreational purposes in conflict with the Ag users. (*Custer County Local Civic Leader)*

> We have to make sure [future generations] have access and have the opportunity to enjoy the same things that previous generations have had with the river….It's going to get tougher because demand is in its infancy. As the pressure [rises],…there will be more issues. Right now, it's in the beginning stage. (*Rosebud County Local Civic Leader)*

Even though immediate and sweeping changes are not apparent, some discuss the need to plan now:

> Nobody is going to do anything because, right now, there is not that pressure….You add up everybody in three counties here, and you don't come close to the population of Ravalli County….Most people, when they think they want to move to Montana, they look at the ads in magazines or on television. You're not looking at Forsyth or Miles City or Jordan….You see the Flathead Valley, you see the Bitterroots,…[and] you see the Bob Marshall Wilderness. That's what you see…and that's where the pressure is. (*Rosebud County Local Civic Leader)*
>
> So few locals want to be involved….They look high and low to get people [involved. But, many people will complain.]….If it's so much in your heart, hop on board…and you will have input. The things I go to [regarding the river]…there is room on there for input. I mean, people just are too complacent. [They ask,] 'How in the hell could you ever do anything to change the scope of the Yellowstone?' Well, you can destroy that river….People…just don't think that it's ever going to happen. (*Prairie County Agriculturalist*)
>
> These kind of comprehensive planning things, where the river uses are taken to the public to ask the kinds of questions you're asking: What should be going on here? What do you want to happen? The difficulty in doing that is getting people interested and actually voicing opinions, like any other planning. People don't care until their ox becomes gored and then they care a lot. (*Treasure County Recreationalist*)

An obvious challenge is exposed when discussing regulations:

> If we don't have regulations we're going to have development right next to the river. I think development is the worse of the two evils, so we wind up accepting the regulation….[Otherwise] we can lose the cultural resource….[through] an incremental downhill slide. It's unfortunate, but this is America, [and] that's how it works. (*Custer County Local Civic Leader)*
>
> The planning board could adopt some zoning regulations that would describe which land-use possibilities would be along the Yellowstone, and it's probably something that's going to need to be looked at before long. Right now, we're kind of in the mode of not a lot of zoning because we don't want to put a lot of restrictions on the property….We're thinking about how we want to proceed, but we haven't done anything because we want to make it so it's not restrictive. (*Rosebud County Local Civic Leader)*

Conversations across all interest groups reveal a desire to see the issues addressed locally. Attention is paid to the notion that a one-size-fits-all answer will not work, but a desire for collaboration with others is expressed. Virtually all groups understand local control will work best if it is guided by helpful information from others:

> Anytime you get something that…[needs to be regulated], it should be done by the people that are affected. (*Custer County Recreationalist*)
>
> I don't think we need government or anybody to regulate us….[If we must have regulation,] I would go more for state, or even county. I think the closer you get to the people at the local level, the better. (*Custer County Agriculturalist*)
>
> You look at the flood issues in other states, and…[how they allow]development right up to the water['s] edge, is there something to be learned? Should we protect the riparian area? Should we be considering a setback as a tool?…The Red River Valley in North Dakota floods frequently and they go right back in and build again…. I hate having…[control], but you have to. If each county is different, how is that managing the overall river? I see a broader scope of application, either through the council [the Yellowstone River Conservation District Council] or state law, that would allow us [control and still] not get backed into the one-size-fits-all type of regulations. (*Custer County Local Civic Leader)*
>
> [A setback requirement] is probably something that a county can do, but, on…a river like the Yellowstone, it would almost have to be multi-county in order to be effective. I think it's the Big Hole River in Western Montana where three counties went together and established a…[500-feet] setback for roads and power lines….The three counties got together and said, 'Let's do this.' So, for the lower Yellowstone, if it was multi-county, it would be far more effective. (*Custer County Local Civic Leader)*
>
> I really think that, as they develop housing,…decisions would have to be local. Decisions would have to be local, but it's going to be tough for a community—for Treasure County or Prairie County—to come to some sort of a regulation. I can see the Council coming up with a template, 'Here is a riparian management scheme regarding development'….Then the county can take it…[and] rebuild it to what their needs are….In Prairie County, they may have concerns about putting feedlots down in a flood plain….That may not be a problem in Sweet Grass County [where] they're worried about houses….[We need some] kind of a template on developing things that will impact that zone. (*Custer County Recreationalist*)

People in the Big Horn River to the Powder River segment recognize that the familiar way of life may not suffice in the future. Conversations capture the frustrations associated with limited hunting access and with maintaining a balance between the familiar ways, local control, and adequate management in the face of complex change.

Controlling the Yellowstone River

Discussions regarding flood control and erosion control focus on dikes and rip-rap as respective remedies. Both remedies are regarded as effective and expensive. Frequently though, conversations regarding erosion lead to varying opinions:

> What do I do about the erosion? Stand back away from the bank. (*Custer County Agriculturalist*)

> I have places along the river where I see [erosion], but, to me, it is a characteristic of the river and I realize it's a natural thing. So…it's not a problem for me because I think it's a natural thing….I see the river going up. I see the river coming down. I see the ice jams. I see all that stuff….I've lived along here for a long time and you're not going to do…[anything] to stop it. The more you do to stop it, the more it's going to erode. (*Prairie County Agriculturalist*)

> A lot of the erosion is natural and just ebb and flow. (*Custer County Recreationalist*)

> I think it is a natural process of that river system. Islands [are] made, [and] islands disappear. I just think, [in] really high water, erosion is a natural process along that river. (*Rosebud County Recreationalist*)

For some, rip-rap will control the Yellowstone River if it is properly applied:

> In my opinion, most of all the rip-rap projects…have been done wrong. It's because people have not taken the time to assess, 'What am I doing? What do I want this to look like? and What are the true reasons [why] I am doing this?' You know, if you analyze all those things before you go in there…hopefully you'd come to the realization that you'd give the river some room. So that when it comes its day in June that it needs to go over the banks….It has…[somewhere] to go. You could stack the dirt up 40 feet high and just keep narrowing it up. Well, the river is going to rev up so fast that Jesus Christ himself couldn't stand on the bank and keep the bank from disappearing….I mean, we just got to pay attention. (*Prairie County Agriculturalist*)

> You need to rip-rap the corners of the river, but leave the straight-aways alone. The river can meander and it has….It has probably been all over this valley. (*Treasure County Agriculturalist*)

Nearly without exception, participants' conversations recognize rip-rapping as a controversial practice that is expensive and laden with governmental red-tape:

> Rip-rapping is highly controversial because agriculture is such a big part of Montana. If a rancher loses a huge hay field, that's irreplaceable to him; he's out of business. If he's out of business, then Montana doesn't get that. The

> Yellowstone River is a free-flowing stream that brings huge amounts of recreational dollars to Montana. Fly fishermen come from all over the world to fish this river. So, what is right, what is wrong? I think that the rip-rapping should only be in areas that would protect the spring creeks and the rest should not exist, unless it is a highway or a bridge, or something that we need to protect them for public safety and access.…You see, [there are]…tons and tons of rocks dumped in there, forcing the river off to another direction. And some rip-rapping will force the river [to be] somebody else's problem. They have to, in turn, address that problem.…We don't want a Yellowstone River that is all channelized all the way down to Miles City. I mean, we just don't do that. (*Treasure County Recreationalist*)

> We are so gung-ho on making sure we don't have soil erosion. We have to leave stubble on the field; we have to have a certain slope to the fields to prevent erosion. The biggest monster for soil erosion is the river. The reason they don't touch it is…[the]environmentalists and it is so costly. It takes a lot of money to rip-rap a river. We poop that away every day in Iraq….We don't take care of our own country and our own people, just like this river. (*Treasure County Agriculturalist*)

> The answer of the moment is rip-rap, and if you can get the Conservation District, the DEQ, and the Corps of Engineers to agree with you, you have some chance of applying rip-rap. Of course, we apply rip-rap entirely different than we used to. It's not chunks of rock or concrete dumped in there; we'll net it, and vegetate it, and fertilize it. If you can establish the river willows in it, you have a much better chance of saving something. It's not cheap, and everybody can't do that. (*Rosebud County Local Civic Leader)*

> Well, it can stabilize the bank, but you're changing the hydraulics of the stream, so you're going to get a change somewhere else. You're going to deflect it somewhere else or change the deflection somewhere else…and it's going to be hitting the bank differently someplace else. (*Custer County Recreationalist*)

> If you stabilize it on one side, the water has to go somewhere. Maybe it is best to leave it alone. (*Treasure County Agriculturalist*)

The effectiveness of dikes was frequently discussed by the participants of the Big Horn River to the Powder River segment. Most people feel the dikes will probably prevent or minimize flooding:

> No, they don't [have flooding] because of the dike that's built along there. That took us out of the 100-year flood plain. *(Rosebud County Residentialist)*

> We haven't had any [flooding]. This house was built later than most of the houses in the neighborhood, up on the ground, so a flood would still do damage here, maybe the basement….It would have to be a bad flood to damage this

> house….[It] doesn't really concern us now. There would be plenty of warning for it now….[You] insure your house and leave when they tell you it's going to flood….It's not something I am going to worry about living down here. It's the chance you take. (*Custer County Residentialist)*

> [We've had]…ankle-deep water, but it didn't get in the house. We've got a slough that runs parallel to the Yellowstone River down in there, and when it floods that fills up first. You might get three to four feet of water in that, but that's a low area, it's like an old riverbed. But out on the streets and stuff, you might be walking in water ankle deep. (*Custer County Residentialist)*

However, some question the overall security provided by local dikes and not everyone has a dike to protect them from flooding:

> I have an idea: if we ever have a real wet winter, all…[of a] sudden we will find the weaknesses in [the levee]…[that] will become an issue. But we haven't had enough runoff or water to say it's been a problem. There was a period of three or four years when there was quite a bit of ice buildup and ice jams….My husband was working out at the packing plant at the time and one night he really got scared. He heard the ice breaking up and there was ice coming on shore....If there is one of those winters where there is a deep snow pack and then we have a lot of snow—the two combined—then it could be interesting. (*Custer County Local Civic Leader)*

> We're actually two blocks this way from the river….We hope [the dike] will hold….That's always a concern. Our house is out of the flood plain; it's built up high….But, with the drought we've had in the last ten, 20, 30 years, it's not a real big concern. (*Custer County Residentialist)*

> Forsyth is quite secure. The dike is in good shape, and we intend on keeping it in good shape. The community of Rosebud needs help. We are planning to do some mitigation….The ice jams cause flooding. We have an area of the river…[that's] down by Rosebud and makes a sharp turn, and the ice packs up there. It always does. I can guarantee it. We have done some mitigation down in Rosebud….We built up the Dike Road by two feet so it isn't quite as bad. But the town of Rosebud is not a good place to live [during] high water. (*Rosebud County Local Civic Leader)*

> The dike is kind of a funny thing because if you look at the east end of it, it makes a big curve and it just stops. If there…[were] an ice jam in the right place, it would just run through here. (*Rosebud County Local Civic Leader)*

Dike maintenance and the costs of insurance are on-going concerns:

> We see maintenance on [the dike] every few years. If there's ever a spot that isn't very strong, you see them dumping gravel over the bank….So it seems to be maintained very well. (*Rosebud County Residentialist)*
>
> [Forsyth] is built around the river, and the city is protected by a dike. [The decision to build it was] influenced by what the old-timers will call the Great Flood of 1918, so it's nice to have the dike. We have a working relationship with the Corps of Engineers to maintain the city's responsibility for the dike. (*Rosebud County Local Civic Leader)*
>
> Maintaining the dike area [for its] aesthetic value [is important]. Who wants to have a wall of concrete along the river? Then it's not a river, anymore. It's…been turned into a canal. (*Rosebud County Local Civic Leader)*
>
> [The] Corps of Engineers require us to keep the dike from being invaded by trees and shrubs so that its integrity isn't ruined….They also want the dike clear [so that if] they have to get up on the dike…to work on it, they have a clear runway. Some people in town, regardless of their deed, rightly or wrongly, incorporate the dike right into their yard….[as] a little rock garden. Most people understand it's a dike, and they're not digging holes in the dike [to] make a water feature out of it….So, we have very little trouble with that. We only have one [continuing] incident where somebody tries to fence it off. Most of the time, we don't have any problem with that at all. (*Rosebud County Local Civic Leader)*
>
> The only change I would like to see in the river is a little better dike system. I don't want to give up the trees….If they had to take out the trees to make the dike better, then I would like to see them replanted….The erosion is moderate.…I saw them putting some rip-rap up there this spring….Everybody complained about how it was done…[and that] they tore out the trees….Why can't you leave trees too? It can't hurt, and it's better than big chunks of cement. I didn't understand that. [The trees] were mostly dead, but still their root structure was still [there]….Don't take the root-balls out.…Then, the way they built it back up, it's soft…[and] over time it will settle….[But] with all the trees gone now, when water comes up, soft ground doesn't take it too well. (*Custer County Residentialist)*
>
> The other issue that is of primary interest is the dike. Most of the north side of Miles City is in the 100-year flood zone. Everybody there is paying flood insurance. They would rather not. This is a town where the average income is a few hundred dollars over the federal poverty level. The dike, according to the Army Corps of Engineers, is not up to spec [engineering specifications] in terms of materials, and there is no way to replace that existing dike where it stands. So, the long-term plan is to back up the existing dike with a new dike. There needs to be a buffer zone of 100 yards, then build a more secure dike, up to spec in terms

> of materials, and either leave the older dike in place or tear it out….It is a massive project, budget-wise, for this community, and it happens when we have an infrastructure which has been aging and neglected for decades. We are fixing some of those critical infrastructure problems, primarily water lines and sewer lines. Those have to be our first priority, right now,…[but] for the people on the north side of the town, we have to get the dike squared away. The Tongue side is secure. The Yellowstone is the one that needs work. (*Custer County Local Civic Leader)*
>
> I know there's people here in this town that will dispute the levee being safe because they want the federal government to come in and redo it completely….They've done surveys and different things….It is my impression that they would basically redesign the levee, make it wider and stronger. If they ever did, I was told that they would buy [land near the levee], which would be nice for me….I don't think that will ever come to be…but my thought was, 'Great, I get to sell some property to the government, somebody that's got money.' *(Custer County Residentialist)*
>
> I believe the dike is stable. I haven't heard a lot of negative on it….It does cause a lot of people to pay high insurance. There is a moratorium, or restrictions, on building in some areas. A pretty big chunk of town is affected by that—everything north of the railroad tracks. (*Custer County Local Civic Leader)*

A number of other discussions can be found within and across the interest group analyses (see individual reports). For instance, water quality and water quantity are common concerns, as well as noxious weeds. This summary addressed only the three dominant local conversations. It is hoped that readers will delve further into the concerns expressed by members of each interest group by reading the attached inventories of quotes.

Powder River to Big Horn River: Agricultural Interest Group Overview

Twenty-two interviews were conducted with individuals representing agricultural interests, including farmers and ranchers. Participants were recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of Natural Resources Conservation Service.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Powder River to Big Horn River: Agricultural Interest Group Analysis

I. Specifics of an Agricultural Perspective

A. Lifestyle and "A Job I Really Love"

Farming, right now at my age, is for my grandkids. I think it's very important for them to see where the basic needs come from. They have so much fun when they come to the farm, whether it's in the winter time when we're feeding cattle or in the summer time when we're irrigating. My wife has wanted me to retire for three or four years. My grandson loves it and that kind of makes my day. And I love what I'm doing. And you better put that in there. I'm not going to retire from a job that I really love doing and go somewhere and park cars at the Metra, or anything like that. (*Rosebud County Agriculturalist*)

I like being associated with the Yellowstone. You worry about the cattle and stuff, but generally, the river is a plus to me all the time. (*Custer County Agriculturalist*)

If I sold this ranch, I would lose my identity, I guess. And I would lose my character. That's what would probably happen to me. I would maybe sell this. But I don't think the town of Terry needs another town drunk. That's probably all I would be. When your family has been here for that long of a time period, you just create some sort of identity from the land…My life is based more on the history of the land and a lot of people don't have that. (*Prairie County Agriculturalist*)

In 1936, my father got a pump and put it in the river. And then he got a wagon and this team of horses and a steam engine. And he put the steam engine down by the river here, and he'd pump the water with it. Then he'd hook up his horses and he'd go up in the hills here and mine coal. And then he would come back with a wagon load of coal and throw it in the steam engine and pump water. (*Prairie County Agriculturalist*)

I guess you…[have] to be born and raised on a sugar beet farm to really appreciate the amount of energy and work that it takes to produce a sugar beet crop…. And I don't know if a lot of people know how hard sugar beet farmers work to get that crop; I mean, it's a challenging crop to raise. (*Treasure County Agriculturalist*)

The young people…[who] are farming here are very sharp, and they are very intense. They're survivors. We still have to be raising some of these people…because the work ethic is not [what it] used to be. And the sacrifice: you're going to eat a lot of noodle soup and stuff like that. And maybe drive not too nice a vehicle [because] you're going to have equipment. (*Rosebud County Agriculturalist*)

I take personal pride in a lot of stuff….The people that are here are good stewards of the land. The other people don't sense that….Just being here, I keep saying we probably have the best of all of the world. People take it for granted…[but] we just appreciate it. (*Prairie County Agriculturalist*)

We get along. Everybody knows each other real well, up and down the valley. (*Treasure County Agriculturalist*)

[There isn't] a better place to raise kids. If my son isn't playing football or basketball, he is down fishing on the river. It is pretty hard to get in trouble doing that. (*Treasure County Agriculturalist*)

One thing we have…is an irrigation ditch association, so we're bonded all together on this ditch. And it's for everybody's benefit that things are done well and right. *(Rosebud County Agriculturalist*)

That's how I would rate it: agriculture, then business, then recreation. (*Rosebud County Agriculturalist*)

As far as farming-wise, there's probably a lot more disadvantages than advantages. (*Treasure County Agriculturalist*)

I haven't thought about the future of people in agriculture to tell you the truth, because the ones I know around here, the young people, they're getting up close to fifty. They've been survivors, workaholics, not afraid to put the money on the line and that type of stuff. (*Rosebud County Agriculturalist*)

The real problem here is that I don't have enough land. There is no way [my grandson] could take over and pay for the equipment and the farm….We would have to be out right now scrapping for acres making this larger, so that when he got here, he would have a big enough unit that he could make enough money. (*Rosebud County Agriculturalist*)

Agriculture is in tough shape; maybe it's just because we're poor operators, but it's getting tougher and tougher. The cost of the machinery, the cost to repair it, the cost of fuel, the cost of fertilizer, the cost of spray—all of this stuff is just going crazy. (*Rosebud County Agriculturalist*)

I would be gone tomorrow if I could get something out of this. I love it here but the handwriting is on the wall. You can't afford to stub your toes on these places. The price of fuel is up. We are dealing with Mother Nature….We do love it here. I don't know what I would do if I left here. I couldn't go to town. (*Prairie County Agriculturalist*)

I'm up here in the wintertime and it's colder than hell and the wind blows 30 degrees below zero. And you're trying to do something with a cow. And there's one acre of land and some idiot will pay you 200 or 300 dollars an acre for the land. And you're freezing your ass up here and there's no grass growing. It hardly rains, you know. I mean, it's tough. And I guess where it probably affects things most is that my children, now 22 and 20, don't see…[the farm] as production-driven like [when] I was raised. (*Prairie County Agriculturalist*)

[Concerning the possible coming of corporate farms,] I think as far as production goes…I wouldn't work as hard for someone else as I would for myself. You won't get the production. And maybe they don't need it because they have the money. I would never put the time in for someone else that I do for myself. (*Prairie County Agriculturalist*)

Without the river, we wouldn't be able to make a living on this place….Our canal system is very important as we have to irrigate; it is a very dry area. (*Rosebud County Agriculturalist*)

I watch high water come down here every spring and I look at that and I just say, 'look at all of that wasted water.' (*Treasure County Agriculturalist*)

Punk wood is driftwood. If you get a piece of punk wood that has been in the water that's very porous, and if you light it, you can smoke it. And it burns the holy heck out of your tongue. And why anybody would want to do that is beyond me, but, as little girls, my cousin and I did this and now I won't let [my children]. But, that's punk wood. So, that was our first smoking endeavor. It was punk wood and you have to find just the right piece from the driftwood. (*Treasure County Agriculturalist*)

I am, was, an avid boater. It's kind of…beyond me. I'm 70 years old now and [I] don't do some of the things I used to do. We used the river for a lot of recreation. We raised a family on the river; water-skied in it, fished in it [and] floated the river, which is very enjoyable. It's better than boating actually, because the floating is quiet and you realize the wildlife and the bird life and everything that's on the river. (*Treasure County Agriculturalist*)

B. Land Should be Productive

They've wanted to reseed the cottonwoods, I've heard, and a few things like this. Well, you're not going to let the cottonwoods grow in your field anyway; you're going to tear it up and get it ready for next year's crop. So, you know, I feel like it's the right of the landowner to be able to stabilize his banks when needed and he needs to do it responsibly, there's not doubt. (*Treasure County Agriculturalist*)

If, for instance, landowners start selling off their water rights to municipals or something like that, you take the water right away from the land; what's it going to produce? It's going to go back to…dry land…Maybe he has the right to sell his water rights. But, it affects all of us; it doesn't just affect him….Price per share might go up; you might run into maintenance difficulties even though we do have [access] easements. (*Treasure County Agriculturalist*)

There's some good ground towards the river and there's some ground that's really very sandy ground. And some of it is maybe not as good….In this area, it seems like our fields along the river are smaller fields and choppier. They follow the river and they're not nice and square. And you get away from the river and you get against the hillsides, you…[have], you know, a lot bigger and blockier fields and they're a lot easier to farm. (*Treasure County Agriculturalist*)

Recreation is important. But it has nothing whatever in value compared to the high yield land and the farm possibilities on that river. And then the power generation, too; that comes from the river. (*Custer County Agriculturalist*)

In this day and age, you don't really base things on production like you used to. You base it more on the assessed value and what it would be if you sold it. That's the way that land along the river is….It's getting less production and more 'what's for sale,'….Now, if a person went to sell this ranch, it would sell more for recreation value than production value…it used to be ten, 15 years ago, and you'd see the productions of the crops would be the value of it. But now when a person comes, like when that real estate agent comes and we looked at it, he put a value of $700 on it based on how many whitetail deer ran out of the trees and how many 'coons there were. (*Prairie County Agriculturalist*)

But, [putting land into production] does not increase the value anymore. It's recreation….For instance, up here there used to be three big sprinkler systems—three big pivots—and they…[were] put in there for production of the land, production of crops, [to] feed more cattle….I sold them…and I just irrigate, I just flood irrigate. I could put a sprinkler up there and I could raise a lot of crops. But, where I live here, if I want to sell it, I would have a high value just for recreation or the opportunity to increase production. What I'm trying to say is, I could go out here and I could buy a big sprinkler that costs, say, $150,000 to irrigate 200 acres, or I could not put it in there, and it's still worth the same amount of money, because some people would buy it for the potential for production versus if it was in production. (*Prairie County Agriculturalist*)

[It] is very important that you…base things on the value of the property, based on what it would sell for, based on its production. Well,…[now] that production is [turning to] recreation.…People are buying things more for the investment value than production value. (*Prairie County Agriculturalist*)

There are archeological finds up here that we keep to ourselves. And I could take you up and show them. But this lady said what I need to do is just take somebody on a trail ride and just camp next to it…and let those people find it. And that's what the value would come from. Now, if people want to come here, we go show them things, and that has a value. But she said where the value would really come would just be from letting them find it….I've found numerous things that you just find…[by] accident. But that's where the value is; it's getting to be that's where the value is more than anything else. (*Prairie County Agriculturalist*)

C. Rural Ideals

The way I look at it, if we don't take care of our land it won't take care of us. If you abuse the land, you're not going to be there very long. (*Custer County Agriculturalist*)

I don't care who you are—you've got to be a good neighbor. (*Rosebud County Agriculturalist*)

The river can be damaging…but that's not a consistent thing. But nobody down here and around here builds close enough to worry about that. (*Custer County Agriculturalist*)

So few locals want to be involved….They look high and low to get people [involved. But, many people will complain.]….If it's so much in your heart, hop on board…and you will have input. The things I go to [regarding the river]…there is room on there for input. I mean, people just are too complacent. [They ask,] 'How in the hell could you ever do anything to change the scope of the Yellowstone?' Well, you can destroy that river.….People…just don't think that it's ever going to happen. (*Prairie County Agriculturalist*)

There's no reason why they can't fix Intake Dam. It's got to take somebody that's got heart who wants to put heart and soul into it. That isn't just a job for an agency person. It's got to take people that are on the land that are willing to go above and beyond the call to get involved. And then put credibility into it, not that agencies don't have credibility, not that they don't have good people. But, there's that division of the 'us and them' mentality. And the *us* have to become *them* to make it really truly work. And then it drags; it's that black hole effect. It drags a whole bunch of other folks into it. (*Prairie County Agriculturalist*)

People that have really good intentions and a lot of money and a lot of influence try to tell us how to better our world. Well, we kind of know how to do it. We don't really need somebody telling us how. We don't tell them they need wolves in Central Park. (*Rosebud County Agriculturalist*)

We had a deal with John Deere. They had a bad gear box on a chopper and they knew it was bad. They kept it on the shelves for a year. It takes us six hours to change it and it would run for two hours and break again. There was nothing we could do about it. They could have cared less. That is corporate America, corporate greed. I have used John Deere for 34 years and it was a low blow. It definitely works on you. (*Prairie County Agriculturalist*)

People have never been hungry in this country. Have you ever seen a famine in the US? My dad came from Belgium and he has seen it. He was in World War I and the soldiers came in and took over all the food in the garden. They took the cattle and the milk cow. Like the potato famine in Ireland; those people have learned to protect their farmers. If this country has a problem, they throw money at it and that may not be the best answer. (*Treasure County Agriculturalist*)

I believe there needs to be some help [such as cost-share programs]. (*Rosebud County Agriculturalist*)

They're still so afraid of having government involvement….And, I hate to say this, but a lot of those guys, they're in farm programs, and as long as they can take money out of the farm programs, well, then the programs are all right. But then, boy, there better not be any kind of strings attached….I can sit out and bark because, for three generations, we've not taken government handouts, or government programs, or government aid of any sort. And, until you get yourself…there, and then stand back and view it, these guys don't have a lot of room to complain about government involvement….I think we can…put [ourselves] in a position that we can protect that river as a resource and it can be there for generations to come….[In terms of accepting regulations] sometimes, along the way, there's some bitter pills that has to be swallowed. (*Prairie County Agriculturalist)*

Other people use the river [for] fishing [and] boating, but I consider agriculture and urban areas as big consumers. (*Rosebud County Agriculturalist*)

That guy, across the river there, he's farming, he's planting corn, and he's just three-quarters of a mile from me. He lives next to the river, he's planting corn there, and he's thinking of this river to get water out of it, to raise…[his crop]. And he's looking at it [as] production only. That's what his land is going to sell for, based on production. And my land values are different….My personal values are different….When you lose that production value, you lose a lot of drive, and then personal pride. You know, it's not lazy, but you lose a lot. (*Prairie County Agriculturalist)*

D. Individual Rights are Important

You can't, in my opinion, you can't take a landowner's right to say 'no' away from him. If he doesn't want anybody on [his property], that's his prerogative [and] that's his right as a landowner. (*Treasure County Agriculturalist*)

Most important for me is that no government people can tell us what we can or can't do on our property. (*Treasure County Agriculturalist*)

E. State and Federal Management Techniques are Questioned

I do know that I consider the riverbed not mine, I consider the river not mine, and I consider up to the high water mark not mine. Like when the water is running right now in the June rise, everything above that is mine, everything below that is the state's or [it's] federal or [it's] the people's. (*Custer County Agriculturalist*)

It seems like the Fish and Game wants to spend a lot of time dabbling in our business, too. If they own the game, why don't they pay a pasture bill on them then? You know, they're so concerned that we have them. You know, no one's concerned about 50 head of deer standing out in your alfalfa field eating. But, if the neighbor's 50 sheep got out in your pasture, in your alfalfa field, you'd be upset as the devil. (*Custer County Agriculturalist*)

Well, who owns the fish? And, whose gonna take care of the fish in the river? The Fish, Wildlife and Parks seems to think that they own the fish in the river. But they want us to take care of them. They think that maybe there are some fish coming down this canal. And, our feeling is, if your fish are getting in our canal, you should put up a fish screen. Because, if there are any fish in that canal, they aren't bothering us. I think if they own them and they want to keep them in that river and out of our canal, they at least should help us put in fish screens, or whatever it takes. They shouldn't expect us to take care of their fish….[They should] cost-share or something on these fish screens….I think it is only right. We, on the canal, have older water rights than the Fish, Wildlife and Parks… our water rights are 1918 and I don't think Fish, Wildlife and Parks started until 1940. So, we have older water rights, and that's already been proven in court, basically. (*Rosebud County Agriculturalist*)

The Fish and Game have total control of the river. Even if we are swimming and we don't have our life jackets on, they are the controllers. It is pretty well regulated. The boats have to be licensed each with a fire extinguisher. Now, they have pulled the high water mark thing. They are in charge. They have total control. Everyone that goes there has to conform. It is heavily patrolled. You will find them there….It is about money. They have their wardens. They sell the licenses. It is not only fishing. It is also hunting. They make a dollar off the whole thing. (*Rosebud County Agriculturalist*)

Fish and Game has an attitude that, if you won't let hunters on, they won't help you. What they are trying to do is blackmail you into allowing hunting. Deer run in cycles like rabbits. You may have 500 to 1000 one year. And five or six years later they will have 100. They die off and stuff. If the numbers are high, they should issue six tags instead of two. They will do deer counts and they know the population has grown. Instead of issuing the permits, they will hold it until the ranchers are annihilated by the deer population. They are trying to force you into opening it up to hunting. (*Treasure County Agriculturalist*)

We used to have the goose hunters. Fish and Game said that we weren't letting enough hunters on. I told them I was going to separate them and limit them to be safe. They said it wasn't fair. This is my workplace! I have this guy I hired and these people are out there blasting away in my workplace. They think I should let everybody on, like you owe it to them. I am saying bullshit—get the hell out. I am not over harassing you at your workplace. (*Treasure County Agriculturalist*)

I know the endangered species thing; it's a real problem….I just can't see the merit in it. Like if they're going to dump a bunch of water out of Fort Peck and our reservoirs up here to save some moth or something like that—I don't know what good that would be. And I wouldn't want that to be first priority, but the Corps kind of does that. This spring, it was a Pallid sturgeon and I suppose that's plum legitimate; it's an endangered species. And they have raised the river levels for spawning. There's only a few of them left. So they took water out of Fort Peck and Canyon Ferry to raise the water levels so the fish could spawn. As long as they didn't really hurt anybody else too bad, there's nothing wrong with that. (*Rosebud County Agriculturalist*)

When they put Fort Peck in, we were supposed to get cheap power and that hasn't happened. We could have 50 thousand acres more. We have that much water rights. You ought to see some of the plans. This was back in the early '50s. There could be twice as much irrigation. (*Prairie County Agriculturalist*)

F. Outsiders Have Obvious Wealth and Different Values

I think if they are buying it as recreation property, it should be taxed that way….Those people don't contribute to the community. (*Treasure County Agriculturalist*)

Bigger money is coming in. [One group]…bought four places. They watch what they do and they are good people. There are a lot of these people like that, but a lot of people don't know what is going on. (*Prairie County Agriculturalist*)

The people that own this in the future probably won't bring the [same] historical [and] cultural values. (*Prairie County Agriculturalist*)

I drove up there to the ranch a couple of weeks ago and some woman was looking at it. And she wasn't looking at cows; she wasn't looking at grass. She was looking at this, 'Geez, man, you got to get some dudes up here. You got to get people up here and show them this. Take them on trail rides and stuff.'…She wasn't looking at cows, you know. And she wasn't looking at the grass as far as this is a gamma grass and this is western wheatgrass and that's big sage and little sage. (*Prairie County Agriculturalist*)

You visit with a guy from Pennsylvania and you look at it from his viewpoint. Hell, the damn thing hardly rained; it's a desert, you know. But, to him, it's awesome. And this is my workplace and other people come and they think it's just great. I guess that's just something that changes your viewpoint or whatever. (*Prairie County Agriculturalist*)

We get new faces and they try to tear it up and buy this expensive ground and they want to farm it right to the edge. Just the lack of knowledge, I guess. It should actually be planted back to grass. (*Prairie County Agriculturalist*)

Make them guys live here and when it gets to be 40 [degrees] below maybe they will leave. Everybody wants a piece of Montana. I don't know what the answer is. It is part of a free system where, if you have money, you buy something. You have the right to buy it. You can't compete if you want to buy more Ag land. (*Treasure County Agriculturalist*)

II. Agricultural Descriptions of the River

A. Ambivalent Sentiments about the River's Character

Where we live here, we are isolated by the river, so it makes us more connected to the river, because the river is between us and the outside world. It's at our front door and it's just there. (*Prairie County Agriculturalist*)

It is like having an artery in your body. It is a vital part of this valley. It is the lifeblood of the valley. Our irrigation district was co-founded by our granddad. (*Treasure County Agriculturalist*)

One thing about living on the river, I think it develops your character. I mean, it makes you. When you live along the river, you know you're different. It develops your character a little bit versus if you lived in the mountains….It makes you more independent. (*Prairie County Agriculturalist*)

[We like] the scenery and the wildlife. In the spring when the flowers are in bloom; you think that smells better than anything you can spray in a can. (*Treasure County Agriculturalist*)

Another thing about the river is that it connects you more to the history of the land….In the beginning [it] was created right here along the river….Custer and all his people…[came] up the river, the steamboats…[came] up the river, and all the first early history was based off the river. You can live 40…or 50 miles off the river and you don't have the feeling of history that we do. (*Prairie County Agriculturalist*)

The Yellowstone…[is] the second fastest flowing river in the United States. I think the Snake is faster…I think that the Yellowstone flows at…seven miles an hour. But it's a good river and it's pretty clean. When they dammed the Yellowtail, that stopped a lot of the silt because a lot of our silt was coming out of the Big Horn. Big Horn and the Powder both run a lot of silt and it cleaned the water up a little bit. But, most of the time, it's a pretty nice river; it runs [and] it stays where it's supposed to. (*Custer County Agriculturalist*)

As we grew up through the years, we learned to respect the river. You didn't just go down and go swimming, even a good swimmer. We have seen different people go across on horses and drown. It is a treacherous river. It is fast and a lot of undercurrents. (*Treasure County Agriculturalist*)

It is our livelihood. (*Treasure County Agriculturalist*)

That's a big river. That's a large volume of water, especially when you have a wet winter and a wet spring….An acre-foot of water that comes down that river is huge. I guess it's the last really free-flowing river in the United States. (*Custer County Agriculturalist*)

I just enjoy the river. I just do. I guess just watching what can be on the river. That river has a wealth of entertainment on it that people don't realize:…watching the ducks float by, watch pelicans come in, and eagles fly over. (*Treasure County Agriculturalist*)

I have something that very few people have. I own land along the Yellowstone River. I have rights to use the water in the Yellowstone River….I did sell a little piece of land along the Yellowstone River and a lot of my…[family] got very upset at me because I sold a little bit of land along the Yellowstone River. There's not very much of it. (*Prairie County Agriculturalist*)

It is very scenic. We take it for granted. You come out here and see the badlands….I get so many comments on this picture about the scenery in the background. We don't think about it too much. It is probably one of the nicest places here. We are close to the Interstate. (*Prairie County Agriculturalist*)

There's 50 species of fish in the lower Yellowstone. I mean, it's so dynamic. And it's just a diverse place, if you live on the banks of that thing. (*Prairie County Agriculturalist*)

I lived before the Clean Water Act. I saw that river before the Clean Water Act. The best thing that happened in recent times to us…was the Clean Water Act. I mean… you can actually go down and take a canoe and float down that river. You can actually pretend you were Lewis and Clark and a lot of places, you can almost feel like you're in a time warp and *be* them because you can't see the debris….I mean, it was a grand cesspool at one time….Anything you didn't want, well, what are you going to do with it? Well, throw it in the river….The big flush was the June rise. It took all the ranchers' and farmers' [trash] along the way [and] private landfills all along the way, and…the same with all the towns….[Now,] everybody is screaming and yelling…because of the Clean Water Act. Now they got to have sewer lagoons and they got to have treatment plants, [and they say,] 'Oh, that's gonna cost too much.' We all survived. All the cities and towns have survived. And the rivers are better for it. But de-watering is where the rubber meets the road. That's where we're going to get into a wreck. (*Prairie County Agriculturalist*)

It's unpredictable and it gives you a sense of excitement sometimes. (*Treasure County Agriculturalist*)

Coalbed methane water is perfectly good to drink. And what it is, is sodium bicarbonate— same thing as baking soda. That's why us humans, or livestock, can drink that water and do fine on it. But if you put it on any soils that have clay on it, it slicks together. It dissolves the clay particle and just becomes very slick. So you get these real slimy spots that don't grow anymore….See, all the coal seams have sodium bicarbonate in them and they pump it out to reduce the pressure so the gas develops. And then they take the gas out. Then they pump all this huge amount of water and dump it in the river….The rivers are going to be the result of what we do with these extractive processes and, if we don't take care of them, we're in peril. That's the bottom line. (*Prairie County Agriculturalist*)

It's such a beautiful example of a prairie river. It's almost as magnificent to me as Yellowstone National Park in respect to the river, the falls, and the whole bit. The dynamics of a prairie river are just hugely significant and hugely important. And you can live there your whole lifetime and never know all the things there are about it: the dynamics of the river, and the way it works, and why it meanders, and what causes it to meander. (*Prairie County Agriculturalist*)

I can't imagine anything that I can pass on to future Americans, future family, future friends, generations down the road, as a resource as magnificent as the Yellowstone River, intact, for generations to come. It's almost as sacred to me as Mount Rushmore; it's as sacred to me as the falls in Yellowstone, all of these natural wonders, these great places and things. Because it runs through a lot of our lives, we can't be complacent that it will always be there. (*Prairie County Agriculturalist*)

B. Flooding and Ice Jams

We've sandbagged…when [we thought] there's only gonna be a few more inches of rise in the river and you've got some crop or something you want to protect. (*Treasure County Agriculturalist*)

When we have the floods, it's great. The flooding is wonderful because it brings the cottonwood seeds in and we have new cottonwood stands which will help the bank….We like that for stabilization. But we haven't had a good flood for a long time. I can't remember the last good flood. (*Treasure County Agriculturalist*)

Flooding. Ice jams. A nice, spring day can go real quick to being, 'Oh, my God!' (*Treasure County Agriculturalist*)

It was in '78 when the river flooded. We [lost] seven acres…. [The bank] had a straight edge and we were losing every year. After that flood came through, it made the bank gradual and the trees that grew up are incredible. Mother Nature took care of it and we haven't lost a foot since. Those trees now are pretty good sized cottonwoods. (*Treasure County Agriculturalist*)

C. Yellowtail Dam: Communication Problems and Jurisdiction Confusions

A big rainstorm came during fairly high water and they had to turn Yellowtail [Dam] loose [by] open[ing] the gates up by Yellowtail….I've seen pictures of some farms below the Big Horn and they had tractors sitting out in the field and all you see is the smoke stack on the tractor. (*Treasure County Agriculturalist*)

I really think that since '96 they've done a lot better job….They had to because [before] they weren't doing their job….They were slipping up. They want to fill Yellowtail [Dam] every year. They want it full. Well, that's good. But if you're going to do that, make sure that you got room for your runoff. Don't fill it, and then let the runoff come, and then decide to dump it on us. And they weren't monitoring their runoff as well as they should have….And they've been doing a lot better job....If I remember right, Conrad Burns even called them up. (*Treasure County Agriculturalist*)

We have had a lot of flooding, but not in the last few years. It's been pretty good. Depends on how they operate that Yellowtail Dam….If they wait and release water when this Yellowstone is high,… it floods….Last time they did it, they flooded everything. They waited until June, which is our high water time anyway. And they opened that thing up. We lost a lot of crop. Water…sat out there for two weeks; not only that, but it changed the whole channel of this river completely….They never should have done it….They probably have caused more erosion than all the farmers could cause in the next 100 years. (*Rosebud County Agriculturalist*)

The Army Corps of Engineers controls it, I think….They did [notify us] for a few years right after that flood, and then they quit again….Well, now that's the biggest problem. (*Rosebud County Agriculturalist*)

We used to get ice jams. We haven't had ice jams for years. I think that has a lot to do with Yellowtail Dam, too. I think that warm water coming out of Yellowtail Dam has kept the ice from getting too thick. (*Rosebud County Agriculturalist*)

There is always going to be moss. The lower the river, the more moss you will have. If there is a controlled flushing, it would be nice if they could control it when it was a little easier for us. I don't know if they are doing it because of fish spawn. If that is the case, it has to be what it is. It would be nice if they would put information out. (*Treasure County Agriculturalist*)

Before they put Yellowtail Dam in, you had a lot more ice. It was thicker and bigger. When the ice is breaking loose in the spring and it moves through the river channels like a big plow. Ice is turning and twisting. [It's] gouging the banks, creating more channels, and putting more deposit in. Just plows the dirt and trees and everything out. With the warmer water from Yellowtail, we don't have the bigger ice flows and the thicker freezing of the river. It is a two-edged sword because that part is good for winter. (*Treasure County Agriculturalist*)

There have been several battles about how they regulate the water in Yellowtail [Dam]. Sometimes, when there is a lot of runoff, they will dump water and it will cause excessive flooding down here. It is well documented that this is an ongoing thing. The state and the Feds don't agree on this process. We have had several go rounds on this. (*Rosebud County Agriculturalist*)

III. Living with the Yellowstone River

A. The River Takes What it Wants Via Erosion

I have places along the river where I see [erosion], but, to me, it is a characteristic of the river and I realize it's a natural thing. So…it's not a problem for me because I think it's a natural thing….I see the river going up. I see the river coming down. I see the ice jams. I see all that stuff….I've lived along here for a long time and you're not going to do…[anything] to stop it. The more you do to stop it, the more it's going to erode. (*Prairie County Agriculturalist*)

In my opinion, most of all the rip-rap projects…have been done wrong. It's because people have not taken the time to assess, 'What am I doing?' What do I want this to look like? and What are the true reasons [why] I am doing this?' You know, if you analyze all those things before you go in there…hopefully you'd come to the realization that you'd give the river some room. So that when it comes its day in June that it needs to go over the banks….It has…[somewhere] to go. You could stack the dirt up 40 feet high and just keep narrowing it up. Well, the river is going to rev up so fast that Jesus Christ himself couldn't stand on the bank and keep the bank from disappearing….I mean, we just got to pay attention. (*Prairie County Agriculturalist*)

I imagine it's lost ten acres since we've been here. (*Treasure County Agriculturalist*)

The erosion is a big one. You can't believe the erosion. I will take you right over to it over there. There is a house over here. We rented that piece of ground when I was in high school. That was 80 acres and there is maybe an acre left. That…[happened over] 40 years. (*Treasure County Agriculturalist*)

What do I do about the erosion? Stand back away from the bank. (*Custer County Agriculturalist*)

If they don't watch the water like they should….It is sandy ground [and] just the normal river flow takes out the ground. (*Prairie County Agriculturalist*)

You need to rip-rap the corners of the river, but leave the straight-aways alone. The river can meander and it has….It has probably been all over this valley. (*Treasure County Agriculturalist*)

B. Rip-Rap Seems to Work in Some Places

About the time they put the rock in, the river was on course to change anyway, see, so it hasn't eroded since then. (*Treasure County Agriculturalist*)

The only rip-rap I've really seen that works is when they went down and [bull]dozed the gravel out of the river and pushed it up…sloped it…If you keep it nice and smooth, the ice doesn't seem to bother that….It's got to be sloped so that it's smooth. But we've got the full force of the river because we've got a 90 degree turn. (*Custer County Agriculturalist*)

You can rip-rap against high water, but the ice—you can't rip-rap against it. You know, it could just take everything. You can't believe the force behind it. (*Custer County Agriculturalist*)

I think there are places where Mother Nature isn't going to slope the banks. The conditions were just right for that to happen that one year. Most generally, if you have a straight off bank, it just keeps cutting in a little at a time for years. (*Treasure County Agriculturalist*)

You slope the bank, then you cut a two and a half key down into the gravel [and] backfill that with large rock. We put, I think, eight inches of gravel on the side slope and on top of that, we put a yard and a half of big rocks per foot. It was just rip-rap. (*Rosebud County Agriculturalist*)

I planted grass along there and it's kind of sodded-up now. And we have one spot where it makes the curve and the water hits it pretty hard. And I've had to put a couple of big rocks in there now and then, because it's trying to eat a hole into the rip-rap. If it would do that, it would just wash it out, like water. I watch that pretty close, [and] when it looks like it's pretty weak, we get another rock or two down there…I suppose maybe in 50 years [it] might disintegrate. I can see a little bit of that on that now. It's okay. (*Rosebud County Agriculturalist*)

I don't want old cars down there and I don't want any concrete rip-rap. If it could be done naturally, I don't want the Yellowstone turned into a ditch. We were down in California and the Colorado River is a ditch and it made me very sad. (*Treasure County Agriculturalist*)

C. Rip-Rap and the Potential for Shifting the Problem Elsewhere

You have a bend in the river up here by Billings somewhere and they put some rip-rap here because it's cutting. They put a bunch of rip-rap in here and all it's doing is…narrow[ing] it down. It just creates more energy and it just erodes over here. (*Prairie County Agriculturalist*)

I think it's a good approach. As long as it doesn't wash out the neighbor on the other side. (*Prairie County Agriculturalist*)

If you stabilize it on one side, the water has to go somewhere. Maybe it is best to leave it alone. (*Treasure County Agriculturalist*)

D. Rip-Rap and Difficulties Getting Permits

That guy came down from Helena and looked. He said it needs to be rip-rapped. And when he made out our application he changed it and said that it will be an ongoing project. So he made it so that if we need to rip-rap there some more, we just go ahead and do it, so we can protect our pump site….He showed a lot of common sense. I said well, really what we should have done is just started there so everybody else could have rubber stamped it after he made his decision. But, it seems like the Fish and Game wants to spend a lot of time dabbling in our business too. (*Custer County Agriculturalist*)

I just feel like landowners should have the ability to stabilize banks, you know. You're farming along the river and it doesn't do any good to have that water on your fields. And I don't really think it does the river any good either. (*Treasure County Agriculturalist*)

You have to go through quite a process of applications. (*Treasure County Agriculturalist*)

[I] always have had such a time getting permission to do something about river erosion. But, I've always looked at it and wondered, 'Is it better to watch that dirt fall in the river all the time and all the soil going down, choking up the waterway?' 'Is that better than doing something about it?' (*Treasure County Agriculturalist*)

I don't know if you could jump through that many hoops. That is something that they should make easier, besides the cost. You should be able to go through the hoops a little easier to do some rip-rap….Sometimes they will work with you and sometimes it is tough, especially on the Yellowstone. They watch it pretty close. People want it left natural…I can see their point-of-view. (*Treasure County Agriculturalist*)

The most difficult part of getting it done is you go through the Corps of Engineers and then the Fish, Wildlife and Parks, and then the DEQ. I think it ought to be good enough if the Corps said it was needed that would be enough...So many entities… [are] involved and who wants to be in complete control? Maybe [you could] deal with one department. As it is now, you have to go through each and every one of them and it makes a complicated issue more difficult. (*Treasure County Agriculturalist*)

We started [rip-rapping] when it was under a cost-share [program] that's no longer available. As a matter of fact, it's frowned upon; you have to get a permit to do it now. And you have to go through the Fish and Game, the Soil Conservation, and they are the easy ones. (*Rosebud County Agriculturalist*)

The barbs are the answer. Now whether you need blanket rip-rap or not depends on the conditions. Getting through the Corps of Engineers—that's the tough one….The Soil Conservation says this is good. Fish and Game is in love with the barbs because it makes some excellent still water for fishing. But then you've got the Corps of Engineers. They would like to do it, too, but they work with the federal government, so they have a problem. (*Rosebud County Agriculturalist*)

E. Rip-Rap is Costly and Few can Afford It at an Effective Scale

The first estimate was about $300,000…..The way it sets now, the only one that can turn the river is the railroad, or the government. (*Custer County Agriculturalist*)

There's quite a lot of expense to that rip-rap. (*Rosebud County Agriculturalist*)

It is beyond us little people. The railroad tracks were about to wash in and they rip-rapped up there. The estimate was for $800,000 and it ended up being $1.2 million dollars. It is beyond us little people. (*Prairie County Agriculturalist*)

We are so gung-ho on making sure we don't have soil erosion. We have to leave stubble on the field; we have to have a certain slope to the fields to prevent erosion. The biggest monster for soil erosion is the river. The reason they don't touch it is…[the] environmentalists and it is so costly. It takes a lot of money to rip-rap a river. We poop that away every day in Iraq….We don't take care of our own country and our own people, just like this river. (*Treasure County Agriculturalist*)

F. Other Techniques

People have put chunks of sidewalk in the river. Then you have pieces of rebar sticking out and that should be cut off before it is put in the river. The price of concrete is so high. There has to be a different way of doing it. (*Treasure County Agriculturalist*)

I don't know a lot about jetties. I guess they're really coming in to play and I'm sure if you talk to lots of people all along the river, I'm sure you'll run into some that have put some of the jetties in. And I know they've got one right over here even. The Hysham water users, I believe, put them in. And maybe they're better than just rocking, I'm not sure….I don't know if they're cheaper, but maybe they're cheaper to put in, that might be an advantage. But I think the Conservation Service likes them. (*Treasure County Agriculturalist*)

We put a Cristafulli pump in the river. Instead of fighting that river and changing it, we put in a Cristafulli, pumped into a sump, and would pump it up the hill. And they haven't said we couldn't put the Cristafulli in the river, so that's how we do it. (*Rosebud County Agriculturalist*)

They seem to be having pretty good luck with the jetties….They are a little less expensive than completely rip-rapping the bank….They seem to kick that water out and it will silt back in behind the jetty. (*Rosebud County Agriculturalist*)

When we were kids, we were down by the river, by Hardin…[There was] a car in the river [that] still had a motor in it. We got the motor out and put it in an old car and that thing ran for years. (*Treasure County Agriculturalist*)

The barbs, they're looking to be very effective. We have one over here, [but I] haven't had time to get in the river with the boat. I wanted to take another look at it, to see how well it's working. It worked well last year. I think it's a good approach as long as it doesn't wash out the neighbor on the other side. (*Rosebud County Agriculturalist*)

I was talking to an old-timer that said they had a bunch of steel mats that the airplanes could land on in World War II. It is linked and you can roll it up. You could roll that out into a riverbank. I don't know if the army has surplus stuff or not. It would hold the bank together. You would have to go on past where the river turns. Maybe anchor parts of it on down. This guy was saying he didn't know why they didn't use them. They had a surplus of them. (*Treasure County Agriculturalist*)

We had a hole starting in the bank. I took some Russian olives and set them over the bank. I set the root on the next tree on the limbs and kind of stacked them up. We raise hay barley and wherever we plow a ditch, we would have to swath through there, because you have this hay barley in the ditch. I baled off the hay barley when it was green with no twine. I dumped that big green bale on the Russian olives and spaced them out. The next year I came back [and] it was all silted up and kept it from washing away. It was building and [it] protected the bank….If they could take the Russian olives, which are basically a weed, and clean them out [it would help]. All of the limbs and leaves collect debris in the water….I think they should take a stretch of water and try it. What if it worked? It would be a cheap fix. Look at a beaver dam; parts will wash out and they repair it. This system here, you may have to have Russian olives or willows sitting there to put back in, but you could repair it. If it doesn't work, then figure something else out. I think it is worth a shot. (*Treasure County Agriculturalist*)

Ideally, I would like to see a dam on it, but I think we've passed that opportunity. At one time, there was quite a bit of engineering done; they were going to put a dam above Livingston. Now they've developed housing so much along the Yellowstone that it probably won't happen. (*Rosebud County Agriculturalist*)

G. Rip-Rap and the Question of Fish

I know rip-rap is a bad thing for the Yellowstone according to the Corps of Engineers and a lot of other people, but you know there were a lot of catfish caught there. When that was put in, people asked to come fish and they would fish along that rock or the rip-rap. And that was where the fish was…and water quality [improved]. There's no soil or silt being emptied into the river and going down. I think the Corps or some groups are saying that rip-rap is bad, [that] you're controlling the river and that's not good; let the river do what it wants to do. But if your farm is going down there, you're not too happy about that. (*Rosebud County Agriculturalist*)

H. Rip-rap and the Question of Aesthetics

This rock was marble and was brought in from Illinois on flat cars. They hired someone from Dickinson and they strategically placed the rocks. They did a beautiful job. They have willows planted and passes for the deer to follow down there….Old cars and cement, nothing like that is good. (*Prairie County Agriculturalist*)

IV. The Public Demand for Access is More and More Problematic

A. My Land versus Public Access

I think that the recreationist and the rancher, we have more things in common because we both want to use the land. What we need to do here is to always have a multiple use concept. And I mean, once we get to a single use, we always want to think of multiple uses. I mean, the recreationist can use it, irregardless of ownership….And I best stay away from that subject. (*Prairie County Agriculturalist*)

It is hard to access. We are fortunate that we have access to the river. (*Rosebud County Agriculturalist*)

I'm very possessive of that land….I can tell you my feelings, which may not count, but we go down there for peace and quiet. And [my spouse] and I were down there one evening and it was just beautiful. I can't believe that a boat came down the river and parked right in front of us and anchored. My feeling was, 'Please get off my river. I am here for peace and quiet; you are really disturbing me….' But what really bothered me was that possessive type of thing. And then I had to laugh because, you know, it's their river, too….[How] could I say it's fine for me to go there and [for them to] stay off my land? That's very selfish, and that would not happen, but I would doubt whether I would ever vote in the corporation to open it up….That is probably the primary…purpose—for that land to be with my family…to have a place to go that nobody else can go. (*Treasure County Agriculturalist*)

I don't like these guys restricting these school sections and denying access. They should be able to get to it. In every township, section 16 and 32 belong to the school. It is public. If they have it surrounded, they can deny access. I don't know if that is in every state. For years up here, there was a landowner that had control of the school section and leased the place to an outfitter and he had exclusive use of that. I think that is terrible. It is public land. (*Treasure County Agriculturalist*)

The phone starts ringing in mid-August. A lot check and see what it is [Block Management]. We ask them to call in advance. We have room for several, but when it is full, I restrict it. Come mid-January, we are glad it is over. Some of the people are the greatest guys in the world. Great people. (*Treasure County Agriculturalist*)

I think there is a recreation importance that's…[growing] all the time. (*Custer County Agriculturalist*)

Now most private land is being guided. In my opinion, 70 to 80 percent is. What isn't being guided is being bought up by hunters. The hunting and fishing is a commercial venture.…When you get to Bozeman [and] Missoula, if you want to do anything, you fork over 300 bucks. Get a hold of a guide to go fishing. (*Rosebud County Agriculturalist*)

B. Abiding by the "Old School" Rules of Accommodation

Someone will come to this door and they'll say, 'Can I go agate hunting?' Hell, yes. And they can just go agate hunting along the river here and they don't have to worry about anything. And they have a certain amount of peace to themselves. (*Prairie County Agriculturalist*)

I have a theory that when the hunter comes in here, I don't mind the hunter as long as he don't ask where the BLM land is. And as long as he…[doesn't] kick my dog for peeing on his tire. (*Prairie County Agriculturalist*)

I get a little pleasure watching people hunt and fish and enjoy themselves. [Maybe] get a deer or a big fish, or a big agate. It's kind of neat. We enjoy campers, too, because we'll go down there and pester them. Make them feed us. (*Custer County Agriculturalist*)

I let anybody hunt that wants to and it works extremely well because the hunters that come here regularly love it and they discipline the other hunters. So we don't have a discipline problem; it's a self-controlling thing. (*Rosebud County Agriculturalist*)

Well, we've got one hunter, he's a personal friend...[and,] being a coach and a school teacher, he knows a lot of people and knows how to talk. So he talks to the hunters. He's down here quite often. And, he talks to hunters that are down here and explains to them the reasons they should behave themselves. He mentioned to me a few times about some that aren't doing things. He's a little bit particular about them, [and there are] some things that he thinks are unsportsmanlike….He goes beyond the discipline I would and he takes care of that. (*Rosebud County Agriculturalist*)

The river is a real recreational asset…someway or another landownership should be encouraged to give access to the river to a population that…[doesn't] have access. I think that should be encouraged. It would make life better for everybody. (*Rosebud County Agriculturalist*)

C. Access and Abuses

To get on my naughty list, you drive through a gate, don't tell me and don't fix it. That's happened a number of times. You leave a bunch of garbage lying [around,] that will do it. You maybe hunt without permission. That's happened; you know,…not taking care of the land and stuff—that's how you get on the bad list. (*Treasure County Agriculturalist*)

They have the right to go on the river, but not through my property to get there. I don't ever want to stop [them]….I don't pay attention to what they're doing, because 99 percent of them appreciate what they're doing. (*Custer County Agriculturalist*)

That's just one of the things [about living here], these guys coming down in boats and hunting on private property. Sure, there's state land here, but they don't know where the lines are. Maybe the state should fence it….We've had two horses shot. We've had a calf butchered. We had a cow shot, too. People used to have respect. I don't think they have respect like they used to. (*Rosebud County Agriculturalist*)

If you run people off, or you turn them in to the Fish and Game, [the authorities] don't do anything to them….Secondly, it makes them mad at you. So, they'll come back and shoot your cow or calf….One [cow] got butchered. It was probably somebody that we run off. I don't know. I'm on this deal [and] I put gates at night so that they can't get in. They took a log chain up and ripped it open, tore apart the fence. That's just spite because they can't get in. We put up 'No Hunting' signs. And [we] paint up there off of Highway 12. No matter—they still come in. (*Rosebud County Agriculturalist*)

We have lived in many areas in our life and conservation is just pretty important. And I've just picked up too many diapers and too many beer cans in places I feel that are public use. You know, we've always been quite generous with certain things, but people do take advantage of it. (*Treasure County Agriculturalist*)

During the hunting season…[there are] people coming up and tying a boat up and hunting on the land. They are the worst hunters out there. They will shoot cows….One year, we had two. We had a steer in the fall that they shot and covered up with leaves. (*Treasure County Agriculturalist*)

What is high water? This is a federal waterfowl area out here and you have to be away from the high water mark in order to hunt geese along this stretch. There are hunters that push that. (*Treasure County Agriculturalist*)

There are people that will come unglued if you step off the sidewalk onto their grass in Billings and they are the same people that expect to use your property out here. (*Treasure County Agriculturalist*)

As more and more people move in to Montana, there is more hunting pressure. It is wide open to the boaters. They come in and park on your place and you have no idea when they are coming. Like last year, they found two deer gutted [and lying] on the bank. We have had people that have shot deer off boats on the private land. One person came up with a boat and threw their puny antelope and deer off on our place and got another, bigger deer and antelope. To me, it isn't watched close enough. (*Treasure County Agriculturalist*)

D. Denying Access: Avoiding Abuses and Liabilities; Generating Income

Everybody comes to hunt on the weekend. I had a guy stop and I told him that I had too many hunters already on and he could come back during the week. He was madder than hell. Last year, we said, 'To hell with it!' and closed it and leased it out to five individuals. You hate to do that. These guys formed a hunting club and leased it and they hunt it. Everybody else is out. That is too bad, but they forced me to do it. I had hunters that would come on drunk. Some would come on without asking. (*Treasure County Agriculturalist*)

If someone bought this…you wouldn't be here interviewing [me] and you probably couldn't get access here either. I mean, that's the thing….Look at the Ted Turner syndrome, you know….They bought all that land and then just closed it off from all the people using it. (*Prairie County Agriculturalist*)

I think if there is ever somebody reported for doing something like that they should be banned for five years. We do Block Management and I had one guy that came down a couple of times. He was rude and obnoxious and a total jerk. He called one time and was rude to my daughter. When I got home that night, I called him at eleven o'clock. The Block Management people called me the next day and I told them what this guy's name was and they put him on the list so he won't draw any special permits for five years. As far as bad hunters go, if there is a way to catch them, they shouldn't be allowed to hunt. (*Treasure County Agriculturalist*)

I like them better than outfitters, mainly because they are not associated with Fish and Game. These private guys, they just have to get a Montana license when they are on your place. A guide has to have a work plan that he turns into Helena. If he doesn't turn that in, he is in trouble. A guide will take as many big bucks off as he can. He won't leave anything for seed. Five guys aren't going to take as much as an outfitter, who is getting paid per day. A guide will say if he gets a big buck he will give you $1500. Do you think he is going to come and show it to you? He isn't going to tell you. He will drive off with it. That is another reason I don't like them. (*Treasure County Agriculturalist*)

E. Access as a Benefit to Agriculturalists: Block Management

I'm somewhat of a believer in letting the public use your land as long as they're responsible….For instance,…Block Management,...[has] been working real well for us. And hunters just appreciate it, because, you know, they're having such a tough time getting onto private property to hunt and stuff. As a landowner, I don't mind them hunting, and they appreciated it. As long as they take care of the property, I think it's beneficial to us. And, the fact is, they keep our deer population and stuff in sync. So, that's a good program. And…I still have control, because I can tell somebody, 'No, I don't want you on [our place].' We keep a bad list. (*Treasure County Agriculturalist*)

We know landowners that let people on to hunt at $1000 a buck. Who can afford that from around here? So, [Block Management] keeps the availability open to them. We have had people come in and say, 'I can't believe we've never heard of this and this is wonderful. Do you guys like salsa?' They'll give us gifts. You don't have to give me your mother's salsa. We used to have, before Block Management, a lot of gifts given, And, I'd tell them, 'Signing your ticket is your gift to me now.' But, we still get a few people who want to give you something….We used to get jars of whiskey, hams, turkeys, cheese from Wisconsin, and fish. (*Custer County Agriculturalist*)

We have more waterfowl. We have goose hunters from as far as North Carolina. We are in Block Management. We get ten dollars per hunter. It was temporary, but now I think it is permanent. It is strictly voluntary. It has brought a lot of revenue to this neighborhood. Most around here is from $3000 to $5000. (*Prairie County Agriculturalist*)

It only takes one person to turn you off. It doesn't take much to say, 'Why am I doing this?...What is ten dollars per hunter?' To me, it is birdseed for your trouble,…[and] when the money for Block Management ran out,…[landowners] didn't get paid. That isn't right. If they don't have the funding, they need to let them know. (*Treasure County Agriculturalist*)

We are in Block Management. Last year we had over 400 hunter days. We don't let just anybody come. We manage it right. We limit how many can come. (*Treasure County Agriculturalist*)

V. Life-forms of the River

A. Wildlife

The warm water from the Yellowtail [Dam] keeps the river open. As long as the river is open the geese stay….Just the other day, I was down there and there's a bunch of pelicans down there. (*Treasure County Agriculturalist*)

Prairie dogs. They're going to take this country over. We've got prairie dogs up the river here and they're up on our pivots, on our hay fields, all the way across here. They're even down on the bottom….Get rid of the prairie dog—that's the number one thing right now that's eating us up.…For these outfitters, you can give somebody a couple $100 to go shoot prairie dogs, [and], well, that's a good deal. What they don't realize is that [a] couple $100 is a drop in the bucket to what the prairie dogs…[are] doing to their ranch or their grass or our fields….They're all over; they are a problem. (*Rosebud County Agriculturalist*)

I blame the prairie dog problem on Lewis and Clark. If they'd have called them prairie rats instead of prairie dogs, it would have been better. (*Custer County Agriculturalist*)

People want to protect the prairie dogs and stuff. [It would be like] if we went to the big cities and told those people that they couldn't poison or trap the rats. You know, a rat in an apartment in a big city? I don't think [it] is any different than a prairie dog on our place. (*Custer County Agriculturalist*)

Mosquitoes. Yeah, skeeters. (*Treasure County Agriculturalist*)

Sharptailed grouse, sage hens, [and] we've got wild turkeys, we've got whitetail, mule deer, antelope, geese, pheasants, sharptail, and sage hens. That little flock of sage hens up here on the pivot that I don't want people to shoot—guess what, they shot them….We've got pheasants from here all the way across the dryland all the way over…. I like to see them; I like to see those sage hens, those sharptail. We used to feed them up on top….It's just like feeding chickens. But somebody comes along and shoots them. I don't know who does it, because if I did, they'd be in trouble. (*Rosebud County Agriculturalist*)

We used to have a lot of sage hens at the old place and they get gentle. Well, we used to have two sets of flocks of sage hens and long about the middle of summer, they would always come in on the irrigated hay fields. One old hen, she was crippled, she had a limp, and we always kept her. She always had a brood of chicks….Well, I said, 'Sage hens are good eating, but nobody shoots them on my place.' If you ever want to be back on my place, you'll never shoot one on my place. (*Custer County Agriculturalist*)

I'm concerned about the wolves and lions, yes.…Wolves are bad and the lions are too. But I'm concerned. I've got three little grandsons, triplets, that are seven years old, but, you know, if these lions get too thick and stuff, they'll stalk them kids when they're out playing. And that would be just devastating. And I know that we've got eagles that sit in these trees down here when we're calving. They'll swoop down and get the afterbirth and stuff. I've seen them do that. I haven't seen them kill a calf or anything. (*Rosebud County Agriculturalist*)

I've never had a ticket or a run in with Fish and Game, but when they start telling you that they're going to go here and there. [If] they ask, 'Do you mind?' I'd probably say, 'No, go ahead.' But they say, 'I'm going to go up there and count the sage hens.' You don't have to count the sage hens; I know how many there are. When somebody tells me [rather than asking me], I bristle up a bit, especially on my property. (*Rosebud County Agriculturalist*)

Flooding is not a problem. No, I think that's natural; I don't consider that a problem. The beaver, is it a problem? Yeah, it can be if it's not controlled. (*Treasure County Agriculturalist*)

They put that diversion dam in over here and they held it up for a long time and finally they said, 'Let's put some cement things out and the fish can come out behind that.' That was okay then. The first winter the ice took all of them away and the fish still cannot get up the dam. (*Treasure County Agriculturalist*)

We've got the wildlife. This is a very natural place for the geese migrating down. And we have some of the better goose hunting right in this area because the geese…like the river formation.…It's the wildlife; we have a lot of deer…In the fall…they come over and eat beet tops, and regrowth on the alfalfa hay. You can go out there and…wait until they come out in the evening and take your pick. The wildlife is very important and enjoyable. (*Rosebud County Agriculturalist*)

B. Cottonwoods

Now, my brother is right across the river here. He's been there for probably about 30 years. He said one year a big old cottonwood tree floated down the river and kind of hung out, out there in the middle of the river. And he said he thought he should go out there and move that tree. But he didn't.…That silt started building around that. And now it is a huge island and it is taking his place. It's just a cottonwood tree, hung up out there, and just started silting around it, and built a great big island....Now, it's a pretty good-size island and it is forcing the water over into his place. (*Rosebud County Agriculturalist*)

And the cottonwoods, they take 1000 gallons a day. In the fall, when the trees and stuff go dormant, the river raises ten inches. All of them trees and stuff, all the water that they're utilizing—how much [are]…[they] sucking out of the river on a drought year? (*Rosebud County Agriculturalist*)

C. Exotic Invasive Plants—Noxious Weeds

Right now, we've got leafy spurge something terrible and it's going to be a battle that can't be won. You know, all we can do is try to maintain it as best as we can. We got the county helping us. And we do some spraying and the county does some spraying. (*Treasure County Agriculturalist*)

The salt cedar and stuff like that—I'm sure that I'm not the first one that's mentioned salt cedar. It's a big problem. It hasn't been, but it is now. You've got the Canadian thistle; you've got the knapweed. You've got everything coming down the river….It's getting down here and it's coming down the river. (*Rosebud County Agriculturalist*)

I'm thinking that the state should do this. The federal government should do it, [and] not necessarily all the weight on the state. We spray for knapweed or Canadian thistle out of our own pocket. Now, there's some cost-share. But these chemicals and all of this stuff is high priced. (*Rosebud County Agriculturalist*)

I asked the weed board, which is a certain amount of our money goes toward, I asked…[the county]to come out and spray…and they don't do that anymore. They contract it out, and that's another sore spot….The guy that's doing the weed spraying on contract, he's getting rich off of people, including the county, the state, and the whole works. (*Rosebud County Agriculturalist*)

We see a problem in the increased Russian olive and salt cedar. And we are experimenting with [different ways to control it]. (*Treasure County Agriculturalist*)

The Russian olives have completely overgrown much of the island. Much of our river land is overgrown with Russian olives. (*Treasure County Agriculturalist*)

One thing that I think is important is the salt cedar problem. I don't know how that will ever be controlled. Maybe they can with some kind of a bug or something they can import in that will eat that up. The river down there, it's just completely saturated. And, the stuff takes 200 gallons a plant and they're as thick as a willow grove up and down the river there. They're everywhere. (*Rosebud County Agriculturalist*)

The geese bring it in. We are starting to see Roundup-resistant kochia. Lamb's quarters is our worst weed. Pigweed was [a problem,] but it took a hiatus. (*Prairie County Agriculturalist*)

We have a little critter called salt cedar. It is controversial. It was brought in to dry up wet areas….It has migrated here. It was brought into swamp areas. It has taken over, instead of [the] willows and native plants. The salt cedar comes in and chokes these out and dries up the sloughs that create the riparian areas. It is kind of a problem. We have been fighting it on a local level. The Feds haven't been too interested in helping. (*Rosebud County Agriculturalist*)

D. Moss

It periodically comes…it's been there before any of us can remember. But the Upper Tongue River has the same problem as the Big Horn. It's a living thing and it goes through a year's cycle. And it dies and it moves on downstream and it comes into the Yellowstone. And if you have lower flows and it starts moving out of the Tongue into the Yellowstone, then people are going to see….At times, it's really bad; you get it onto your fishing line….Well, that is something that has a lot to do with the Tongue River and the clarity of the river up there. Because it's laden with moss where it wouldn't have been before the dam went in the '30s. But there's scarcely…[anything] we can do about that. (*Prairie County Agriculturalist*)

When they go to flush the moss out of…the Big Horn, so the fishermen can fish better, it kind of bends us over, down here….It plugs up the pumps and tubes. Rolls of moss, unbelievable, coming out….You never know when they might do that….They don't tell you. (*Treasure County Agriculturalist*)

We used to get a lot of runoff from the Big Horn before the dam. It had a lot of clay in it. It would get in the river and it basically didn't let the sunlight through. The water was so dirty with the clay particles. You didn't have a moss problem. Anglers will throw their line in and come up with tons of moss. We have the same problem in the irrigation ditch. It clogs the pumps and the lines. It grows on the bottom of the river. In the high water, you can see it and it dries out and looks dead. When it gets wet again, it grows again. (*Treasure County Agriculturalist*)

E. Corridor

When you…mention a river corridor, I think there's going to be a 'dam' police here. That's my honest opinion….I mean, if they put an interstate through here, well, the first thing they'd do is they'd get to put a highway patrolman here. I don't want you to think I'm an outlaw or anything, but that's what I think of. (*Prairie County Agriculturalist*)

I have heard of the corridor, but you'll have to define it for me. (*Treasure County Agriculturalist*)

VI. Management Priorities

A. Concerns

[I'm concerned about] weeds, for one thing, noxious weeds, and out-of-state money coming in and buying all the places. (*Custer County Agriculturalist*)

Probably education [would help]. Educate people [so they know] what [the weeds] are, and what they look like. (*Custer County Agriculturalist*)

They [the Yellowstone River Conservation District Council] want to do this and they don't want to fund it. When this first project came in, there used to be a drain with a dragline and now everything has changed. They worked hard and got things producing well. You don't see that anymore and I don't think you ever will. I don't know who to trust them to. I would like to see people that have come up the hard way to be on a council and they would do a good job. They aren't around much anymore. (*Prairie County Agriculturalist*)

You need to have someone to oversee the development of the river, especially as it progresses, and we become more and more populated, in their need for more recreational country, as well as the use of the water downstream. We have to be extremely careful that the Corps of Engineers doesn't limit us and damage us with the Yellowstone and the Missouri, as well. So, you need all the information you can gather so that you are able to intelligently talk to those people, tell them why we have to have it. (*Custer County Agriculturalist*)

They need an expanded role and it's got to be political. I don't like politics, but that's the way it is, in getting good, logical Corps of Engineers specifications for controlling erosion where it should be done. They can draw up a plan and specifications for controlling erosion. Draw up the parameters on where it should be done and where it shouldn't. They did and it was kind of a fight, and they were correct… Some constriction of the river should not be allowed….So, the Corps of Engineers are probably well meaning, but they don't have guidance. They need guidance. (*Rosebud County Agriculturalist*)

I don't think we need government or anybody to regulate us….[If we must have regulation,] I would go more for state, or even county. I think the closer you get to the people at the local level, the better. (*Custer County Agriculturalist*)

Sodium from the surface wells…[that are] dewatering the coal seams. See, all the coal seams have sodium bicarbonate in them and they pump it out to reduce the pressure so the gas develops; then, they take the gas out. Then they pump all this huge amount of water and dump it in the river. (*Prairie County Agriculturalist*)

You know there are certain people that feel…[strongly] about that. There's some people that don't quite frankly give a damn about that. What about the sicklefin chub? That's another endangered [species]. [Or] the bluefinned chub? That's another endangered species in the Tongue River. But, the fact remains,…it's far better off to have done something and be proactive about it. People aren't so scornful of agriculture ruining the land or your doing this wrong and that wrong and it's raising hell with the environment. It'd be pretty hard for someone to say that I'm not concerned about the environment and I'm not concerned about the future of Montana in respect to the rivers….If it's gone ten generations away and it isn't there, they're not going to know what they missed, but wouldn't it be nice to do all the right things so that maybe it is there. So that maybe there's a few people that maybe have the same attitude that I have that we need to keep going with this thing. (*Prairie County Agriculturalist*)

Cities, obviously, have to have more water, [and] are more important than farms. I'd set the priority at cities—that would be the highest priority. Probably select manufacturing, like the electric plant [second], [and] probably third would be agriculture. And we've got to put recreation below agriculture, because recreation can stop and go without very much economic problems, or people having bad misfortunes for people. (*Rosebud County Agriculturalist*)

Absolutely, bar none, [dewatering the river] is absolutely the…[biggest] thing. The next most important thing is fish movement past diversion dams, but dewatering is actually even worse than that. (*Prairie County Agriculturalist*)

I think the land along the Yellowstone River should stay natural, that's my feeling. I don't like what's happening out west….Back when I was a kid, it was fine to drink out of the streams, but you don't dare do that today. Geez, what did we do to those nice mountain streams? What did we do to those mountains? And we can do the same thing to the Yellowstone, but we don't need to. It's undeveloped and I think it needs to stay undeveloped….Those little cabins and stuff along the river and the creeks, that's just for somebody's personal pleasure. We all live here just a short time; we have other generations that need to see this and enjoy it, [they] need to see it the way God created it. That's why, I guess, I got a deal on the [conservation] easement. Maybe I can sell it to the Fish and Game Department.…[Only] it's really not selling it either, because I can still run cattle and do whatever, but it's…where I can't sell it to a millionaire so he can own it to say he has some river frontage on the Yellowstone River in Montana, just because he has a lot of money to play with. The personal pleasure thing, again. This is happening all over, this personal pleasure thing. (*Custer County Agriculturalist*)

I don't want it to change, that's the big thing. We got to keep part of this world the way it is….You've got to preserve some of the prairie and rivers. Building cabins along rivers—we're not talking oil production or coal production;…we're just talking settling somebody's desire. And they clutter up our mountains and they can clutter up our prairie, too. We don't need to do that. (Custer *County Agriculturalist*)

[In order to have a lot more water] you'd have to build a dam up in…Paradise Valley or somewhere up in there. And that is such a beautiful area, you'd hate to see that lost….I'd have a lot of misgivings in this day and time. At one time, I was real strong in favor of it. I think it is important for future generations. You know, I suppose that's as important as the land we irrigate now, [but] we already can overproduce what we sell. So, it's hard to say. (*Custer County Agriculturalist*)

I'm not in favor of ruining the quality of the river, whatsoever….[We have] feedlots, and there's certain restrictions. A few years ago, the state had developed something where you couldn't allow any of your water running through your feedlots to enter into the river….I would have to say we need to be very careful there….I built my corrals over here and the county agent says it's not here now, but it's going to come someday. When you build that corral, make it somewhere where no water can get to the river. (*Custer County Agriculturalist*)

A lot of pumps and sprinklers have gone in, in the last five years….Something has to be done. They can't just keep taking water out of [the Yellowstone River] and expect to have water for projects that have been in here…since 1918….Somebody…has got to start controlling access to that water. There has to be a limit on it somewhere. I mean, they're pumping water clear up on the flats….You know, the high flat? They're pumping water that takes two pumps and a lot of electricity. And it is very expensive, over a million bucks, to get that water up there to sprinklers….I think the State of Montana should take control. (*Rosebud County Agriculturalist*)

With the water and the amount of people that there is anymore, we're more in jeopardy of losing our water rights, so we need to keep our water rights….A lot of your downstream people come up with some idea [that] this water is theirs, too. They pay taxes. They're a citizen of the US. We need to keep all of it here that we can, for development and agriculture and those types of things in Montana. (*Rosebud County Agriculturalist*)

Anytime we are this close to the river, the chemicals end up in the river….Big shots don't want that, but you are going to see more and more chemical use….Silt is another thing that [ends up in the river]….When you are flood irrigating, those things are going to end up in the river. Society is going to want less of that as time goes on. We have seen some good changes. It used to be that empty five gallon [chemical] buckets were all over. The industry [now] has shuttles so we take the containers back. That is good and I think you will see more of that. (*Treasure County Agriculturalist*)

B. Water Rights

Water right adjudication is another thing. You always wonder what they will come up with next or who is going to say, down river, 'No, that is my water.' (*Treasure County Agriculturalist*)

The state [has to regulate]….Somebody with a lot of clout [because] if you go over and tell the neighbors, 'I don't like what you're doing,' you might not make it back to your own land. So, you would have to have some upper enforcement, like state regulations. (*Custer County Agriculturalist*)

[The Role of the Council] It's all going to have to shake out. It's going to have to get grassroots support, but it's going to have to result in a certain amount of regulation, [and] a lot of people are going to grimace about that, but I don't quite see how a lot of things are going to happen….There's going to have to be some regulation on water to keep that free-flowing. Politicians and the people that are going to make the decisions; there's always a price tag on it….[So] we've got to have…some mechanism that allows us to view the river as something that is so sacred that it's not for sale at any price. (*Prairie County Agriculturalist)*

We have approximately 300 acres and we get 726 acre feet of water. It is like two and a half feet and you are assessed. You get overage so you pay overage. You don't get it back if you don’t use it all….[There is] no incentive to [not use the water]. You are charged regardless. (*Prairie County Agriculturalist*)

Probably the most important is working with the Corps of Engineers to get a reasonable method of controlling erosion along the river. Every one of these little towns has to have an intake for water. They need some kind of control, guidance, engineering, that sort of thing. Farmers need it. We need more help from those people, to get the Corps of Engineers educated as to what we need, what will work, what’s functional. (*Rosebud County Agriculturalist*)

Farmers have a reasonably good reputation. If a major portion of the farmers would let the town people camp on their ground, hunt rocks, hunt, fish, whatever they want to do, if they had free access or relatively free access to a lot more land, we’d be the heroes of the earth, and we could get some pretty good things done, [even as] a small group of people. (*Rosebud County Agriculturalist*)

VII. Visions of the Future

A. Visions of Change

More than likely there’s going to be change. You always think that it’s going to stay the same, but it doesn’t. (*Treasure County Agriculturalist*)

I think we’ll see more sprinklers,…[and,] conservation wise, you’re saving water. [We will] probably…[utilize] fertilizers better because you can put fertilizers through the sprinkler systems so you’re not using as much fertilizers. You know,…[it’s] just a better conservation type of system. You don’t have runoff water. (*Treasure County Agriculturalist*)

I think it’s all going to be corporate-owned and tenant-farmed, that’s what I think is going to happen. Because there is a lot of money out there, but it’s not in agriculture. And these people coming in, buying this land, are not buying it with money they made in agriculture, unless they sold a place in California and bought some cheap land in Eastern Montana. It’s an investment; it’s not going to work to buy it and pay for it and stuff. (*Rosebud County Agriculturalist*)

Our community is kind of dying. The high school has 30 students. The town is turning into a retirement community. There is nothing to keep the youth here. It is a typical Eastern Montana town. Hunting is getting to be a big deal. We are getting a lot of non-agriculture people buying for hunting. It is hard to compete when you are trying to make the land pay. (*Treasure County Agriculturalist*)

It hasn’t changed in eight years for us, so in ten years I don’t see much difference. (*Treasure County Agriculturalist*)

[My neighbor] is always accumulating lands from the folks that are dropping out. He has 500 acres there, along the river….He's picked up a lot of ground, [probably] 1700 irrigated acres. (*Treasure County Agriculturalist*)

I think the big thing that will happen [is]…mining that methane gas. That's something we will have to watch closely. I believe, and I am convinced, [if] handled properly, [we could] still do like Wyoming has done, and develop the use of that methane. I don't know if it would get this far up or not. I do think in the southwestern part of the county, we probably will see some development there. (*Custer County Agriculturalist*)

I hope that, and my prayer, and my wish is that whoever we lease it to, whoever is managing that, they will maintain good agriculture conservation practices so that we can have good farmland. And good grazing…so that it will remain a good productive land. (*Treasure County Agriculturalist*)

We are third and fourth generation. We are farmers and we are stewards of the land. We don't really want to give that up….People from other places come in and the land here is cheaper and a lot of places are getting bought up. People come to hobby farm, not to invest. It drives the prices up. The second, third and fourth generations are in jeopardy. It is financial. (*Rosebud County Agriculturalist*)

I'm just concerned about how much water's going to be in this Yellowstone River. Not only from agriculture, but from the housing [and] the urban development up and down the Yellowstone. (*Rosebud County Agriculturalist*)

I don't see the river changing much. I hope to see more sprinklers…[and] less drain water back to the river….That is a good thing for us and a good thing for everybody downstream. I think you will see more sprinklers. (*Treasure County Agriculturalist*)

Our kids don't want anything to do it. There is no future. It is so expensive. I look for it to be one big corporation some day. The youngest offspring that has stayed around is 34. The rest want no part of it. There are a lot that are up against retirement. We have a lot that is 60 [years] plus. This is really going to change in ten years. I am sure it will be corporate owned....I don't think it will be Microsoft or something like that, but somebody big with money. (*Prairie County Agriculturalist*)

[Rather then corporate farms,] I would just as soon see individual guys farming….If it is an outside business [that owns the farm] there is nothing in the community except for the workers. It is not like a personal business. Half the time, the guys working don't care about the cows or the ground. They are just doing it for the dollar....I would just as soon see individual guys do it. Farming is a heritage. The tax breaks, I am sure, help the bigger guys. (*Treasure County Agriculturalist*)

You go in the western part of the state [and] you can't have a boat with a motor. I would say we are headed to paddles, kayaks [and] canoes. We don't want that, but I doubt that we can prevent that. (*Rosebud County Agriculturalist*)

B. Pivot-head Sprinkler Irrigation

I see sprinkler systems taking over, and I'd like to have a couple. And, hopefully, in the next ten years when you sit in that tractor and look out, you might see some sprinkler systems that weren't there. (*Custer County Agriculturalist*)

There are a lot of benefits from pivots. They use half the water….They're run with electricity and that goes up every year. But,…in a dry spring,…when you don't quite have enough moisture to sprout your crop, there's water in the ditch which would be there pretty early if it's needed, then bring water in and you can run a circle around and get it sprouted….The guys with circles or sprinklers, they can add [chemicals] right in with their water, so that saves the airplane cost of applying. You can also put chemicals in there for weed control, but the way we handle the weed control on beets…has to be done early. (*Rosebud County Agriculturalist*)

Flood irrigating is cheap, but these sprinklers cost close to $1500 per acre by the time you get the lines in. In 15 years, it will probably be worn out. You save a lot of water, I think. (*Treasure County Agriculturalist*)

[Electricity] from a coal-fired plant…is a lot higher. Over a five year period, you will see a 42 to 50 percent increase in the cost of power. Where does that leave you on your sprinkler? You got rid of a hired hand because one guy can handle a lot more acres but you have to pay the sprinkler costs and the power costs. Which is the best way to do it? Right now, it looks like the sprinkler, but I am sure the power is just going to get higher. (*Treasure County Agriculturalist*)

Another advantage to the sprinkler is the runoff. You don't have it. If you put nitrogen on your crop, it stays there and doesn't run into the river. That causes a lot of aquatic plants to grow more. (*Treasure County Agriculturalist*)

The fall of 2004 was when we switched over to sprinklers….Excellent. Production is somewhat better. That is a surprising thing. We have to build pressure for the sprinklers, but our overall energy bill is only ten to 15 percent higher because we're using so much less water. Of course, the original investment was huge; [it's] an investment analogy: you're not going to save it on labor savings, [so] production has to be better. It is better. Production is somewhat better, five to ten percent better. Fertilizer use is markedly less, that's 20 percent less. (*Rosebud County Agriculturalist*)

With the sprinklers, you can inject nitrogen in with the water, and you, more or less, spoon-feed a crop, so you can get a better use of it. Those are probably the two reasons why fertilizer is less [expensive]. Production is better because irrigation can be more timely, and you can irrigate, like in sugar beet production, you can irrigate a light irrigation when you don't need very much, for instance, in germination or first irrigation. You don't over irrigate like you commonly have to in flood irrigation. (*Rosebud County Agriculturalist*)

The original investment which was, I want to think,…500 to 600 dollars an acre. (*Rosebud County Agriculturalist*)

Glaring detriment is the less wildlife habitat. We don't have the ditches; we don't have the drain ditches, and it's associated with our weed production. We don't have the weed production on the field edges anymore. We have large, open fields now, which…[lend themselves] to less weed production, more efficient equipment use, more efficient labor use. It does take away the wildlife habitat to some extent. It doesn't eliminate it, but it takes away some of it. (*Rosebud County Agriculturalist*)

Powder River to Big Horn River: Local Civic Leaders Overview

Fourteen interviews were conducted with individuals holding civic leadership positions, including city mayors, city council members, county commissioners, floodplain managers, city/county planners, and water/wastewater treatment managers. Participants were identified through public records.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Powder River to Big Horn River: Local Civic Leaders Analysis

I. The River Provides

A. The River is Important, Historically and Today

If you live in this part of the world, you’re drawn to the river because it’s water, and it’s the only water source around. So, you’re drawn to the river that way. People have always settled by rivers, lakes, or streams [for two reasons]: one, out of necessity, and, two, for an aesthetic value. (*Rosebud County Local Civic Leader)*

This particular community, Hysham, is wholly dependent on the river, because their house water and their fire department water…comes from the river. They have a waterfront treatment plant down next to the river. (*Treasure County Local Civic Leader)*

All rivers have some history, but as a gateway to this part of the state, it certainly can’t be denied….Miles City, at one time, [had] steamboat landings there. (*Rosebud County Local Civic Leader)*

From our standpoint as commissioners, the [river provides] economic benefits for the local area….[It] provides irrigation for the farmers….It brings…the hunting and fishing people…[and it serves] our own recreational uses. (*Rosebud County Local Civic Leader)*

Our [town] water…comes from the river….Most of the municipalities and rural water systems that draw from the Yellowstone need a certain amount of treatment, not only with chlorine and anti-bacterials, but for turbidity, etc. (*Rosebud County Local Civic Leader)*

Occasionally, we’re approached by the Irrigation District, which feeds from the river, to join them to repair [or] replace the weir….The DEQ is very concerned about what we do with our drinking water, for public safety. They’re also very concerned about the discharge from the sewer plant. So that’s continually monitored, 24/7, 365, [with] reports and samples. Nobody likes to think of a breakdown in a sewage plant anywhere along the Yellowstone…and [raw sewage in the river is] my major concern. The integrity of the river [is important]….The Yellowstone is not a river that I would consider drinking out of anytime of the year, unless it were treated first. (*Rosebud County Local Civic Leader)*

I think the consensus is, we are so far removed from the factors that contribute to the never-ending chain of float tubes and rafts, that striking a balance is not going to be a real concern here for a while. The long-term economic forecast is for steady decline due to continuing…migration…[from] this part of the state. I personally believe that is not accurate. We are seeing a turn around. We are seeing a trickle of people from the west part of the state that are coming here. That is the recreational use of the river. (*Custer County Local Civic Leader)*

The north side of the river is extremely dry. Some of the names of the creeks explain [the situation]: Froze to Death Creek, Starved to Death Creek. They, quite literally, mean exactly what they say. (*Treasure County Local Civic Leader)*

B. Local Farms and Ranches Need the River

As far as agriculture goes, you can't deny the importance of the river. At the river's edge, [near] town, there is a weir that stretches across the river which feeds a major irrigation canal for the north side of the river. [The canal] runs miles and miles downstream. (*Rosebud County Local Civic Leader)*

This is an agricultural valley. There are many crops grown here [like] grains, and sugar beets; sugar beets are a prominent crop. When you get away from the river valley, it goes to cattle….If there was not the river, we would not have irrigation; if there was not irrigation, we would not have sugar beets, spring wheat, winter wheat, [or] any of the crops that…[are] in abundance along the river valley. (*Treasure County Local Civic Leader)*

The agricultural sector of the economy in Custer County contributes anywhere from nine to 13 million dollars per year. Much of that is generated in the Tongue River Valley. There is a great deal of irrigation that is derived strictly out of the Tongue….It is very important for this economy that the quality of the water in the Tongue River and downstream is acceptable to the kinds of crops that have traditionally been grown. If we lose the water quality, we lose a significant contribution economically to this community. The Powder is the same. These are stretches of water that just in normal runoff, that runoff is piling sodium load into the river. If we have additional sodium in the reservoir, we end up with a precarious situation for irrigation. (*Custer County Local Civic Leader)*

The water can be used for improving the communities that it flows through,…primarily [for] irrigation…[on] another five or six thousand acres on the benches. (*Treasure County Local Civic Leader)*

Another thing that's happening…[a lot] around here is sprinklers….You eliminate a lot of high labor….I know a family that…[has] a place with sprinklers on it. His kids have grown up and gone….We don't have any kids that do the farming now. (*Treasure County Local Civic Leader)*

[The river is] important. Our livestock water out of it, we receive our irrigation water out of it, [and] we run livestock next to it. (*Treasure County Local Civic Leader)*

C. Recreational Uses are Good and Have Minimal Impacts

I take the dogs into the river. I don't have a boat; I wish I did, but I don't. I'm boat-less for one of the first times in my life and it's killing me. We spend a lot of time on the banks of the river, just being by the river and listening to the river. I don't fish the river often. I'll fish the river with my grandchildren. (*Rosebud County Local Civic Leader)*

The river helps make a nice community, with the trees and stuff. That is probably why I moved to Miles City. I was real hesitant to come until I got here and saw what they had to offer. I fished on it for a number of years. I know that, without the Yellowstone and the Tongue coming from the other direction, the recreation would be very sparse. (*Custer County Local Civic Leader)*

Yes, we still do [allow hunters on our land]. We ask that people check with us, and we ask that, if they come to a gate that is closed, [that they] shut it….If that gate was open, you leave it open. Check with us when you come out, because we want to know that you're safe. As landowners, we want to know that you're safe. (*Treasure County Local Civic Leader)*

The people here that use the river are really appreciative of the river. I was the first one in the whole State of Montana that had a boat that you could run on that river when it's in low water, and I have a jet boat that I can go fishing with. I bought that in '95, and now there must be 15 to 20 of them. (*Rosebud County Local Civic Leader)*

We have scheduled a huge regatta with rafts on the second of July….There is a group of at least six people, and we have a couple of large rafts, and we will load up a large cooler and a battery-powered blender. We listen to the blues on the battery-powered CD player. We mix margaritas. We have a great picnic. It is usually a 15 mile float. We put in at Moon Creek. It takes about six or seven hours. Most of the float goes through Fort Keogh which is pretty nice. It is clean [and] quiet. There is a mixture of little riffles. In the times that we have done it, in the height of the summer, the largest number of boats I have seen on the river is three all day. (*Custer County Local Civic Leader)*

Forsyth is a great place to live. It's one of the best places that I've ever lived in my life, and I've lived in Portland, Seattle, San Francisco, then also in rural Oregon and rural Montana….This is my city of choice. Forsyth is a great place to raise kids, good school system here, good hunting, good fishing if you like that type of thing, pike, walleye, catfish, sauger. Go downstream and snag paddlefish when that happens. (*Rosebud County Local Civic Leader)*

I place a lot of value on wildlife, probably more so than some people….And that's why when we go out, I just enjoy seeing any kind of a new bird or other type of wildlife. I like walking or riding my bike. (*Custer County Local Civic Leader)*

There are two fishing accesses, one is a campground [and] both have boat ramps. It's a rare time, [maybe when it is] 20 [degrees] below and the wind is blowing 40 miles per hour, when you will not find a fisherman at those accesses, either one of them….From geezers to young boys, fishing carries that image….Fishing is a big-time thing in our country. (*Rosebud County Local Civic Leader)*

Rivers are made for such things. People swim in it, [and] people float in it with inner tubes or rafts. A lot of kids in the summer will put in at Meyer's Bridge, which is on the other side of Hysham, and float down and somebody will take them out in Forsyth. That's a great float….Anytime in the summer, you can see adults and kids doing that....People fish on it. People hunt on it during hunting season, particularly [for] geese but certainly ducks. People will walk its banks just to walk the banks of the river. People will walk its banks to collect rocks because the rocks in this river are truly phenomenal….The famous Yellowstone agates, which, at the turn-of-the-century were considered semi-precious gemstones, were sent to New York, London, Paris and Rome to be cut into jewelry. There are two old-time collectors here whose backyards and outbuildings have nothing but these piles of agates that they have collected….The river gets a lot of use….My wife and I spend a lot of time on the river…Seldom are we alone, and we don't go to the easy access places. (*Rosebud County Local Civic Leader)*

[One of our assets is] this little "oasis." It is this old swimming area that is so charming to see it for the first time. I am instantly reverted back to six and seven years old and you would get up and you would go swimming all day. The water is from the Tongue….[In the future,] we might get water from the Yellowstone. (*Custer County Local Civic Leader)*

There's at least two fishing accesses within Treasure County [and] there's one more that's just across the Big Horn River. (*Treasure County Local Civic Leader)*

You have lots of fishing. There are people that go fishing all the time and a lot of them who like to go search for agates, up and down the Yellowstone, especially from here to Sidney. It's my understanding that it's the only place you find moss agates. (*Custer County Local Civic Leader)*

D. The River is Fascinating and Un-dammed, Mostly

It is a fascinating river to watch….I have seen it when it's been cold enough and frozen enough and ice-jammed enough to throw blocks of ice up into the field that are a story and a half tall. And when you look at that field in the winter covered with snow and these blocks of ice that look like they belong in a movie out of Alaska, and you realize that next summer there's going to be corn there, to me that's a fascinating natural phenomenon. And the color of the ice is magnificent in this river when it freezes….It has a blue-green cast to it, which is very much like glacier ice. (*Rosebud County Local Civic Leader)*

Personally, I love the river. I recreate on it. (*Custer County Local Civic Leader)*

It is taken for granted that people that live along the river understand the value of that asset and they really don't fully. (*Custer County Local Civic Leader)*

It changes every 100 miles. It's a fascinating river. (*Rosebud County Local Civic Leader)*

When it gets cold and clear, the river…steams a lot and that steam will frost the vegetation along the river, and that's truly magnificent. And it's unique to these type of cold water rivers….In summer, it's great because with the number of gravel islands that are close around the city; it's a perfect place for people to go out and picnic and camp. The Yellowstone, at least in this section, is very much an all-season river. (*Rosebud County Local Civic Leader)*

I don't have a farm or ranch on the river, [so] for me it's nice to go down and picnic or fish on the river. It's just recreational [and] it's nice to have it close. (*Rosebud County Local Civic Leader)*

That's another beauty about the Yellowstone—it isn't dammed. And it's truly a miracle that it isn't because there have been numerous thoughts about doing that all through its history. (*Rosebud County Local Civic Leader)*

I love the Yellowstone. It's a great river. Last of the un-dammed, natural streams….From its headwaters to its confluence with the Missouri, it's just a great river. (*Rosebud County Local Civic Leader)*

Some people find this area to be very desolate,…[but] it has the beauty of the river and the beauty of the drylands. It's very much a prairie/plains environment. The wind always blows, so you [had] better be ready for that. (*Rosebud County Local Civic Leader)*

It may not be dammed, but it's been rip-rapped, [and] confined. [There are] irrigation ditches and all the municipalities [take water] the length of that river. (*Rosebud County Local Civic Leader)*

You can live here and the river doesn't have a huge impact on your life one way or the other. (*Custer County Local Civic Leader)*

E. Noticeable Changes: Inevitabilities, Mysteries, and Improvements

When I was a kid,…[and] probably four-and-a half or five-feet tall, I could stand up against the ice….[Since] they put the Yellowtail [Dam] in, that water comes out warm….When we have a little ice jam, now, they are a foot, foot-and-a-half thick….The Big Horn water is warm….The water comes from underneath the dam, it doesn't come over the top. And, that water is usually 40 or 50 degrees, when on top it would probably freeze. And that's what keeps the water warm past us. (*Treasure County Local Civic Leader)*

Back as a kid,…you could go down and sit with a fishing line in the river all day and pull the hook out and never have moss on it. Now, that's all you catch, is moss. And above the Big Horn there's no moss in the river; that's the warm water making it that way. (*Treasure County Local Civic Leader)*

The other thing that [has changed is that]… the Big Horn used to be a really muddy…[river]. The water would be muddy enough that the canals pretty much stayed sealed. Now, with the clear water, all the canals are leaking. It's destroying a lot of farmland. (*Treasure County Local Civic Leader)*

From the Big Horn River to the boundary of Rosebud and Custer Counties, you cannot hunt geese….It's a resting area [and] they did that for a place for them to rest….I think it's a good idea…Really, it makes it better hunting. This area is well-known for some of the best goose hunting in the whole state. And I think part of it is because they have a place to go and sit—[a] kind of refuge. (*Treasure County Local Civic Leader)*

From the Big Horn River down to the Rosebud County line, the river is closed to hunting. You can not go on the river and hunt. You have to go into the fields that are away from the river. Consequently, we have geese that live here all year long. And, if they hadn't closed that portion of the river, we wouldn't have that. (*Treasure County Local Civic Leader)*

To go to a lake or reservoir, it's easily a 150-mile commute, and, with energy costs now, we're seeing people look at the river. Ten years ago, you could go down to the river and there would not be hardly anybody there. It would be uncommon, now, to go down to the boat ramp and for there not to be somebody with a boat in the river. It's changed. The fuel prices have changed how far people are willing to go. They are looking closer to home than they ever did before. (*Rosebud County Local Civic Leader)*

II. Dealing with Flood Plains

A. Flooding and Dikes

Oh, yeah, some people have been [in the flood plain] forever….The farm and ranching operations that have been in that area… know…what the risks are. (*Rosebud County Local Civic Leader)*

Forsyth is quite secure. The dike is in good shape, and we intend on keeping it in good shape. The community of Rosebud needs help. We are planning to do some mitigation….The ice jams cause flooding. We have an area of the river…[that's] down by Rosebud and makes a sharp turn, and the ice packs up there. It always does. I can guarantee it. We have done some mitigation down in Rosebud….We built up the Dike Road by two feet so it isn't quite as bad. But the town of Rosebud is not a good place to live [during] high water. (*Rosebud County Local Civic Leader)*

I believe the dike is stable. I haven't heard a lot of negative on it….It does cause a lot of people to pay high insurance. There is a moratorium, or restrictions, on building in some areas. A pretty big chunk of town is affected by that—everything north of the railroad tracks. (*Custer County Local Civic Leader)*

The other issue that is of primary interest is the dike. Most of the north side of Miles City is in the 100-year flood zone. Everybody there is paying flood insurance. They would rather not. This is a town where the average income is a few hundred dollars over the federal poverty level. The dike, according to the Army Corps of Engineers, is not up to spec in terms of materials, and there is no way to replace that existing dike where it stands. So, the long-term plan is to back up the existing dike with a new dike. There needs to be a buffer zone of 100 yards, then build a more secure dike, up to spec in terms of materials, and either leave the older dike in place or tear it out….It is a massive project, budget-wise, for this community, and it happens when we have an infrastructure which has been aging and neglected for decades. We are fixing some of those critical infrastructure problems, primarily water lines and sewer lines. Those have to be our first priority, right now,…[but] for the people on the north side of the town, we have to get the dike squared away. The Tongue side is secure. The Yellowstone is the one that needs work. (*Custer County Local Civic Leader)*

You can look at that [Forsyth] city map…and, just by looking at the geology,…you know that, at one time, the river did run through here….It might have been 500 or 600 years ago, but the Yellowstone is a river that snakes its way from its source to the confluence, and, unless it's trapped…between the hard rock canyons, it weaves. Those rock or gravel islands,…you look at them one year and they're different the next year. And, maybe, three years down the road they're not there. They're on the other side of the river because the river meanders. So, anybody that lives along the Yellowstone that has any sense at all and knows anything about hydrology and the velocity and the flow of the river, [knows] it makes a tremendous difference. You can be 100 feet away from the river and end up ten feet away from it when it's over….Rivers like the Yellowstone, the Missouri—that's why they have such a gravel path, and that's why they had such a flood plain….Instead of being confined, as the Mississippi is, they would spread out. And that affects the velocity, and it affects the volume of that water, and the force that the volume carries. The faster it goes [and] the deeper it is, the more force it has. If it spreads out and gets tangled up in bushes, and trees, and shrubs, and has to run through all that, it loses its velocity….It's not nearly as damaging. (*Rosebud County Local Civic Leader)*

The dike is kind of a funny thing because if you look at the east end of it, it makes a big curve and it just stops. If there…[were] an ice jam in the right place, it would just run through here. (*Rosebud County Local Civic Leader)*

[Forsyth] is built around the river, and the city is protected by a dike. [The decision to build the dike was] influenced by what the old-timers will call the Great Flood of 1918, so it's nice to have the dike. We have a working relationship with the Corps of Engineers to maintain the city's responsibility for the dike. (*Rosebud County Local Civic Leader)*

I have an idea: if we ever have a real wet winter, all…[of a] sudden we will find the weaknesses in [the levee]…[that] will become an issue. But we haven't had enough runoff or water to say it's been a problem. There was a period of three or four years when there was quite a bit of ice buildup and ice jams….My husband was working out at the packing plant at the time and one night he really got scared. He heard the ice breaking up and there was ice coming on shore....If there is one of those winters where there is a deep snow pack and then we have a lot of snow—the two combined—then it could be interesting. (*Custer County Local Civic Leader)*

[The] Corps of Engineers require us to keep the dike from being invaded by trees and shrubs so that its integrity isn't ruined….They also want the dike clear [so that if] they have to get up on the dike…to work on it, they have a clear runway. Some people in town, regardless of their deed, rightly or wrongly, incorporate the dike right into their yard….[as] a little rock garden. Most people understand it's a dike, and they're not digging holes in the dike [to] make a water feature out of it….So, we have very little trouble with that. We only have one [continuing] incident where somebody tries to fence it off. Most of the time, we don't have any problem with that at all. (*Rosebud County Local Civic Leader)*

This area is fairly attractive to out-of-staters. They love the beauty of the area, and two of the key things they like are trees and water….They want to be right down on the water's edge. They want to stand on the porch and cast that dry fly in the water….The people who have lived here, and grown up here, and have seen the Yellowstone at it's worst—pushing those eight-foot thick ice flows 100 yards from the riverbank—have a lot of respect for the river. You can go out here and see the stars and the trees. The locals know not to build there. The newcomers do not….There's no understanding of the power of the Yellowstone or of the damage it can do. (*Custer County Local Civic Leader)*

[Locals] are thinking that, if the flood only comes every 100 years, they will take their chances…[and] there is a bit of animosity [toward those that don't pay for insurance because they live outside the flood plain]. But the people that lived through the last major flood in that part of town understand the need for insurance. Those that moved here in the last ten years haven't really paid attention to the water stains that are five feet high on the walls of the houses in that part of town. (*Custer County Local Civic Leader)*

Maintaining the dike area [for its] aesthetic value [is important]. Who wants to have a wall of concrete along the river? Then it's not a river, anymore. It's…been turned into a canal. (*Rosebud County Local Civic Leader)*

B. Little Sympathy for Building in the Flood Plain

We don't have the tools to say, 'No, you can't build there.' We do have the tools to say, 'Well, yeah, it's your investment, and [you should] understand that the Yellowstone can turn mean and ugly….And, if you're going to build, here's the requirements'….[Another restraint is that] Montana-Dakota Utilities provides the electric power and is particularly hesitant to put power poles in the path of ice flows on the Yellowstone. Those poles do not stand a chance against a big heavy ice flow or a raging river. So they're reluctant to even do that; they recognize the problems. (*Custer County Local Civic Leader)*

In the old days, people would just abandon their houses, or hook the mules up to it [and] put some logs under it and roll it back. There's a lot of that in this section of the river. In fact, the whole town of Finch was moved….Rosebud…[is] very fascinating because the town is in three sections. Two of the sections you can see…because that's where people are living. The third section is across the river, and that's where the town was originally. (*Rosebud County Local Civic Leader)*

One of the most difficult assignments I had as a Conservation District Supervisor [was up]…along the banks of…the Bitterroot….[The difficulty] was keeping people from building right on the edge of the river. They [wanted] a 'river view.' We see that clear across the country….Any body of water…[is] majestic but also very dangerous, and [it] doesn't have much respect for human beings or human edifices….Of course, everybody wants to be there. (*Rosebud County Local Civic Leader)*

The new people want to hunt from the rocking chair on the porch as opposed to the long standing residents that aren't afraid to get out and hunt. It is not just them and the cannon; it is the house, and the well, the septic, and all the traffic in the riparian areas….Local people hunt and fish and then they leave that [river] area to go to their house. People coming in want to have their house in there. (*Custer County Local Civic Leader)*

Flood control is fine, but if you're that irresponsible in your money management that you're going to put a million-dollar house on an unstable bank, then don't cry for help because the bank goes away one day and your building goes into the river. (*Custer County Local Civic Leader)*

C. Flood Plain Maps and Designations Can Be Credible, but Must be Current

There's disagreement among hydrologists [about] whether that [1918 flood] was the 100-year flood or the 500-year flood. If it was the 100-year flood, we're due for it again. I have a picture of the [1918] owner in a boat on the front porch [of my house] so that really pretty much took care of everything in town. Everything was flooded. (*Rosebud County Local Civic Leader)*

We have a rough concept [of what] would replace that dike to meet Army Corps standards….[The new dike] would be inset some from the high water mark, and the Army Corps, also, is rather insistent on a substantial 'No-Build Zone' inside that….I have campaigned for a flood control system that [includes] a 'No-Build Zone' that we use for recreational purposes. With the community the size of Miles City, and a river like the Yellowstone here, it's just like a magnet for fishermen, for swimmers, and, to a certain extent, boaters and jet skiers….There's a substantial value in recreational potential....There are programs and procedures that the city could use to go about getting the land in [the flood plain] in their possession. (*Custer County Local Civic Leader)*

We maintain the flood plain maps here, [and] provide information to landowners as far as what property is in the flood plain….We just got those new ones in the last five years….I think they are accurate. (*Rosebud County Local Civic Leader)*

About two months ago, we had a big map that somebody gave us of the flood plain area….[The map has] the flood plain in the wrong area and it's costing a lot of people high insurance….And one fellow, he wanted to add a room on his house, and he [went to] get everything lined up, and he [was told] your insurance is going to double because you are in the flood plain. And his house sits way above the old shelf out there. Even if the Yellowtail [Dam] ever went out it wouldn't get to his house. (*Treasure County Local Civic Leader)*

You look at the Yellowstone and [you can see] how flat it is….The whole flood plain issue would have to be looked at, and although there's people wanting to come in and build their own dike systems and money doesn't seem to be an issue,…I wouldn't think you'd want to be any closer than 300 [feet].…An ice jam [can cause] floods for half a mile….It happens. (*Rosebud County Local Civic Leader)*

FEMA has told us they are producing new maps, and we're waiting. We are holding our breath, actually. This has only been going on for five years. There were some maps, but being a local, I understand this place floods, this place doesn't…So, even if it doesn't say so on the flood plain map, [sometimes I know it's] not a good place to build. (*Rosebud County Local Civic Leader)*

D. We Need Help with Noxious Weeds

The Russian olives [are a problem].…My dad said [they were] brought here in about 1920…[as] windbreaks. (*Treasure County Local Civic Leader)*

Salt cedar, that's a big issue, and a pile of money gets spent on it. There's some knapweed, but, you know,…they were brought it in for honey bees. I was just reading about it the other day. They brought it in up around Idaho and it took a long time to get started, but once it got growing…[it didn't stop]. (*Treasure County Local Civic Leader)*

We have solutions we can offer…. There are things you can do. Spraying is a little piece of all of those things. Producers are looking at managing a whole bunch of issues and weeds are part of that. I am here to help them with that and weed control gets further ahead by doing that and they figure it out that it is in their best interest to make that happen. (*Custer County Local Civic Leader)*

The Russian olives are thick on the bank….The roots go back in the bank and the water washes under them so that when they lean over,…they take a whole bunch of grass with them, probably the size of this table....One thing that these invaders have done, [they have] just about destroyed the habitat for cottonwoods. [The cottonwoods] are not reproducing anymore because of Russian olives….Cottonwoods are open underneath…so you got some grass…[for] grazing. Where these invaders come in, and it's so thick you can't even walk between them. They pretty well destroyed the land as far as for agricultural use….Now, it's just a thicket….In some places the deer…can't get through [the salt cedar]; it's that matted and it's got big old thorns on it. Turkeys love it. In the winter and fall [they]…pick the hell out of them berries….Salt cedar is the one…[with] the big root system.…I've seen figures [and] a big salt cedar [takes] a couple hundred gallons, a day. I think the other [concern] is their seeds and leaves [which] are really heavy in salt….Under a lot of that cover there's nothing growing because they've poisoned the soil with salt. (*Treasure County Local Civic Leader)*

III. Dealing with Erosion

A. Erosion Happens and Should/Shouldn't be Fought

Anybody that lives along the river has to have problems with bank erosion. Five years ago, there used to be one of the best cornfields in the whole area, upstream about five miles….[Then the] river took one of its classic loops way off to the other side,…[and] it went right through the middle of that cornfield. It took out 40 acres of that field and abandoned 120 acres where it had run before. And [now] if you look at that abandoned section, occasionally in high water [the river] will move through there, but there are young trees in there, and there's shrubs and bushes….So, as the river moves, it both creates and destroys, as it has always done….I happen to be a fan of wild rivers. I hate to see people lose their homes, and I have a certain amount of sympathy for a home that has been standing for 100 years,…but the river changes….I think a person should be able to protect their property, but I am absolutely opposed to new construction in the flood plain. That's an accident waiting to happen….That is eminently foolish. (*Rosebud County Local Civic Leader)*

So, when you live in an area like this, where there is no bedrock, or hard rock, if you build by the river, you're in trouble. And you will notice that the established ranches, those that have been here for 100 years or more, all of their buildings are on the highest ground. They seldom put important fields close to where the river is…[or] where they have seen the river flood. They'll leave that as tree and brush land and build their fields back….Then you look at newer construction, in the last 20 years, and people who wish to escape the city, whether it's a Montana city or a California city, or a Pennsylvania city, there's this tendency to build close to the river….We have this fascination with the 'cabin-in-the-woods.' A little fishing cabin, right by the lake or stream,…that's what we want….[But,] if it's sand or gravel, like we are here, you can build a mile back from the river and still be in danger. (*Rosebud County Local Civic Leader)*

Private properties, logically, have buildings on them. As the river washes and erodes its banks, those buildings become closer and closer to the river. Consequently, with the earth eaten away from underneath them, they tend to fall into the river. There is one specific place that I have in mind that [may] fall into the river this year. If it doesn't go this year, it will go next year. That's a given. The owners live in Pennsylvania, but DEQ is very concerned about it because the building could fall in the river and that then becomes a danger to areas on down the river. (*Treasure County Local Civic Leader)*

If [the river] takes a turn out down here by one of the farmers, that's part of God's natural way, we can't order that. Like the cut across the center of the guy's cornfield,…we can't do anything about that….If the Corps of Engineers had been here with bulldozers, we still couldn't have stopped that. (*Rosebud County Local Civic Leader)*

B. Rip-rap as a Known Solution to Erosion

I would probably go with whatever kind of natural rock application….It's the easiest….The rock is accessible here, and, from a placement standpoint, it doesn't require trying to build some kind of diversion while you do it. It's really about the only cost-effective way to do bank stabilization. (*Rosebud County Local Civic Leader)*

Allow the landowners to protect their property.…[Allow them to] do whatever they can afford to do. I wouldn't say, 'Go get 35 or 40 car bodies, run a cable through them, and anchor it to the bank.' I don't like that. I've seen it done. It's not effective. (*Treasure County Local Civic Leader)*

The answer of the moment is rip-rap, and if you can get the Conservation District, the DEQ, and the Corps of Engineers to agree with you, you have some chance of applying rip-rap. Of course, we apply rip-rap entirely different than we used to. It's not chunks of rock or concrete dumped in there; we'll net it, and vegetate it, and fertilize it. If you can establish the river willows in it, you have a much better chance of saving something. It's not cheap, and everybody can't do that. (*Rosebud County Local Civic Leader)*

You know how the railroad would rip-rap theirs without permits? They'd just go back 15 or 20 feet and build a great big trench and fill it full of rock. It's on their property,…[and] above the high water mark…Someday, when the river washes away, they'll have a barricade. That is the plan, a pre-plan. It…[isn't] a bad idea. (*Treasure County Local Civic Leader)*

Erosion is very serious, and, because of the laws, it's almost impossible to protect your land….The Greater Yellowstone Coalition and some of the other environmental groups sued because…[rip-rap] was supposedly ruining the river….They didn't care about the landowner losing his property. They wanted [the river] to just go wherever it wanted, and wash their homes over. And there were some homes that…[were] damaged….It's more the agricultural land down here that's being lost. About 150 acres [were lost over] 25 to 30 years….One year you'll lose 30 acres, and the next year you might not lose any….But you still can't build rip-rap. (*Treasure County Local Civic Leader)*

[The] Army Corps of Engineers needs to get involved and shore up these banks, but they won't do it….They'll let the river run its course. But, you see, with this one particular area, when the river eats out the rest of that field, there's not much until the railroad tracks, and you don't mess with BNSF. Oh, yeah, I can foresee that once the river has eaten all of that field out, BNSF will come in and they will shore that up because you can't wash out the railroad. It doesn't matter that people lose their crop ground, but don't do anything to the railroad. (*Treasure County Local Civic Leader)*

Fortunately, they've changed the rules of rip-rap. You don't get to throw your old car bodies and things like that. When you start dealing with rip-rap, that's not…[natural]. I would rather do it naturally, if we can. (*Rosebud County Local Civic Leader)*

C. Timeliness of Permitting Process is Questioned

Because of…303 permits, and people objecting to doing anything,…we can't protect [it] anymore. And we've probably lost 150 acres of land that the river has washed away. (*Treasure County Local Civic Leader)*

You don't want the troublesome fight….For example, [when] the Hysham water ditch system [needed to have some work done],…they had a tough time getting permission for that. (*Treasure County Local Civic Leader)*

There's still a lot of management issues over erosion….Landowners [with] a lot of erosion problems [talk about] getting permits to rip-rap and doing it in a way that doesn't create…[a problem for] other property across the river. It's not easy to get a permit to do much work on the riverbank.…[Loosing productive ground] can impact us from a tax base because he's got a couple of irrigated fields in jeopardy. (*Rosebud County Local Civic Leader)*

The individual landowners have to take the initiative to go through the permitting process and work with the local Soil Conservation Districts to come up with a remedy and, hopefully, get the permits. (*Rosebud County Local Civic Leader)*

I got a pump that was there in 1903 or '04. So, I can do anything I want to that pump sight because it's established. [When] my son [applied for permission to put in a new pump site],…they had to cut down three trees to make the paperwork. It was a humongous pile of paperwork to put a pump site in there. (*Treasure County Local Civic Leader)*

IV. Managing for the Future: Is it Here?

A. Growth and Development are Needed

People are becoming older [and there are] more retirees. I think this would be a fair statement. We've already seen [this happen in] the community of Hysham. (*Treasure County Local Civic Leader)*

[Hysham will be] smaller than what it is…because our children see the parents working like Trojans and not making any headway. They won't stay. I've got a neighbor who has three children. One of them has gone to Bozeman [and] is making good wages [that] can't be made here. The second one, the girl, is married….She's in Helena. That's where her husband can get work. The third is in Missoula. I don't know if she's still in school or if she's working. (*Treasure County Local Civic Leader)*

As a city council member [in Forsyth], one of my concerns is to encourage different businesses that would hold our kids, where they could go to [college] and come back and have something to work for. Right now, there's nothing. (*Rosebud County Local Civic Leader)*

This historic main street [in Miles City] is pretty unique….We also have two rivers that come through town, and…very few people that seemed to be tapping into that. In other places I have lived, if you came into a town like this you would expect to see lots of people selling rafts, people renting rafts, lots of people going to the river. (*Custer County Local Civic Leader)*

They have been talking about a rail line for 50 years. It is supposed to follow the Tongue River…Burlington would operate it. I think they did some grade work in the early 1920s….We received front page billing in 1896, so we aren't holding our breath. (*Custer County Local Civic Leader)*

We have a middle school, a great school that has been empty for four years because the population has shrunk so much. The high school has…seventh to twelfth grade[s] and the elementary does first to sixth grade[s]. (*Rosebud County Local Civic Leader)*

Back in the '60s, when there was so much emphasis on installing coal plants along the Yellowstone,…I am told that the blueprint for the full utilization…would divert up to 75 percent of the river flow. This was a U of M study that I read. We are gung-ho on energy now and the focus seems to be on building power plants and shipping power by wire rather than shipping coal by train. It is important that we have sufficient water coming through the river. That would be a long-term consideration. (*Custer County Local Civic Leader)*

The school is in bad shape….When I was going to school there were 70 or 80 [students] in high school, [and it] got up to 100. And now we're at 30…[or so]. (*Treasure County Local Civic Leader)*

Right now, my major concern is the infrastructure. Like so many entities across this country, and in this state, the infrastructure, as far as the delivery of water, is very old….The lines were [last] repaired in the '40s or the '50s, or even early '60s….Forsyth has no industrial base, so the availability of funds is always a burden on the individual taxpayer, that means small business people and homeowners in this community….State statute mandates that the water system is self-supporting. So, you can't pay for it out of a gift,…[or] from the general fund. It has to create its own revenues. That didn't seem so bad when that statute was first put in place in the early '50s. But, with the rising cost of this and that, how is it going to support itself [except by] a continual rise in water rates and sewer rates? That really frosts me. It just does. I think government has certain responsibilities, and to me that would be one: provide basic services to the public. (*Rosebud County Local Civic Leader)*

This growth policy sets up a two-mile radius outside the city limits. We have a building inspector within the city limits who has jurisdiction over any new homes, and monitors the flood zone, and makes sure everything complies with Army Corps, and all that. Outside the city limits, that inspector has zero jurisdiction. There is no county inspector….What you have is real haphazard. You have residential structures going up in potential commercial zones. When I look at what has happened between Billings and Red Lodge, and you look at all of the ranchette places, I can now see how that happened. These areas of limbo that were exploited by people that wanted to put things up on the cheap. I don't think the city and the county are on the same page. (*Custer County Local Civic Leader)*

There is an average of 30 trains that run through Miles City a day. There has been a lot of talk of a railroad running from the area near Decker where all the coal reserves are and bringing that online where that ties into the tracks here at the Tongue River. It [would] increase the train load to 46 per day, on average. (*Custer County Local Civic Leader)*

In ten years I expect [Forsyth] to be pretty much the way it is now. (*Rosebud County Local Civic Leader)*

B. Newcomers Needs and Desires Change the Local Context

The old-timers…are selling those sections because they're not usable….So, they sell them and laugh that some guy from California or Pennsylvania has bought this. [Then the buyer] builds this thing and only turns up during goose hunting season….Hunting has become more and more difficult for the locals who are not landowners because ranchers will lease rights to their property to an outfitter, which, from the standpoint of a rancher, is a smart thing to do….The leasing of those hunting rights is very important. Well, that [area is now] closed…and that's very irritating if you've lived in a place all your life, and you've always gone there to hunt along that river bottom. Or, if you've always gone there to fish and camp and you're very careful you don't burn the place down, you pack your garbage out, and now you can't go. You're 40-years-old, you've been going there since you were a kid, with your dad and your grandfather, and you can't go. That causes consternation. (*Rosebud County Local Civic Leader)*

When you come here, you actually see cowboys coming into town from the ranch. You're not seeing somebody from New York that's got a hat and a pair of boots….The part that bothers me a lot is the fact that we have these people coming in from out-of-state, with big money, buying big ranches and shutting them off. They don't want anybody to hunt on them. They're taking them out of Ag production, and [the ranch] is just a tax write-off and a place to bring their buddies hunting, but they won't let the locals hunt….One guy bought six ranches around here. They're all big ranches, and it just absolutely makes me sick. It's very difficult, now, for the family ranch to carry on, partly because of the tax structure. You've got inheritance tax. If your ranch is very big in size, that inheritance tax will kill you. And you can plan all you want, but it seems like somehow or another it gets you….A lot of people are buying acreage along the river for recreational uses…In the past, it's almost always been irrigated farm ground, but now it's wealthier people buying it strictly for their own hunting habitat. (*Custer County Local Civic Leader)*

I look at it as a farming community, primarily. It's changing somewhat, with different ownerships coming in, and….a lot of recreation, plenty of hunters….Fishing, boating, relaxing, camping. I've talked to people camping, and they've said they like how peaceful and quiet it is. The pelicans, and the geese, and ducks, and just wildlife, everything, all around the river, is wild. (*Treasure County Local Civic Leader)*

There's quite a bit of money spent by hunters in town here. You always see them in town at noon. They stay overnight at the motels, they stop in at the Friendly Corner, down here and buy stuff. Quite a bit of money gets spent here because of them. (*Treasure County Local Civic Leader)*

[A group of buyers] never even thought when they bought 20 acres [of riverfront land] that they needed to get easement from the [adjoining landowner to cross them]. (*Rosebud County Local Civic Leader)*

People [are] moving to Eastern Montana and subdividing large pieces of property. People from the west, California, want to move to an area like [Kalispell]. The housing market in this town is so high because people have sold their house in Kalispell and come here because they want to go to a smaller community….More and more people are flocking to Eastern Montana. (*Rosebud County Local Civic Leader)*

Someone told me they sold 20 acres and a house to some airline pilot.…It doesn't matter where he lives. So, they think they can live here and commute, and we're going to see that more….It's going to drive up the cost of real estate along the river. It's already [increased] ten-fold in the last few years, but it's going to get even more so….The Missouri is ahead of us….Go down to Mandan, [or] Bismarck, North Dakota, and see the development that's…[gone] on with expensive homes along the river. It's going to be a while before we see that, but we're going to start seeing people that want to build homes on that riverfront property eventually. It won't happen right away because of the dike and the Army Corps of Engineers, but once you get outside of that, people are going to watch for those parcels to open up. (*Rosebud County Local Civic Leader)*

In the summer time we don't have trouble with [people getting on private land]. It's in the fall…[that it's a problem].They come down the river and just go up on your place. And sometimes we hear our cows…bawling and we go over there and look, and there'll be a couple of guys walking through there…telling *us* to get out of there. (*Treasure County Local Civic Leader)*

C. Recreational and Environmental Interests as Threats to Agriculture and Development

We have seen that on Fort Peck. Recreationists are making a lot of noise, but the reality is that reservoir wasn't put in for recreation. It was put in for barge traffic and power. Now we have people lobbying so that the water stays at such a level that they can recreate. Another example,…is a group of people that want to drain the reservoir to mimic spring runoff, to maintain the fisheries below the reservoir. We haven't seen those issues on the Yellowstone, but the reality is we would be foolish to think it won't happen. (*Custer County Local Civic Leader)*

Priorities have been lopsided towards the environmentalists and communities have not been considered….I think [the] conservationists,…[who] are already doing things as far as the land [goes],…get penalized and shut out because it doesn't quite suit some environmentalists…[who] don't have a clue what it's like out here. (*Custer County Local Civic Leader)*

A lot of people from this area see the river as a recreational resource….Sometimes that can take precedence over a real good logical use of the river. (*Custer County Local Civic Leader)*

D. Pollution in the River(s)

I know how much fertilizer, and I know how much herbicide, and I know how much insecticide is put on the sugar beets….You fertilize your field, and then you flood irrigate it….It doesn't disappear, it ends back up in the drainage, and it all ends up back in the river….There's no question about it. [For] most of the rivers in this country, the nitrogen rates are far higher than they should be. (*Rosebud County Local Civic Leader)*

If you have your little house on the river, and your neighbor has a little house on the river, and then another neighbor [has a house]—that's a lot of septic systems….It can be clean looking, but that's a lot of nitrates. So you concentrate those riverside homes in that groundwater area, and then you have an issue of nitrate in the river, which is not good for aquatic life. (*Rosebud County Local Civic Leader)*

E. Questions Regarding Coalbed Methane

It's the same old thing…[It's an] economic boom….It's jobs; it's money….When we were small enough, after we messed up an area, we'd pack up our tents and move 20 miles upstream, and the [messed-up] area would recover. But we don't do that anymore, we just continually do stuff so it's harder for the area to recover….[Concerning the discharge water from coalbed methane production, if] you listen to one side, there's no problem with discharging that water, and you get all these facts and figures and that makes sense. Then you listen to the other side, and there's a horrible problem with discharging that water because of the salt and it kills everything, and they have all these facts and figures, and, 'Oh, that makes sense'.…So, I don't know why that is, but that's the most contentious situation. I'm sure you're aware that Montana and Wyoming do not see eye-to-eye on such things, and we're having a fuss now on the Powder and the Tongue Rivers, because they rise in Wyoming. (*Rosebud County Local Civic Leader)*

I am concerned about that impact of coalbed methane development in the Powder River Basin. I am concerned about the reality and the perception, because if a farm….comes up for sale and the perception is that runoff from coalbed methane upstream will affect the fertility of the pastures, it diminishes the value of that [farm]. (*Custer County Local Civic Leader)*

V. Troubles: Who Will Regulate the Future?

A. The Future Looks Troublesome

We have to make sure [future generations] have access and have the opportunity to enjoy the same things that previous generations have had with the river….It's going to get tougher because demand is in its infancy. As the pressure [rises], there will be more issues. Right now, it's in the beginning stage. (*Rosebud County Local Civic Leader)*

If we don't have regulations we're going to have development right next to the river. I think development is the worse of the two evils, so we wind up accepting the regulation….[Otherwise] we can lose the cultural resource….[through] an incremental downhill slide. It's unfortunate, but this is America. That's how it works. (*Custer County Local Civic Leader)*

The next [Miles City] Mayor's Task Force is a quality-of-life task force. [The group will consider how we] can provide amenities that leverage some of our best natural assets. The trees are something that we have an abundance of, [and] we are looking at becoming a 'Tree City.' We have these rivers and the levee….These could be scenic walking, biking, and horse paths. [Right now] we have ATVs and four-wheel vehicles that are ripping around….It will be an uphill battle to ask, 'Why are you abusing this resource?' If we don't do it ourselves then I fully expect other people to come in and say, 'We built this dike and the activity is going to stop.' The city council and the mayor's office have been dominated by people that have grown up here and have a maverick spirit….[but,] if we are going to ever be attractive to people from out-of-town, we need to start treating those resources with a little more respect. (*Custer County Local Civic Leader)*

[We need a] collaborative plan that ensures varied use for all users, whether it be Ag… or homeowners, just so there was adequate planning to address all of the needs fairly for all….It's going to be a shotgun thing….The legislature will be sticking their nose in, the Soil Conservation Boards are already in,…the Fish and Game will be up against issues, and so will the local planning boards. So, it will be a multi-faceted thing. [I don't know] how a person can keep it all organized and not have every entity doing their own thing….That's the way it is right now. We have never had a collaborative meeting of any kind, with Fish and Game, with Soil Conservation, [or with] county planners. When an issue comes up, we do our part, [and] they do their part. (*Rosebud County Local Civic Leader)*

The Yellowstone is in much better shape than the Tongue as far as appropriations, but it concerns me, as we move through time, that more emphasis is placed on wildlife at the expense of irrigation. We haven't seen huge issues yet, but they may come. And, [as for] municipalities,…the water is going to go where the votes are, ultimately, and that can be a concern. (*Custer County Local Civic Leader)*

If we get into a drought, and we did see it two or three years ago, some of these newer pumps were shut down. I am okay with that simply because…when the Conservation District adjudicated the water they put some towards in-stream flow. What concerns me is, in 20 years, [if] the legislature changes the law and all of the sudden they say we have to maintain a certain amount of flow and to heck with the guys that have 100-year-old water rights. (*Custer County Local Civic Leader)*

The only issues that come up that I know of are river access issues. There are a number of Fish and Game access points, but there are still issues from time to time with people over ownership of islands. [When] a river channel has changed….there gets to be a gray area [where] one part of the law will say an island is public, and then you've got landowners that actually have deeds to islands…[that] weren't always islands. So there…[are] those issues out there. And those usually surface during hunting season or that type of thing. (*Rosebud County Local Civic Leader)*

Recreation and agriculture aren't necessarily in conflict with each other. We irrigate and then the water comes back when the pumps are shut off. I don't see it rapidly deteriorating or disappearing. They have obviously done something right. One of the other issues is the aesthetic value. That has maintained itself quite well. (*Custer County Local Civic Leader)*

I think there is a whole bunch of old state laws that have already set [water] priorities….We [should not] change those priorities. I think they are right…now: first in time, first in right, basic water laws. (*Custer County Local Civic Leader)*

I don't like Billings and all of the box stores and the pavement. Bottomland is the most important thing for agriculture. You see all this bottomland being paved over and you know it is going to impact the river. It seems like poor design to me. (*Custer County Local Civic Leader)*

As commissioners, you are trying to promote survival of the community, which is economic development and expanding the community. That means jobs….Yes, we want the power plant and those 150 new jobs that pay well. How does that impact the farmers, the users of the resource? How does that impact the recreation? Sit down and give it serious consideration. We don't want to say, 'No, we don't want you here.' But we have to work to minimize the negative impact. As we grow the community, we are impacting that resource for recreational purposes in conflict with the Ag users. (*Custer County Local Civic Leader)*

Let's put…into this formula subdivisions and non-agriculture development. I see the hunting camps right on the rivers as possibly detrimental to downstream operators. Pump sites will get wiped out by passing houses when the river rises. How do we manage that situation? [By] private property rights alone? (*Custer County Local Civic Leader)*

My thought would be safety….If somebody does buy a 20-acre parcel and plans on building along the river, we are going to make sure that things are in place that they can't disturb the riverbank, and all those kinds of regulatory issues….[We will be] making sure that properties are developed in a way that is not going to create a bigger problem. (*Rosebud County Local Civic Leader)*

What great industry is going to come to Forsyth? What great industry is going to come to southeast Montana? Zilch….Our children are all gone because they couldn't find work….The land is cheap. If somebody wanted to build a factory here, and make whatever, and employ 50 people, that would be a great economic boom. But it would put a tremendous strain on this city to provide services because our water plant and our sewage plant…cannot support a factory's needs. That's the catch-22. (*Rosebud County Local Civic Leader)*

I think there is a potential, looking into the future, for industrial development. Coal generation plants that use high levels of water—they will need a source and the Yellowstone is right here….The question becomes, if we do move into the future where people have to make a choice, 'How can water be used?' Right now, there aren't tough choices being made. Everyone gets what they want around here. (*Custer County Local Civic Leader)*

There are probably issues out there that are waiting to come up, [that] would be my guess. From a planning board perspective, they rarely come up [here] because so much of the river is Ag. (*Custer County Local Civic Leader)*

The farmer sells land off down in the trees because he can't use it. Should we allow [the new owners] to put houses next to the river? How do we manage that? From a planning end, yes, we have producers and their way of life that we want to protect, and yet we have development issues that are non-Ag-related….We need a broader, multi-county, approach on setbacks. The amount of setback could be determined locally, by the site condition itself. (*Custer County Local Civic Leader)*

Nature Conservancy, World Wildlife, the Audubon Society—they're not in here making a ruckus because, at the moment, there's nothing of interest. The Elk Foundation isn't going to do any work here. Ducks Unlimited and Walleyes Unlimited are very active, but not in the sense of preservation, except for those particular species. There just flat out isn't the pressure at the moment. The pressure basically stops downstream from Billings, and there just isn't the pressure. (*Rosebud County Local Civic Leader)*

Make sure [out-of-state buyers] are educated….They buy it, supposedly, because they want a piece of Montana's peace and quiet and open space, but then they want all the convenience they had in California. We see that with subdivisions. We've got a couple subdivisions where people buy site-unseen, and they come up here and wonder…[why]

the pavement [ends]…and…[why] there's no electricity to their place? They have no idea how rural Montana is. (*Rosebud County Local Civic Leader)*

B. Local Values Support Local Control

[The Yellowstone River Conservation District Council] is going, and we need to do what we can to work within the system…to address the issues. The studies have been done….I think [we need to] get our say in here, and remain vigilant through this study. (*Custer County Local Civic Leader)*

I don't think we should be putting [decisions] into the hands of the [Yellowstone River Conservation District Council] because they…[operate] on soft money, and they may not be here in five years….I think…people rely on state laws….The Council can reinforce that. (*Custer County Local Civic Leader)*

We can always use examples of strategies that have proven to be successful in an area that is not that different from the area where we live. An example is the National Main Street Program….Miles City can look at a database of communities that have made these changes, and what the challenges were, and how they overcame those challenges. [The Yellowstone River Conservation District Council] could give us some models as to how we can manage the bottomland of the Yellowstone. How do we zone the area around the river so it is preserved for the kinds of activities that are most important to us, like Ag and recreation, [with] security against flooding, and [protection for] wildlife and fishery habitat?….[We need] some set of priorities that the [local community] can then start working on incrementally. (*Custer County Local Civic Leader)*

The [Yellowstone River Conservation District Council] could help with [the following] questions: Culturally, what does it mean to live on this river? How does the river affect the design of the bridges [and] the roads that either transverse or run parallel to the river? The kinds of structures?....Recreationally, what we do, here, on the Yellowstone is different than what they do between Gardiner and Livingston. There is a great deal of attention focused on the fly fishing and…the white water in Yankee Jim Canyon. That is great. Nobody would argue that that isn't an interesting, fun recreational pursuit. On the other hand, this stretch of the river has its own feel, and how can we potentially use this river for more languid floats, raptor watching, and warm-water fishing?...It is time to share some of the enthusiasm for the river and to adjust worldviews as to what that river is. It is not just white water, it is not just trout. It is warm-water, agates, and raptor habitat. It is all beautiful. Acknowledge it and…[raise] up the self-esteem of the communities [on the lower river]. (*Custer County Local Civic Leader)*

I would hope that as we move forward there is a huge amount of local input. It can't be Custer County [only] because [we] may impact the County of Richland. I don't want Washington D.C. making those decisions. (*Custer County Local Civic Leader)*

People have concerns. You listen to the concerns and try to provide an answer. You don't make up an answer; you don't say 'I don't know,'…and you don't say 'I'll talk to the mayor'….Most human beings…[are] not very patient critters, and so, when somebody has a concern, they want it addressed immediately. [But,] even in a small town, it takes time to get things done. The City Council only meets twice a month [and] you have a part-time mayor. (*Rosebud County Local Civic Leader)*

The growth policy [compiled by the Planning Board] is underway and due to be finished in the fall….It essentially tries to forecast growth and allow for some flexibility. The City Council's role is to become aware of responsible growth versus cancerous growth, and to direct that growth in a way that balances economic development and quality of life. Recreation would be included in that. That is where the City Council interfaces with the river. (*Custer County Local Civic Leader)*

C. Agencies Are Suspect

Federal money is channeled through Conservation Districts that are, for the most part, controlled by NRCS. That is the other real concern I have….The Council, whether we recognize it or not, may simply be a vehicle to take away local or state control and turn it over to the Federal government. (*Custer County Local Civic Leader)*

Landowners are getting extremely reluctant to allow people from the federal government to come in and inventory anything on their places....Landowners do not want more intervention on how they manage their property. As we move forward, we need to make sure that the inventory isn't used as a starting point for a change in management practices along the river. It is fine to suggest [new ways] and to tell people why it is important to do those things, but in my opinion it is not appropriate to force them to do these things….Our role is to help people understand the changes, not to dictate that they will change. I think it is appropriate to have control of things…[but] these federal mandates tend to get scary because, at the federal level, they are very gifted at the one-size-fits-all style of regulation. (*Custer County Local Civic Leader)*

There is a bunch of water that isn't adjudicated. They are holding [the rights] that nobody has laid claim to. As usage grows over time, there is liable to be more demand for the water….There is an excess of it that just blows by, but, in 20 years, it may be the people in St. Louis that will dictate how much blows by in the name of barge traffic. (*Custer County Local Civic Leader)*

D. Regulations Are Necessary, But Sometimes Late and Difficult to Accept

The question is, should there be coordination? And who's responsible for doing that? You can have a federal program, you can have a state program, you can do all that, [but] those only work if people want them to work. It has to come from the people. You cannot mandate that stuff….If this report ends up saying that there are a lot of issues and that there is no consensus, well, we already know that…There needs to be time to process and think about something and not make snap decisions. (*Rosebud County Local Civic Leader)*

You look at the flood issues in other states, and…[how they allow]development right up to the water[‘s] edge, is there something to be learned? Should we protect the riparian area? Should we be considering a setback as a tool?…The Red River Valley in North Dakota floods frequently and they go right back in and build again…. I hate having…[regulations], but you have to. If each county is different, how is that managing the overall river? I see a broader scope of application, either through the council [the Yellowstone River Conservation District Council] or state law, that would allow us [control and still] not get backed into the one-size-fits-all type of regulations. (*Custer County Local Civic Leader)*

One of the things that I have been working on and that I need to continue to work on is subdivision regulations. We have subdivision regulations, but thanks to the 2005 legislature, they changed some of those regulations. I need to be sure that our regulations meet legislature’s dictates. (*Treasure County Local Civic Leader)*

The agriculture industry is afraid that they’ll be banned from doing this, that, or the other, which might be the case if [some] groups get the upper-hand. (*Rosebud County Local Civic Leader)*

Nobody is going to do anything because, right now, there is not that pressure….You add up everybody in three counties here, and you don’t come close to the population of Ravalli County….Most people, when they think they want to move to Montana, they look at the ads in magazines or on television. You’re not looking at Forsyth or Miles City or Jordan….You see the Flathead Valley, you see the Bitterroots,…[and] you see the Bob Marshall Wilderness. That’s what you see…and that’s where the pressure is. (*Rosebud County Local Civic Leader)*

By the time you realize that [the community is changing], then you’ve got a mess on your hands, and that’s really too late. The agriculture guys don’t want land-use planning, and they don’t want to be told they can’t farm the flood plain because that’s the best ground, that’s their easiest access to water. And for years the irrigation method of choice was flood irrigation, which is the most wasteful, but it is the least expensive. It’s far easier to take the water out of the ditch and run it through the…pipe and send it down the rows, than it would be to buy pivots. (*Rosebud County Local Civic Leader)*

Those land-use planning…ordinances, or flood plain ordinances, or DEQ, or whatever the ordinance may be, people forget that it’s not just because somebody wants to keep you out of some place. And it’s not a situation of, ‘Well, I’ve got lots of money, so if my house is washed away, it’s my loss and don’t worry about it.’ It doesn’t have anything to do with that. It has to do with loss of life….And, if that gets washed downstream, it messes everything up, and scatters all that material in the river where it doesn’t need to go. (*Rosebud County Local Civic Leader)*

The planning board could adopt some zoning regulations that would describe which land-use possibilities would be along the Yellowstone, and it’s probably something that’s going to need to be looked at before long. Right now, we’re kind of in the mode of not a lot of zoning because we don't want to put a lot of restrictions on the property….We're thinking about how we want to proceed, but we haven't done anything because we want to make it so it's not restrictive. (*Rosebud County Local Civic Leader)*

The people that come off the ranch, and have had a great deal of latitude in terms of what they can do on the ranch…learn first-hand the statutes that control the city zoning and planning decisions….[Some of them] go ballistic or feel some real indignity….Part of the attitude is rooted in the economic scarcity [that] people who have lived here for generations [endured]….The good times come around so seldom and [people think] 'Let's make hay while the sun shines.' (*Custer County Local Civic Leader)*

[A setback requirement] is probably something that a county can do, but, on…a river like the Yellowstone, it would almost have to be multi-county in order to be effective. I think it's the Big Hole River in Western Montana where three counties went together and established a…[500-feet] setback for roads and power lines….The three counties got together and said, 'Let's do this.' So, for the lower Yellowstone, if it was multi-county, it would be far more effective. (*Custer County Local Civic Leader)*

Rather than a flat 500-feet setback, there's usually an identifiable meander channel where the river wiggles back and forth over time. And that could be the no-build zone.…[The no-build zone] would depend on the topography. We have some steep hills coming up to the river's edge, and there is no meander channel….[We could be] flexible…based on some criteria. (*Custer County Local Civic Leader)*

Powder River to Big Horn River: Recreational Interest Group Overview

Sixteen interviews were conducted with individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity. Participants were recruited from referrals provided by members of the Resource Advisory Committee of the Yellowstone River Conservation District Council. Participants were also identified and recruited by contacting various organizations such as Ducks Unlimited, Trout Unlimited, and the Audubon Society and by contacting local outfitting businesses.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Powder River to Big Horn River: Recreational Interest Group Analysis

I. Valuing the Yellowstone River

A. This "Isn't a Cabela's Fantasy"

This isn't a Cabela's fantasy….[We've] been making this three-day trip, annually, for 33 years….We build our own homemade canvas-covered boats….[and when] we poked a hole in one, we pulled over and all got to chewing gum and patched it on both sides. (*Custer County Recreationalist*)

It's scenic in its own way. We're kind of in the intermediate stage of the river. It's not a free-style mountain river, but it's not [like] Glendive where it looks like a channel. It's kind of in the middle. It has a lot of character. It's pretty diverse. (*Rosebud County Recreationalist*)

It's a prairie river; there's not much in the way of rapids. The river…can run muddy, but most of the year it is fairly clear. It has an abundance of wildlife; it's just great. (*Custer County Recreationalist*)

It's different every day, depending on what the weather is doing and the river is doing. In the area where I use it, it can be really clear or it can be pretty high and muddy. I used to do a lot of [catfish] fishing; I like the muddy part best. (*Treasure County Recreationalist*)

It flows through basically open country, wild country. Its beginning [is] there in the park, and then [it goes] up and down the agricultural centers of Montana. (*Rosebud County Recreationalist*)

[There is] constant change every time you go up or down the river—you look for the change. You will see gravel bars and trees that weren't there the year before. It is like going to a different movie every time. (*Custer County Recreationalist*)

It used to be that you could throw a rock to the island. Now, you had better be a flinger. Of course, when it takes it off one bank, it puts it on the other side. It can happen in 24 hours if the river is pretty high. (*Custer County Recreationalist*)

Well, it's a pretty big river for the way we think about rivers in Montana; it's pretty big:…meandering, lot of vegetation, trees, brush. I think it is a pretty river. *(Rosebud County Recreationalist)*

And cormorants, and seagulls…were never here before, so it's changed. And now we have osprey moving in within the last few years; the osprey are going crazy. (*Treasure County Recreationalist*)

I would describe it as an extremely diverse ecosystem….Obviously, it flows to the land, but it's quite varied [with] lots of wildlife, lots of fishing, and just beautiful vistas, and [it's] dangerous. But, to me, [it's] welcoming water. (*Treasure County Recreationalist*)

In fall, you have the colors of the trees…like you do in town, but [by the river] they are all natural….There are trees that are 100-years-old. There are willows and wild grapes. Those are fun. (*Custer County Recreationalist*)

We have a huge waterfowl population that uses that…deer. Riparian areas support upland birds, as we discussed earlier, songbirds, raptors, [a] huge population of raptors, and provides a tremendous water fowl hunting. To alter that, or to change that in any way right now, would be a national loss, a national tragedy. (*Treasure County Recreationalist*)

There are lots of eagles. I keep a record of all the stuff that we see. I should have brought my book in. It is amazing the difference in the amount of ducks and geese you see one year to the next. (*Custer County Recreationalist*)

So, a great population of eagles out there, bird watching….You see them every year. Tons of eagles—I can't give you a number of them. Every day we'll probably see one bald eagle or even a golden eagle and those…are tremendous. (*Treasure County Recreationalist*)

On the river, this time of year [mid-June] is pleasant, but it is an unpleasant misery. Ticks—oh my God, they are atrocious. You can pick a coffee can of ticks off you. You don't want to be running around in the brush with shorts or sandals because of the poison ivy. As long as you stay on the bank where it is bare, you are fine. It will get you in the winter time too….Earlier the ticks are worse, but you don't have to put up with the bugs. (*Custer County Recreationalist*)

We're dependent on the water from the river for irrigation purposes. (*Treasure County Recreationalist*)

B. The Many Recreational Uses

I just like the river because it's about the only thing in the county you have to do. This isn't a real hot spot as far as things to do, and I think when you grow up, when you learn how to fish when you're young, and you enjoy the water,…it's part of you. (*Treasure County Recreationalist*)

It's fun to go up there and roam around the territory that Lewis and Clark actually roamed in. (*Rosebud County Recreationalist*)

It's just so peaceful, whether you are walking beside it or on it. It's beautiful. A lot of people from Western Montana would beg to differ. You just get used to it. You find beauty wherever you can out here….You see a lot less people. So once in a while you will paddle past somebody's ranch, you can hear kids or cows bawling or something. (*Custer County Recreationalist*)

C. The River as a Refuge and "Seasonal Elixir"

It's a seasonal elixir for my obsessive compulsive disorder. I have two things that I might consider to be OCD: one is pheasant hunting and the other is river rafting. (*Treasure County Recreationalist*)

Focusing just on Treasure County, what I like about the river is that it provides a haven, a safe haven for waterfowl, which in turn provides this tremendous population base which we can harvest, and hunt, and recreate. (*Treasure County Recreationalist*)

Geese use the river as kind of a sanctuary and then they come back. (*Treasure County Recreationalist*)

I enjoy getting away. It's a good solitude, good place to go get away from telephones, sitting here all day answering phones for customers, and it's good to get out. I grew up with it. It's relaxing. You get away from the ordeals of your work. (*Treasure County Recreationalist*)

I spend a surprising amount of time just down by the river doing not much. My wife makes me pick asparagus while I'm down there. The other thing is the sense of solitude there. (*Treasure County Recreationalist*)

It's the quiet and the peacefulness of being down in that area along with the water. It's kind of a place that you can go,…relax and do the things I like to do. (*Treasure County Recreationalist*)

There's something real peaceful about being near the river, too. *(Rosebud County Recreationalist)*

D. The Free-Flowing "National Treasure"

I would like to keep the Yellowstone a free-flowing river. It is a national treasure. (*Treasure County Recreationalist*)

It's the longest free-flowing river in the United States. No dams, no water control on it whatsoever and, from that aspect, you know, that's what makes it unique. That, and the other thing that amazes people is the paddle fishing. (*Rosebud County Recreationalist)*

Without any dams on the river, it goes through a normal cycle like a river ought to, but the channel changes a lot because of that, a lot of new gravel bars come and go, and the river channel moves and changes. I put a boat ramp in here and five years later it's sitting on a gravel bar. So, you can't blame anyone for that, it's just the way it is. (*Rosebud County Recreationalist*)

I don't think that floods should be controlled. And the reason is [because] it cleanses the river. It provides sanctuary for the birds; it is a natural process. It is almost like a flush. It cleans off the gravel. It helps the spawning [and] provides a nesting habitat for particularly the geese on these big islands because the debris and junk will come down there, so it will protect them. (*Treasure County Recreationalist*)

Whether it is up in Park County or it's all the way down to Miles City, [it] should never have a dam on it. It's free-flowing, free-stone bed stream. And it has a wild and scenic designation. In fact, I think it is the only major river in Montana…or in the United States that doesn't have some kind of a dam on it. So, in itself, that is a national treasure, as far as the river goes. (*Treasure County Recreationalist*)

E. The River's Resources

I grew up waterfowl hunting in north central North Dakota, you know, which was as good as it gets, and I put this waterfowl hunt against anything I ever seen as a kid. I mean it's great. And people…say, 'Waterfowl hunting and Eastern Montana?' [They] just don't go together. *(Rosebud County Recreationalist)*

Not only is the waterfowl doing well out there, it's done that for 25 years. But also there's the fishery, you know, where walleye and smallmouth bass….They are wonderful. That fishery is being managed by Fish, Wildlife and Parks, and it's doing good. Whether that impacts Treasure County directly, I don't know. (*Treasure County Recreationalist*)

We have excellent goose hunting here…There's a…restriction or conservation easement for waterfowl on the river from the confluence of the Big Horn to the confluence of the Tongue River, and you cannot shoot waterfowl up to the high water mark of the river. So that's good and bad. It makes for good goose hunting, because they basically have a safe haven, but most of your goose hunting is in fields adjacent to the river. Ducks are a little harder, but areas with water away from the river…can be pretty good duck hunting as well. Sometimes you wish you could actually hunt them on the river, but you know that if everybody could, the hunting would be much worse. (*Rosebud County Recreationalist*)

In the mid-'80s someone said that red squirrels showed up on the river. We had never seen one before. They are good eating….[We hunt] whitetail, usually. Mule deer if we see one. We don't see many mule deer anymore. (*Custer County Recreationalist*)

We're right at the balance, I think now, between recreation and agriculture. If we switched from one side to another, we would alienate the landowner. That would hurt the access….Then we lose generations of future hunters and we lose those dollars into the economy, whether they go buy iPods, cars, or motorcycles, instead of buying fishing poles, and goose decoys, or something. I don't know. People will spend money. (*Treasure County Recreationalist*)

We've seen programs, like the equipment program, that encourages farmers to go to sprinkler irrigation systems and provides funding to replace flood irrigation as a more efficient means of irrigating crops. But I don't know necessarily if it's had the effects that they wanted it too. I see a lot more farmers, both on the Tongue and [on] the Yellowstone, flopping a pump in the river. There are a lot more acres that are under irrigation than were ever irrigated before. I think the overall use of that water has gone up versus being conserved. And that's at the taxpayer's expense. (*Custer County Recreationalist*)

F. Dangers

It's a very dangerous river. (*Treasure County Recreationalist*)

II. Access Dilemmas: Demands, Limits and Controls

A. Increasing Uses and Overcrowding

With more population in Billings, we're seeing more people coming down this way to use the river. (*Treasure County Recreationalist*)

We have been doing it a long time and the traffic anymore….They have big, fancy boats, jet boats….There was one that came by us last year that was as big as a school bus. I thought we were going to sink. It is not rustic anymore. They…[aren't] hunting. (*Custer County Recreationalist*)

Last year it was nice, but we saw more people than we have ever seen. (*Custer County Recreationalist*)

There's a,…I don't know the word I'm looking for,…a desire, you know, to be in touch with nature….We all have it. *(Rosebud County Recreationalist)*

B. Montana's "Sacred" Public Access Law

Someone once told me, and I am not sure this is true, that our access law is based on what Lewis and Clark did when they came up the Missouri. They mostly stayed on the high water mark, and we protected the access. That is very, very sacred. (*Treasure County Recreationalist*)

Montana has always prided itself on access. (*Treasure County Recreationalist*)

Montana is blessed. We are blessed because we have a tremendous access law….Compared to Wyoming and Colorado, this is paradise, because people can walk up and down the high water mark and not be trespassing. In Wyoming or even in Colorado, the landowner owns the riverbed, and, theoretically, you can't drop your drift boat anchor on his property because you'd be trespassing. (*Treasure County Recreationalist*)

One more thing you can put under important items is Montana needs to maintain its stream access law. That's real critical, although there are plenty of landowners who would like to see it go away. (*Custer County Recreationalist*)

It seems like every couple of years, someone takes a run at the stream access law, and that's pretty important to our way of life….The riverbed is public property, [and] a pretty big asset to us. And, if they take that away, that would pretty much put the kibosh on most uses of the river. (*Rosebud County Recreationalist*)

I think that…having public access along the river in different places is a huge thing. I think that's important. (*Treasure County Recreationalist*)

Block Management is a wonderful program. It benefits, obviously, the hunter; it benefits the landowner, and it also benefits the game, too, because it disperses them. It's not all crowded into closed-off areas. (*Treasure County Recreationalist*)

C. Problems with Access: Abuses and "Little Kingdoms"

Sometimes big money from Denver or other places will come up and try to get the same laws that they have [in those other places] in order for the landowners to protect their little Sherwood Forests, their little kingdoms. You know what I am saying? We can't lose [our access law], we just can't. We depend upon that. (*Treasure County Recreationalist*)

And [there are] people that live in the country on 20 sections that have a place to hunt, but won't allow people to hunt because of how they've abused it or whatever reason. And I could give you examples all day long about that kind of stuff, but there is still a need there for the service that's provided by the Fish and Game or an outfitter. *(Rosebud County Recreationalist)*

In 1980, access was virtually unlimited. All I had to do was go to the door or call up and 'You bet, wherever you guys want to go, that's fine.' As we progress through a quarter century more and more hunting pressure is out there. Hunters are getting better, decoys are better, camouflage is getting better, birds are getting tougher, and access is getting tougher. (*Treasure County Recreationalist*)

What you are seeing now, not only in fly fishing but also in waterfowl hunting, our youth are not getting involved in that as much. The reason I think is twofold. One [reason] is that access is a problem. (*Treasure County Recreationalist*)

Harder access—access is much harder as it is everywhere. (*Rosebud County Recreationalist*)

I think probably access to the river [is a problem]. I know farmers and ranchers that have unauthorized people going through their place for hunting and fishing. We could probably use more access sites. (*Treasure County Recreationalist*)

[We're seeing] primarily out-of-state, big money coming in to buy their little piece of Montana and they don't want to share it with anybody. (*Custer County Recreationalist*)

They want their piece of Montana and it's theirs, I guess. Ask Ted Turner or some of those ones in the western part of the state. You know, there…[are] a lot of new landowners that have blocked access on the streams. (*Custer County Recreationalist*)

D. Privatizing "Prime" Hunting Land

We're seeing that jealousy. The rich people can go hunt on all this prime land, but the guy that lives here and drives the school bus can't get in on the property because he doesn't want to pay to do it. (*Treasure County Recreationalist*)

[Access]…is getting harder all the time. That has changed. It used to be you could go anywhere pretty much. Now places are getting bought up for the purposes of their own hunting. It is getting tough to find somewhere you can hunt. (*Custer County Recreationalist*)

We are probably fortunate in the fact that we have been doing it long enough that we know everybody that owns the land so we kind of have an out. That changes with time as some of them are being bought up solely for their own hunting. (*Custer County Recreationalist*)

Say the landowner has some really good whitetail hunting [and] wants to be able to control that, even though the deer are owned by the State of Montana….Everybody could hunt when we were younger…When people started getting better hunters and getting big deer, all the sudden, the doctor from Billings comes in, buys the rancher something during the year, gives him some gifts. It has gotten to be a money deal. (*Treasure County Recreationalist*)

I suspect that access will be harder in the next decade, as far as hunting, as far as getting permission to go, whether to go out pheasant hunting, coyote hunting, [or] deer hunting. I envision Block Management to be even a bigger thing out there. I think that is a good program. I would pay more in license fees in order to make sure that big ranches don't close off huge sections of land to the average guy. I am a big supporter of that. [Now it seems like] five or six sections are closed up by someone who has leased it to an outfitter. (*Treasure County Recreationalist*)

I've heard other people saying it is more difficult. I mean, [with the] guides getting in there, tying up areas, paying off the ranchers to keep everybody else out. I think if I lost the ranchers and farmers I know, it would be tougher to get on. (*Rosebud County Recreationalist*)

The only hindrance I can see is more guides [and] outfitters coming in. I don’t see the recreation potential diminishing any. They say there’s not a lot of growth out here in Eastern Montana, unless they build a power plant somewhere up on the river somewhere. (*Rosebud County Recreationalist*)

E. Decorum: Respecting Others and the Resources

It seems like the property owners adjacent to the river are excellent stewards of the land and guard that as an incredible resource. I would say from the types of things I do is that there are people who disrespect it, and do not treat it well, and should be killed or thrown in jail, or worse. (*Treasure County Recreationalist*)

[Just] like everybody, out of 100 hunters, one of them is going to do something stupid, and that’s the one they remember and makes a bad name for everybody else…It’s up to the rest of us to police them and to keep them in line, which we do pretty well, but people are people. Not everybody has the same value system that we do. They just don’t care; they’re here for months in their life and they’re gone. They don’t have to live with the repercussions. (*Rosebud County Recreationalist*)

Those people that just want to be turned loose on your land are the same kind of people that have the mentality that when they walk up to whatever they have harvested, an antelope or a deer, and it isn’t big enough, they look around and say, ‘Well there isn’t anybody watching, let’s get another one.’ There’s a problem with that kind of thinking. And I’ve seen it 20 times in 20 years. *(Rosebud County Recreationalist)*

You often hear that from old-timers talking about the good old days. Well, today is the good old days, too. It’s just requiring you to be a little cleaner, a little tighter. We use steel shot in order to protect the birds out there….As far as the eagles, we don’t want to lead up a goose, he goes to the river, and then the eagles would eat him. (*Treasure County Recreationalist*)

Let’s say for example, that a fisherman is fishing a hole, and [there’s me]…and my raft, or somebody else coming from the other direction upriver in a power boat or jet ski. They see the fisherman, cut it, give him a wide berth, give him as much room as you can, so it goes back to courtesy and respect, which will get you further faster than all the laws in the world. You can’t legislate courtesy. (*Treasure County Recreationalist*)

The hunting on the river is vague. You are eligible to go as far as the high water mark. I have talked to umpteen officials about the high water mark and they all have different answers. (*Custer County Recreationalist*)

Now you get back to the conflict of the people, the guys that own the land along the river, and these boats and hunters. You hear stories of hunters and farmers clashing because who knows who owns the island and who owns what land, was it an island two years ago and now [what] is it this year. That type of thing has been a problem. (*Treasure County Recreationalist*)

There is a guy that is on the south side,…the section marker is on the north side and the guy that has possession on the other side paints all of the trees. The guy on the other side told me I could hunt there. It is too much hassle to fight it. You just make everyone mad if you do that. (*Custer County Recreationalist*)

I've seen more orange paint. That increases every year probably. It indicates 'No hunting', or 'No hunting without permission.' It's just a way for landowners to mark their lands to tell you to stay off or to come ask. You don't know one way or the other until you go ask. (*Custer County Recreationalist*)

I would like to see the state or an appropriate entity, typically the state, develop more fishing accesses, because it gives the public a clear authorized way to get to the river, which keeps them off of private land that they're not supposed to be on. So, the more access that's given, the more chance they have of using it and respecting private property rights and landowners. (*Treasure County Recreationalist*)

People just don't care….All the way down to micro-trash, which can be flip tops, twist ties [or] cigarette butts. Just pick it all up. And, most of the people I go with, if there's something that has been discarded, they'll pick it up. (*Treasure County Recreationalist*)

Having respect for the riparian areas….I think most landowners do respect it and do a great job. (*Treasure County Recreationalist*)

Common sense ain't too common. *(Rosebud County Recreationalist)*

III. Shifting Scenery: Development Along the Riverbanks

A. Homes on the Riverbank/Flood Plain

I hate to see the river banks over-developed by many ranchettes and farms and that sort of thing, because that has a large impact on the slightest amount of habitat. So, I think that, in terms of management, if you want to talk about some statewide zoning, maybe there needs to be a river corridor or a subdivision that is managed. (*Custer County Recreationalist*)

Encroachment of people into the river valleys, you know….That's where I think, maybe, you're getting more of the demand for people to stabilize those river banks because, of course, you've just bought your 100 acres or 50 acres and the river runs through it and you don't want to see it washed down to Billings. (*Custer County Recreationalist*)

It's not overrun so much that it isn't wild anymore. If it comes to…[that] point,…[they'll] regulate who and how many can be on it. (*Custer County Recreationalist*)

Decisions would have to be local, but it's going to be tough for a community—for Treasure County or Prairie County—to come to some sort of a regulation. I can see the Council coming up with a template, 'Here is a riparian management scheme regarding development'….Then the county can take it…[and] rebuild it to what their needs are….In Prairie County, they may have concerns about putting feedlots down in a flood plain….That may not be a problem in Sweet Grass County [where] they're worried about houses….[We need some] kind of a template on developing things that will impact that zone. (*Custer County Recreationalist*)

When you get a lot of people on there, they have septic tanks and different things that they all manage their private 20 acres for….One guy might prefer a nice green grass lawn down to the water's edge and another person might just want it natural…So, that needs to be managed. (*Custer County Recreationalist*)

Either to protect their interests or how they want the river to be, [some people] need to get involved and recognize the more development that occurs on the river, the more impact we're going to feel….From the perspective of living here in Miles City [ask] 'How is that going to impact us?' With unbridled development, you could have a situation where the problems are prevented from occurring upstream, only to be exacerbated downstream. So, that's where we would have to take a look [and ask] 'Are we sufficiently protected with the dike system we have here or are the neighbors here going to suffer because we are sending some of our problems downstream too?' (*Custer County Recreationalist*)

I could take you up the river and show you a foundation where a person built a house next to the river. Because of a bad thunderhead and a cloud burst, he had to get a boat to get out of the house. I mean,…it came right to the foundation. It didn't take him long to move that house, and that same house is on top of a hill in Forsyth because he didn't want to be next to the river. *(Rosebud County Recreationalist)*

I think we're going to see more and more of those small acreage pieces—people who bought their piece of heaven. Maybe not so much down there to build a house on, but bought it for recreation purposes and maybe pull their camper down there. (*Treasure County Recreationalist*)

I see a lot of people that are moving to live next to the river because of the prestige, or pristine beauty of it. [They are] making the rules when they don't understand what an ice jam can do, what a spring flood can do, or [anything about] the Big Horn Dam dump. And they're going to…[need to ask] those people [who've lived there longer] why they can't do that. There is no historical knowledge to promote common sense. And it's going to cause some problems. *(Rosebud County Recreationalist)*

When that fire went up in Red Lodge six, eight, ten years ago, every one of those people was losing their house, yet *their's* was the most important….Firefighters were shipped in from who-knows-where….[People were saying,] 'You've got to protect *that* house'….Nobody had any control over it except for the person that went and built the house there in the first place. *(Rosebud County Recreationalist)*

People are plumb content with not knowing....[They don't want to know the hazards.] *(Rosebud County Recreationalist)*

B. The "Wonderful" Cottonwoods

Those cottonwoods will grow three to four feet in a year on those gravel bars. (*Custer County Recreationalist*)

I have seen farmers take a wonderful, old…stand of cottonwood [and bull]doze them right into the river, so they can farm right up to the riverbank. That's something that I understand what they are doing, trying to increase their farmable acreage. But what are they really doing? Those cottonwoods are there probably helping that farmer more than what he realized. (*Custer County Recreationalist*)

The other thing you see is the removal of the cottonwoods replaced with farm drills. Anytime you take out the woody vegetation and replace it with…whatever, alfalfa, or wheat, or crops, you're putting those lands at risk. You know, especially the willows along the stream bank. (*Custer County Recreationalist*)

Mother Nature does some erosion control by putting some trees in the water, bushes and…things like that. We have seen a decline in cottonwood trees in our area. I think that's from chemicals and stuff in fields. Those cottonwood trees don't grow, so that takes away some of your growth and therefore erodes some of it….You just don't see many cottonwood trees around here anymore. (*Treasure County Recreationalist*)

It tends to cut, even in places where you think the bank should be stable. We have some huge cottonwood trees that went down this year. You'd think those trees would hold that bank, but they don't. (*Treasure County Recreationalist*)

C. Inadequate Weed Management

The weed problem: We're getting a tremendous invasion of Russian olive, salt cedar, there's always been some leafy spurge kind of weeds there….We're getting a new invasion of salt cedar that we haven't seen before. (*Treasure County Recreationalist*)

IV. Ideas About Erosion and Rip-rap

A. Erosion is "What the River Does"

I don't know if you'd call it a problem or not. That river is very active; it moves a lot so it's always cutting banks and moving things around a lot. The ranching part, the farming part of me looks at that as, 'OK, what's it going to take next?' I don't particularly worry about it. I don't see it as a problem….It does what it does….I look at a cut bank here, and [know it] deposits something down there. It gives and takes. (*Treasure County Recreationalist*)

It will always try to find its natural way. (*Custer County Recreationalist*)

A lot of the erosion is natural and just ebb and flow. (*Custer County Recreationalist*)

That is [the river's] own renewal. Yeah, it does eat away at the bank, but that's the nature of that. Again, nature is the operative word; it's natural. I guess I don't see a benefit to try to control something that is that big and powerful. (*Treasure County Recreationalist*)

I prefer it not to be stabilized because I think we need that flood plain to be utilized by the river. It's there for a purpose; even though floods impact a lot of people, it has a lot of benefits too. It recharges the soil. It spreads out water so that floods aren't as severe downstream. So, the more we stabilize our banks, the more we armor them, the more intense the flooding will be downstream. So, that needs to be managed. There must be a master plan for managing bank stabilization. (*Custer County Recreationalist*)

I think it is a natural process of that river system. Islands [are] made, [and] islands disappear. I just think, [in] really high water, erosion is a natural process along that river. (*Rosebud County Recreationalist*)

I think one of the things that people are not ready to accept is that it takes a little longer to build those new areas than it takes to cut them….All [of] the sudden, there's three acres that went in the river. There's a new gravel bar down there that will gradually turn into a useful piece of land. You lose that in a week, or month, or summer; that other piece doesn't become useable for several years, but it's there. (*Treasure County Recreationalist*)

My brother-in-law that lives down there says we've lost 90 acres right here. And I compared the photos that the Conservation District Council has put together, and it compared 50 years ago to today, and we've not lost 90 acres; we've maybe lost 20 acres in one area and gained 20 or 30 or 40 in another area. It's hard to see that because what you've gained is not mature cottonwood gallery area, like what was lost. (*Treasure County Recreationalist*)

B. Rip-rap and Its Effects

The other fight is when you start talking about bank stabilization structures. It's easy to say I want to protect my little piece, and who cares what happens down river. It's not my problem. (*Treasure County Recreationalist*)

They keep saying plant trees to stop erosion and the best rip-rap they have ever had is old cars. They have been there forever and they are mashed but they are still there. (*Custer County Recreationalist*)

He did put in big pieces of broken concrete [for rip-rapping]. They bedded it in and that has helped. He got into some kind of battle with the Fish and Game over that. (*Custer County Recreationalist*)

Well, it can stabilize the bank, but you're changing the hydraulics of the stream, so you're going to get a change somewhere else. You're going to deflect it somewhere else or change the deflection somewhere else…and it's going to be hitting the bank differently someplace else. (*Custer County Recreationalist*)

When the railroad came through there, they put stuff in and rocked stuff and some of that stuff is still there. I don't think it had a detrimental effect. (*Custer County Recreationalist*)

It's a good place for fish to hide. It's good stuff. Throw in a few wing dams here or there, and we'd have some better fishing. (*Rosebud County Recreationalist*)

Leave it like it is. It has been working pretty…[well] for quite a while. I say that the old cars are the best rip-rap they ever had, if it is up against the bank. We have been looking at them so long, they aren't unsightly to us. (*Custer County Recreationalist*)

And the rip-rapping down there doesn't seem to have much of an impact, whether it is on the waterfowl or whatever. (*Treasure County Recreationalist*)

If you start channelize-ing that river…is it a free-flowing river? I don't think so anymore. And that argument could go clear up to Park County and where they have done some extensive rip-rapping in order to protect those spring creeks up there. (*Treasure County Recreationalist*)

Definitely, they should not be using old cars or junk or tires that move suddenly. [They] are dangerous and don't stay where they are put. I'd just as soon not see concrete with rebar. I'd just as soon not see concrete at all. If they need to stabilize those banks then I'd just as soon see them use some natural rock or try to establish vegetation to do that. With a river like the Yellowstone, you're never going to get vegetation to hold the Yellowstone back anyway. But, if they really, really have to do it, I'd say hard, natural stone is the best way to go. (*Custer County Recreationalist*)

I kind of like the idea instead of armoring the banks, use barbs or jetties to try to move the velocity of the stream…you got to take into account the nature of the force you are dealing with, the water. Some techniques are just going to be less impacting, dealing with that hydraulic force, and they are going to be more effective. (*Custer County Recreationalist*)

Landowners put rip-rap or whatever….You just cause the problem to shift somewhere else. I think if you are fortunate to own land on the Yellowstone that you ought to take what it gives you. (*Rosebud County Recreationalist*)

C. Restraint and the Possible Uses for Rip-rap

You should see the springs; they are a national treasure you have to protect. I've seen rip-rapping, maybe along a quarter mile on the Yellowstone, in order to protect the field. I don't know if that is right. Personally, I think that is wrong, but in order to protect the springs, I think that is probably the right thing to do….If the Firehole River was threatening Old Faithful would they rip-rap it? (*Treasure County Recreationalist*)

But it's like they're taxing people that live along the river…because they happen to make their living there….I'm not saying…there doesn't have to be some regulation, because there will always be that case where somebody's being 100 percent neglectful and harmful to it. But, for somebody to just do something like put a barb in to preserve what he has,…I don't think you ought to begrudge that or make that system as tough as it is. (*Rosebud County Recreationalist)*

Rip-rapping is highly controversial because agriculture is such a big part of Montana. If a rancher loses a huge hay field, that's irreplaceable to him; he's out of business. If he's out of business, then Montana doesn't get that. The Yellowstone River is a free-flowing stream that brings huge amounts of recreational dollars to Montana. Fly fishermen come from all over the world to fish this river. So, what is right, what is wrong? I think that the rip-rapping should only be in areas that would protect the spring creeks and the rest should not exist, unless it is a highway or a bridge, or something that we need to protect them for public safety and access.…You see, [there are]…tons and tons of rocks dumped in there, forcing the river off to another direction. And some rip-rapping will force the river [to be] somebody else's problem. They have to, in turn, address that problem.…We don't want a Yellowstone River that is all channelized all the way down to Miles City. I mean, we just don't do that. (*Treasure County Recreationalist*)

There must be a master plan for managing bank stabilization. The goal should not be to just totally armor the banks so we don't lose any soil….My goal would be to take a good, hard look to measure the benefits against the losses. Determine if it is needed. If it is simply a matter of one fellow losing his real estate that might fit in the equation, but there would be some other factors involved, too, you know. Because if you are going to lose it on one side, you're picking up on the other. If one guy loses, the other gets it, so it kind of balances out. So, you measure that against what is to really be gained….You need everybody's input and their perspective on how it is they think that should be managed because there may be some unique variables that they're familiar with that everybody else doesn't have to deal with. (*Custer County Recreationalist*)

I guess you have to divide up the impacts to that river from the most serious to the least…and the most serious potential impacts, [like] pollution, would be tops on the list, I would guess. [Those] should be regulated, and then it would move down the ladder from there to the voluntary practice. So, I'd say pollution at the top of the regulatory scale, and at the beginning of the voluntary level. Yeah, there should be a river rider. You know, it would be nice. (*Custer County Recreationalist*)

D. Rip-rap Does Not Work

Some of the fields we hunted were flooded, and actually, crop-wise, destroyed. It went over the rip-rap and flooded their fields. (*Treasure County Recreationalist*)

I don't think they are going to be able to say, 'I am going to keep this point where it is.' [Not with] rip-rap or whatever….They may stabilize it there, but they will move it somewhere else. (*Custer County Recreationalist*)

It used to be rip-rapped down there, but the river got behind the rip-rap, and that's what's happening. There used to be a Burlington Northern pumping station down there, and the river was all rip-rapped. They abandoned their water pumping plant. The water cut in behind the rip-rap and it's chewed up acres and acres of land. It's come in 300 or 400 feet into the bank and it's still chewing. (*Treasure County Recreationalist*)

This is a coldhearted thing. You bought…[land] next to the river, and stuff happens…..It is kind of cold, but,…dependent, on how they were looking when they bought it, [they were as likely to] gain some acres as they were to lose some. The idea of putting in rip-rap, or doing a lot of monkeying around in the river, I don't think it's a good idea. You can save that small piece of acreage, but when you start pushing that current around somebody else is going to be effected by that, and you don't know who downstream is going to lose their piece of heaven that they bought. (*Treasure County Recreationalist*)

E. "Money Talks" with Bank Stabilization Projects

It's a shame, because money talks…and with a local board you get that good old boy syndrome. It…[isn't] what you know, but who you know….The board's project is more important than the guy down the road that had his paperwork in a day later. And that's the biggest problem….[We] have to take the money aspect out of it [or] regulation won't work….Unfortunately, we're in a world where money rules. *(Rosebud County Recreationalist)*

F. Other Bank Stabilization Practices

I've tried to convince those guys to stay off of those [river banks] in the summer with livestock. What will build those bars is willows that come, but if you have cows on them all summer, then they won't. (*Treasure County Recreationalist*)

Higher up the river, I see more of the weirs…a little more subtle stuff. But there is a tendency to dump rock in the river,…[and my objection] depends on what it is. If it's natural stone—not really. If it's concrete, it doesn't look nice, and [the] goofballs who leave the rebar sticking out of it aren't too nice. (*Treasure County Recreationalist*)

V. Sympathies and Concerns

A. Agriculture: It Ain't for Sissies

Agriculture: it ain't for sissies….We're talking again about guys that are making a living off the land. They are not, for the most part, wanting to harm what they have going. *(Rosebud County Recreationalist)*

When we lease the property, we do it for a couple of reasons. One: for ourselves [and] to secure a place where we always have a place to go to hunt. And our second reason is that…the rancher we know is having hard times right now with the fuel [and]…the cattle prices [are] fluctuating back and forth. (*Treasure County Recreationalist*)

The number one priority to me,…when you boil it down,…has to be agriculture. That's who puts the food on the table. When we start impacting their ability to produce and keep food on the table—…they have to be our first priority. Whatever fix comes down the road needs to be shared by everyone, and probably come from tax dollars because everyone benefits from what they produce. And if there's some practices that can be identified they can institute right away that aren't going to hobble them up too bad, well, let's do it. (*Custer County Recreationalist*)

The biggest concern is not that there won't be any recreation. The biggest concern is there won't be any agriculture. All your eggs and vegetables and produce and meat…[will]come from Brazil or Australia where…they're light years behind this country as far as inspection and chemicals….I mean, there's big chemical companies…selling chemicals that have been outlawed in this country for years to those people, and now they want to sell us the food. I mean, we're back to second grade math. *(Rosebud County Recreationalist)*

To Montana, we need the agriculture. That's what we are up here. We don't ever want to lose that heritage. And they can co-exist. (*Treasure County Recreationalist*)

The people that are making a living up there, trying to keep their family farms and ranches going—they should have priority. They were here first, living a unique lifestyle that seems to be slowly dying. (*Rosebud County Recreationalist*)

The Ag culture, for the area, I think is waning, even though the majority of the land use is agriculture. The idea that whatever farmers want to do they can do is probably waning. (*Treasure County Recreationalist*)

If you don't make a living, you're had. So if the regulation infringes on making a living, then I don't necessarily agree with it. *(Rosebud County Recreationalist)*

They go hand in hand....I say it's 50-50. I do. Agriculture needs it as much as we need it. It's not a position of 'them' versus 'us.' My interest is recreational, but I also want agriculture to do well because them doing well allows me to recreate….We just don't want any battle. It would be so unnecessary. It's worked before; we can work together. It's good for everybody. (*Treasure County Recreationalist*)

B. The River Corridor

To me, the river corridor is almost in three pieces. You have the river itself. You have the immediate riparian area that is river-influenced. And then you have the cottonwood corridors that are turning quickly to Russian olive corridors, some wetlands associated with the river, that kind of thing. It's a relatively narrow strip in most places. And then you have irrigated fields that are directly adjacent to that riparian area. That boundary is flexible depending on who wants to do some modification of the area. I think that corridor has to include the Ag areas that are immediately adjacent to the riparian areas because there is so much influence to the wildlife and how the river operates based on those fields too. The deer, for example, living in those riparian areas use the heck out of the Ag fields and depend on them. (*Treasure County Recreationalist*)

I would think it would be similar to, like, a highway and you know you have a traffic way. And the traffic way is between the fences on the road. It's between fence-to-fence. It is the corridor for the public to use that way….I would think a corridor is probably the whole Yellowstone valley. You know, as it flows out of Yellowstone Park and comes down to Sidney, all the way down there, to its convergence with the Missouri, that's the corridor of that river. It's the valley. (*Treasure County Recreationalist*)

Well, if you're going to say corridor, you're going to have to define the boundaries. Is it a one-half mile or a mile either side of the center line of the river? [Will] that distance be consistent or will it depend on whether you're on public or private land? (*Custer County Recreationalist*)

The water, I mean, it has to have riparian vegetation, the type of vegetation that you associate with the different riparian zones. (*Custer County Recreationalist*)

Grazing is the one big management concern. If you overgraze it, you're taking out the important riparian vegetation, and livestock are breaking down the stream banks. Yes, that's a very common problem….It'd be nice to have better livestock management along the river so you can return the riverbank back to its real riparian-type setting. (*Custer County Recreationalist*)

Designating a river corridor and keeping in that corridor? So, the minute it starts to wander out of that corridor, they fix it. Is that what you mean? Maybe environmentally speaking they set up this corridor and nobody can touch it—it's off limits to any industry. Is that what they mean? So they can maintain it as a wild river? (*Treasure County Recreationalist*)

The riparian area is what I would call the difference between, let's say the low water mark and the high water mark, and places where there is a transition between the land and the river itself. And that can be marshy areas that hold an incredible amount of wildlife. It's all unique plant life, and that sort of thing. Those types of areas, let's say a marsh area, for example, I know there's laws that guard against draining those areas and bothering those areas, at this point I think are largely effective. (*Treasure County Recreationalist*)

C. Attachments

I'm attached to, and pulled into, the kind of lifestyle that keeps me…around the river, or with agriculture. If you don't love it, you won't stay. You won't last. *(Rosebud County Recreationalist)*

It's just been a part of my life. I lived by it when I was a kid and I live by it now. My wife and I have decided we're going to stay here because we like it here beside the river. When we retire, we think we'll stay right here. *(Rosebud County Recreationalist)*

One of the treats I get to experience is I get to cross it twice a day, to and from, and I watch the river to give me indications as to what's going on in the world: river height, color of the river, etc. (*Treasure County Recreationalist*)

I used to be in farming, and it's very important for irrigation purposes. And now that I live in town, we need the river for drinking water, and sewer, and watering our lawns and gardens. It's very important to us. *(Rosebud County Recreationalist)*

I want it to just be itself. You don't have designated campgrounds….You can pull out on an island and camp. (*Custer County Recreationalist*)

D. Guides and Outfitters

But doesn't it help the State of Montana? My argument is that if someone who is inexperienced and does not know the river [and] doesn't know how to fly fish comes to Montana and goes onto our streams and has a mediocre time and is disappointed because of what he sees and what he does [he won't come back again]….[But] if he hires a guide and has a tremendous experience,…he comes back, year after year after year….Those client bases not only bond friendships together, but also provide a tremendous economic resource for the State of Montana. (*Treasure County Recreationalist*)

Say, if I was not a guide, and I was just an angler out there and the guides, they know where to go. They got the best spots, they know how to catch fish and that's their job, to take care of their anglers. Does it detract from my personal experience? I could say it probably does, to be honest and objective. Especially if I was having a bad day, it's easier to blame the guide for your bad experience than to maybe focus on your own skills and your own lack of skills in order to provide a quality experience. (*Treasure County Recreationalist*)

That's what I mean. It's not rich guides cutting a fat hog at the public's expense. People need help. (*Treasure County Recreationalist*)

E. Concern: Water Quality

My number one [priority] would be [to] keep the river natural and clean. Then it's going to take care of itself. The vegetation is going to grow. The fish are going to reproduce.

There's going to be good water for all the cities and farm ground. So I think the main issue is keeping the water in as natural a state as possible, not like a dam. A dam puts pretty clear water out because the silt is on the other side of the lake. As much as you can, keep it natural the way it is, and keep it from getting polluted. (*Treasure County Recreationalist*)

Discharges to the river need to be carefully managed, like coalbed methane, and we are working on that. (*Custer County Recreationalist*)

You might want to take a look at spill response on the railroad. The railroad parallels that river for a long ways, and if you have a train wreck, how do we get to that stuff? It's pretty isolated, rural, most of this point. How do you get to it? Is the railroad in a position to get materials on that river to sop anything that's spilled into it? Probably not. And that railroad ownership changes hands from BN Santa Fe to Montana Railways, so really, [you've] got two railroads that traverse the Yellowstone. (*Custer County Recreationalist*)

Rivers age, and as they [age]… [they change]…from a clear cold water to a slow, warm, less oxygenated [river]….But that's a slow process. (*Rosebud County Recreationalist*)

I don't think pollution is a problem. We have enough environmental boys looking after the pollution problems….A lot of the pollution, like mercury, is naturally occurring in the river. Most of it comes out of Yellowstone Park, out of the geysers and hot springs, so that's where the mercury gets into the fish….Save a fish, stop a geyser! (*Treasure County Recreationalist*)

F. Concern: Agricultural Runoff

I suspect that a lot of our fertilizers and poisons and stuff get into the river. I don't think that's good….[It comes] from agriculture, [but] not just agriculture…from our town [too]….We need to educate everybody more on all that....Everybody used to [think] more chemicals will do the job better, but that's not necessarily the case. People need to be knowledgeable about what they're putting in there….I think they're getting better, but people are still thinking a little bit more is better….It's hard to get people to understand that. (*Treasure County Recreationalist*)

I don't necessarily care [about] irrigation water coming in. It's the runoff from the field, [and it's] all silty, but that's minimal. And you realize that people are making a living… doing what they're doing, and it's not like it's a huge amount of pollution. But I'm not sure how good it is for aquatic life. (*Treasure County Recreationalist*)

Irrigation water [is] being dumped back into the river that…might be saturated with pesticides. It might have excessive fertilizer that would alter the chemistry of the water. Pesticides [are] killing the mayflies, the aquatic insects that the fish need in order to survive. It is the fertilizer supercharging the phosphates and nitrates unnaturally that chokes off, that depletes, oxygen supplies….How do you fix that? I would like to see some kind of regulation where ranchers cannot dump drain water back into the river. I don't know how….The sprinklers help. Sprinklers are wonderful and I support that. (*Treasure County Recreationalist*)

Any time that we dump pesticides and fertilizer back into that water we have a potential of ruining our state heritage. (*Treasure County Recreationalist*)

Agriculture is important to me but, just having been on the river, one thing I have noticed with my background is that a lot of the irrigation water that is put on gravelly terraces eventually makes its way back into the river with a lot of salt in it. [This is] because there is always an interface where that gravel is sitting on top of bedrock….The river is becoming saltier from that. (*Custer County Recreationalist*)

[Those] feedlots that they put along the river—I know they've got rules and regulations on those, but those are bad. *(Treasure County Recreationalist)*

It seems like the feedlot runoff is not being regulated very well. If you look at the size of feedlots now, they are huge. You can see one on the north side of the Yellowstone, a big brown streak running right parallel to the river. I mean, where's all that runoff going to? (*Custer County Recreationalist*)

I've been to public meetings on coalbed methane.…The farmers from around Glendive were commenting how salty their Yellowstone River water's become. And they are blaming it strictly on coalbed methane. I think that there's some impact…from coalbed methane, but there's some impact from agricultural practices that they don't want to fess up to….It's there. I've seen it. (*Custer County Recreationalist*)

What effects, if any, does agricultural runoff have?...I don't think it's really hurt us much. It seems like we're isolated from all that. Part of the biggest demand on the river is irrigation. (*Rosebud County Recreationalist*)

[Irrigators] are going to be forced to use more efficient uses of water. They'll be looking more at what's in the return flows, dumping…[fewer] fertilizers and pesticides back in the river from Ag use. I think that's needed. (*Treasure County Recreationalist*)

G. Concern: Management Strategies

Anytime you get something that…[needs to be regulated], it should be done by the people that are affected. (*Custer County Recreationalist*)

[It's] not a question of more government; it is a question of who is government. (*Custer County Recreationalist*)

It's not a land issue; it's a people issue. It's not a land problem; it's a people and education problem. Whether we are educating them about agriculture and what it takes to make things grow, or whether we're educating them about the river and what it does, and what makes it so wild and pristine, or what makes it so they're drawn to it….And people are scared to death of what they don't know. *(Rosebud County Recreationalist)*

I'm more of the idea of conserving it as opposed to preserving it. [The] difference…[is] preserving it is when people don't want anything to change, so they take measures to preserve it just like it is. Conserve means that it is essentially used, but it's used with an eye toward keeping it healthy. (*Treasure County Recreationalist*)

Then you have somebody in Helena making a decision and they have never seen it. Like me telling someone how to knit something. I have never knitted anything in my life. I wouldn't know what I was talking about. I think any decisions made should be local. (*Custer County Recreationalist*)

Planning would probably need to be at the state level, [with the state] saying 'Here's what we're doing with the river.' And best management practices are fine, but there might be some required management practices that are necessary….I don't think you're going to get voluntary compliance with a lot of that stuff. (*Treasure County Recreationalist*)

I think more value needs to be put on the recreation values of the river and less on the irrigation uses. Historically, irrigation was the king, [and] whatever they wanted to do, they could do. And we still see that right now. You can't really deny guys who want to put head gates in…for irrigation purposes. (*Treasure County Recreationalist*)

In '89 the license had just switched from the Fish, Wildlife and Parks, which was a mistake, to the Department of Commerce. You know, why would you take a license that's wildlife orientated from somebody that's trying to manage wildlife, and give it to somebody who could care less about wildlife? So, it was utter chaos before everybody figured out what was going on. Then they switched it from the Department of Commerce to the Department of Labor and Industry, and now they at least look at it as an industry, and we're regulated by those people and or pay our dues to those people. (*Rosebud County Recreationalist)*

Most of…[hunting license revenue] is administration fees. Very little of it is going back to actually help the resource, to my knowledge. And they're making a mistake because a person with his license, trying to do his paperwork, trying to do everything legit,…they got all these regulations on them. And the person that…[doesn't] have a license, that's just rogue hunting, I'm not doing…[anything] about it. *(Rosebud County Recreationalist)*

A lot of the boat ramps are silted in and non-usable. So I suppose maintenance at fishing access sites is an issue. (*Custer County Recreationalist*)

It's not really clear to myself or others what the Fish and Game is doing as far as stocking fish or managing the fishery….Maybe it's the wrong perception and I just don't see what they're doing, or maybe they truly feel it's healthy the way it is….Not that it's bad. You just haven't seen anything that says 'We looked at it and here's what we think that we can improve'….[We] just haven't seen or heard anything. It makes you wonder what they're doing, if anything. (*Rosebud County Recreationalist*)

In '76 or '77, the Fish and Game was making a big deal about trying to improve the river and hunting….I filled out numerous surveys and I still participate in the fishing law program they have. I wrote them some letters and told them that I felt [since] they were doing all this planting [of] small walleyes, bass in all these lakes in Eastern Montana, Fort Peck and Yellowtail Dam, why didn't they put some back into the river?...About ten years ago, they made a smallmouth bass plant on the Big Horn River and the same time they made a walleye plant….Right now, the smallmouth bass and the walleye fishing at certain times of the year is unbelievable….That was really important….The Fish and Game was doing things to make it a better fishery, as well as putting in the boat access ramps and so forth. To me, it's made a huge difference. (*Treasure County Recreationalist*)

These kind of comprehensive planning things, where the river uses are taken to the public to ask the kinds of questions you're asking: What should be going on here? What do you want to happen? The difficulty in doing that is getting people interested and actually voicing opinions, like any other planning. People don't care until their ox becomes gored and then they care a lot. (*Treasure County Recreationalist*)

There's a group of people that want to blame the cows and the agriculture for the decline in the sage grouse….There's an education problem about the bird. Yeah, habitat's part of it, but habitat is a small part of it. You know, you and I are a very small dot on a big picture. And if we don't look at everybody around us as a very small dot on a big picture, there's a lot of the picture that gets left out, and that happens a lot, whatever issue you want to bring out. *(Rosebud County Recreationalist)*

Ag impacts, or at least…[is] being blamed for, mortality on certain game fish species, such as sauger…down near Sidney at Intake Dam. [The dam] is blamed for killing hundreds of thousands of fish every year. (*Custer County Recreationalist*)

In low water years, they do release a little more water into the river to keep the fisheries going. I am sure that the people with the water rights need that water down there too, for irrigation purposes. (*Rosebud County Recreationalist*)

When I was a kid fishing, we caught lots of sauger, and there were many saugers, and now they're basically endangered, so you can catch one sauger. You have a five-fish limit between the walleye and sauger, and one can be a sauger. When I was fishing, that's all you caught. (*Treasure County Recreationalist*)

H. Concern: Moss

The mosses come in from when Yellowtail Dam was put in Big Horn Canyon. It probably raised the temperature of the river a little bit, so the Big Horn [River] has a tremendous moss problem. That moss gets washed down into the Yellowstone here. It affects irrigation; it gets tied up with the moss. We didn't have that problem before the dam was put in. We still want the dam. (*Treasure County Recreationalist*)

In the last 20 years it has gotten noticeably worse. In the spring it is impossible to fish….A lot of people blame the fertilizer runoff, but I think [it's] the change in the water flow…,The Big Horn River changed from a warm water discharge—now [it is] pretty cold coming out of the Dam. That has to have some effect. (*Custer County Recreationalist*)

And then we need to get the moss out and turn it into an edible salad. If they can market that with a little bit of ranch dressing and clean up the river, that would be great. (*Treasure County Recreationalist*)

When I was a kid, we didn't have any trouble with moss, but we do now. *(Rosebud County Recreationalist)*

I. Concern: Water Rights

The recreationists, I don't think own any water rights. So they're at the mercy of what comes, is what you get. (*Rosebud County Recreationalist*)

When you start talking about modifying irrigation structures for recreational uses, you have a direct tie to money and the irrigation guys are going to go nuts. You are benefiting someone that [irrigators] don't care about, and that [irrigators] don't think have any reason to be there. I think that's one of the fights. (*Treasure County Recreationalist*)

There are other diversion dams, small dams that go across the river that create barriers for people like me that don't have an easy way to get their boat out and around those things. But I'm not going to whine about it. I mean …it was there a long time before I came here and started using the river, so I'll just deal with it. (*Custer County Recreationalist*)

J. Concern: Ice Jams and Flood

There's no common sense involved with any of this that's going on. You know, they're putting animals on the same plane as people. They're putting people that have no control over the rain any more than you and I do, no control over the ice any more than you and I do, no control over the river whatsoever, and they're putting them in a position where they're responsible. *(Rosebud County Recreationalist)*

Because somebody's living on the river, making his living off the river, you know he can't be liable for something that's out of his control. Why keep beating on them…if they're down? I don't see that, but that mentality is there. They should have done something, but they can't do anything….There's an education problem. *(Rosebud County Recreationalist)*

K. Concern: Coalbed Methane

They are monitoring coalbed methane….The State of Montana should have a real good handle on how much salt is being contributed to the Yellowstone River from coalbed methane development in Montana and Wyoming because, the Tongue is not the only river that…coalbed methane water is being dumped into. It's also the Powder River in Wyoming. (*Custer County Recreationalist*)

L. Recreation Adds to the Economy

I think recreation is very, very close to [generating the same economic inputs as] agriculture.…I buy a pickup truck and a trailer. I buy thousands and thousands of dollars of decoys. I buy a lot of fuel. We buy breakfast. We [spend] lease money. We have shotguns, shells,…licenses. When I have guests coming in from all over Montana to hunt with us, we go out to dinner. (*Treasure County Recreationalist*)

Powder River to Big Horn River: Residential Interest Group Overview

Eleven interviews were conducted with property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank. Names were obtained through a GIS search of public land ownership records. These names were randomized within counties. Other people living very near the river and whose primary incomes are not generated by agriculture were also recruited.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Powder River to Big Horn River: Residential Interest Group Analysis

I. Rural-Residential Life

A. "Big Sky" Montana

[Here, we are] less populated, thank God….I like it here. Open, Big Sky country—that's us. I don't know how the western part of the state can claim that. [They have] too many mountains and trees. (*Rosebud County Residentialist)*

We're pretty fortunate to live in Montana. I like it. Not many people. And that suits me fine. *(Treasure County Residentialist)*

[Montana is] a big state, but east of Billings doesn't exist. Eastern Montana is 'phppt' when it comes to funding from the government….The mountains get everything, as far as I'm concerned, in the State of Montana….It's like there's nothing out here. We don't exist. *(Rosebud County Residentialist)*

It was a great place to raise a family. I would still live here if I wasn't farming or working. We are close to anywhere we need….I can't imagine living in a city. *(Treasure County Residentialist)*

We originally came to Eastern Montana to get experience and then move west, but it kind of grew on us after a while. (*Rosebud County Residentialist)*

I'm a fourth generation Montanan. My great grandparents homesteaded here….Being raised here, I just love it. I go other places, and it just doesn't feel quite right. (*Rosebud County Residentialist)*

I guess it is a beautiful part of the country. Not many people. I guess it is pretty rustic really. It is a great river…and there aren't many people on it. It is a great place. (*Treasure County Residentialist)*

Living near the river doesn't seem any different than living downtown, except for the fact that you're on the outskirts of town and it's more peaceful. (*Custer County Residentialist)*

[It's] a small, rural town. We're located in town, close to the river. (*Rosebud County Residentialist)*

We are kind of a community within a community where we are out away from the town. It is a wonderful place to raise children. *(Rosebud County Residentialist)*

[This town] is a very small town. If you were going by on the highway and blinked, you would miss it. It is home….It's a quiet setting. The river is close, [and] people like that. It's always been home to me, no matter where I've lived. This is home. (*Rosebud County Residentialist)*

We like it down by the river. We got all the trees and meadows where there's only cactus and rattlesnakes. (*Custer County Residentialist)*

B. Conflict is Minimal

There aren't enough people here yet [for conflict to exist.] I would imagine if we start getting a lot of people, we will get that. (*Treasure County Residentialist)*

I don't see conflict between the different groups. Like I said, a lot of the landowners are very cooperative about access. The river can be used sometimes for hunting access to the state lands. They'll get in at a boat dock and go up to…state land. [There are] not too many concerns there, as long as the hunters stay where they're supposed to stay.… I think the…recreationists have to be aware of agriculture and be respectful…and I think for the most part that is recognized. Maybe the good access helps too. The roads are all graveled and nice. You can access in any kind of weather. That probably helps. *(Rosebud County Residentialist)*

I have seen jet skis and boats. They take the boats out for fishing, or just a ride on the river.…I don't think it is a problem [sharing the river]….Here, it is just a small community….Everybody knows that everybody needs it for whatever use they have. (*Rosebud County Residentialist)*

I don't think one interferes with the other that much. The only thing that really interferes with the boaters and floaters would be the diversion dam…and that's for the agriculture. I don't have a problem with that….Anybody that floats or boats knows that dam is there and avoids the dam area….I don't think that they interfere with each other….I don't think the areas overlap. The boaters and floaters and fishermen don't use up any water, so they have no effect on the agriculture. *(Rosebud County Residentialist)*

I think [everyone is] pretty compatible. *(Rosebud County Residentialist)*

C. Growth Seems Possible in Some Areas, but Not All

Will there be enough jobs that we can keep some of [the kids] home? Or do they have to go farther? We see fewer and fewer opportunities in these small communities. So, there's a migration toward Billings or larger communities. I'm not sure if we can reverse that….[We're] making sure they get a good education and…from there [they] go where they can. I hope they have the opportunity to enjoy some of the rural areas in the longer run. *(Rosebud County Residentialist)*

The whole area is getting less populated. Our school is truly downsizing….There are no jobs that pay well in this area, unless you're lucky [with] the railroads….There's agriculture jobs…but they don't pay well:$40 or $50 a day….When you start adding it up at the end of the week, it truly isn't [much]....Montana does not take care of its people….They cry that they don't get any tourists, but they don't do anything to welcome them to the state. They have lousy rest areas and…they shut down in the winter time….They don't do anything to promote tourism [and] then they cry that everybody else gets the tourists. I'm sorry, I'm spouting off. Montana is a beautiful state. I love Montana and there are nature's wonders all over the place, but they don't do anything to promote them, and they don't do anything to take care of them. *(Rosebud County Residentialist)*

I see it growing because of the energy in the area. There are companies coming in that deal with energy. If it grows, it's going to be because of energy. It's basically right now an agriculture town and hasn't grown a lot at all….There's always the possibility of the Tongue River railroad. They talk about power plants….Energy is becoming more and more important….At some point, it's going to come in and we're going to see the town grow. *(Custer County Residentialist)*

I would like to see it stay in agriculture. I would hate to see a bunch of houses here. (*Treasure County Residentialist)*

[Farmers'] margins are getting tighter and tighter all the time. That's because of the input costs and not getting substantially more out of the products….I think they tend to get a little bit larger…[and] a little more efficient in their operation as they cover more acres. They're adding center pivot irrigation systems…that make…better use of the water and less labor, possibly produces better in the same acres too. You can control your input a lot better of the water and fertilizer….So those are some things that will,…in the future, help the efficiency [in production]. Otherwise, we're going to see more pieces sell off and being leased back…to adapt to staying out there. (*Rosebud County Residentialist)*

[Farmland is] not being subdivided….I guess we don't see those being subdivided down a great deal….Folks are buying little places close to the river so they have access, and they have wildlife and fishing. It's not affecting agriculture too much as long as that property is still available for Ag use….A lot of it is just leased. It might be a tougher balance in the long run than there is for the recreationists and agriculture at this point. *(Rosebud County Residentialist)*

We had a fellow right down here who is a dryland farmer. He put three big sprinklers up on top, way up high, and he's got two pumps to get it there….He's raised terrific alfalfa,…no problem at all….And I'm certain it cost him a lot of money, but look, he's producing up on dryland ground….There's going to be some of these dryland places…putting water on their [farms] and they could raise anything….They'd have to file for water rights. I'm certain they would…pay by volume, I'd imagine. *(Rosebud County Residentialist)*

The whole eastern part of the state is full of energy resources….Perhaps [we'll see] more folks employed. We're running shorter on houses in town because of increased railroad traffic…related to coal mining in Wyoming….There will likely be more and more developed, as it can be developed, and still take care of the land.…A little bit more [residential development,] here and other places along the river. *(Rosebud County Residentialist)*

Houses are rundown around here. But people are buying and starting to…build nicer places….This place was a complete hellhole, but we bought it and did a lot of work to it….Houses are really going up in value….The lots down here are selling. (*Custer County Residentialist)*

II. Living Near the River

A. Appreciating Play, Scenery and Wildlife

I do like to fish, and we have a river boat. I enjoy that. There is a lot of wildlife. I like to hunt. I enjoy that. As far as recreation goes, there are a lot of things to do. (*Treasure County Residentialist)*

The pelicans keep coming back and increasing….The bald eagles seem to be doing well. And we had a couple of osprey nests on the bridge over the river….I hope the people don't get overpopulated and push the animals away….[Maybe we should be] making areas along the river where nobody can go for a short ways because it's closed as a pelican relief or something. There must be a way we can give the rare animals…or endangered ones a private place to hide, [or] at least nest. (*Rosebud County Residentialist)*

We do [have a boat]. You can't live on the river and not have a boat. (*Treasure County Residentialist)*

My husband took the boys down fishing and they've been swimming down there [at the river]. A lot of people go fishing. There is a fishing site down there. We just went and walked [our] dogs. *(Rosebud County Residentialist)*

It's a big river. I guess I would call it a river that's good for fishing, but it's dirty a lot of the times, fast in the spring, but it's very pretty….I like to walk on the dike. I used to walk my dogs up there. *(Custer County Residentialist)*

We like being on the edge of town. We can walk right down to the river and do whatever you want… fishing, … ride our four wheelers,…take the dog down to it. *(Custer County Residentialist)*

We can go down [to the river] with the kids and skip rocks or try to catch a fish. We utilize the campgrounds and areas on both sides of town. Go with people that do a little bit of boating sometimes….The river is important to all the irrigated agriculture along the way. *(Rosebud County Residentialist)*

I like the agates, and the trees, and the wildlife, the people, and the weather isn't too bad. [It] helps keep it from getting too crowded. (*Rosebud County Residentialist)*

We irrigate out of it. The river, and out of the ditch….We've got to irrigate out of it, or else we'd be drylanders…I wouldn't want [that]. (*Treasure County Residentialist)*

It's an ideal place, really, for an irrigated place….It's sentimental to me. It's my life, really….I like the environment, and I know the environment. I know every foot of the land [and all of] the animals. *(Rosebud County Residentialist)*

B. The River as a Shared Element of Life

Balance,…keeping that relationship that allows agriculture to do well, allows opportunities for recreation and fishing….I just think the balance is important. (*Rosebud County Residentialist)*

Well, farmers use it for irrigation…The city does take their city water from the Yellowstone; they pump it in. We got a new water tank down at the park…And then that [other] tank that's on the hill, that feeds that subdivision over there, and the water comes from the river too to fill that one. (*Custer County Residentialist)*

This particular diversion dam serves 20 miles of agriculture and agriculture producers. That's important to the economy and their livelihood….I don't like hearing the talk about let's knock all the dams out of the river and let things free-flow naturally because that's best for the ecosystem….I think those [dams] serve a great purpose: this one out here for agriculture, the one up there for recreation and agriculture, and to control flooding….I think there…[are] ways to open up around diversion dams so that the ecosystem can stay in balance if that's necessary….I don't want to see agriculture get traded out for the big money, open space, open recreation. (*Rosebud County Residentialist)*

I'm not a great sportsman, [and] that part of it doesn't interest me at all. It does a lot of people, but not me….[The river is] the city's water supply. (*Treasure County Residentialist)*

[Hunters], hikers, people that watch birds [use the river]. Seems like there's a lot of people interested in the birds….Of course, farmers irrigate….Water's the lifeline in our country. And there's no better way for children to grow up than appreciating everything about a river, including everything that lives along it. (*Rosebud County Residentialist)*

A lot of people like to fish. They also like to hunt agates. There are agates in this area….[There are] people with boats. Of course, there are people coming with four-wheelers now. *(Rosebud County Residentialist)*

[There is] a lot of boating. The river has pretty good depth along here. Jet skiing,…fishing, boating, [and] irrigation. (*Custer Residentialist)*

C. Outsiders Change the Local Context

We'll continue to see more outside ownership. The folks here that want to be in agriculture need to develop long-term leases with the [new] owners….Land sells at higher prices than it will produce in cash flow. So, if you've got to pay for it with the [farm] income, that doesn't work anymore….Folks that come from out of the area, whether it's Billings, or back east, or other states,…[some are] part-time, or they're moving here and retiring….[Maybe] they first came here hunting and [then became] interested in owning some land to hunt on because it's getting harder and harder to find places to hunt. Or [they] just believe it to be a good investment….When the stock markets went lower, and they weren't doing very well with their money, there was a common thought to put it in land. [Land] will always be there. *(Rosebud County Residentialist)*

I still get to drive over the place. Those new owners said, 'Anytime you want to.' Of course, we kind of look out for it. It's a family investment, and he's not here. He's in the city. (*Rosebud County Residentialist)*

Some groups, maybe the US government,…come in and purchase the easements to ranch land. And basically they pay the rancher X amount of dollars.…They'll do an appraisal before [and after] the easement…because if you go to sell the ranch and there's an easement on it, a lot of people think that devalues it….Theoretically, what they're paying for is the devaluation of the land because it's got this easement….They certainly can pass it on to their kids, but the easement stays with it….In turn, the rancher agrees to a lot of different things, depending on the easement. The ranch can't be sold for subdivision; they identify wildlife…[and] wet areas….And then they help you manage the grass and that kind of thing. We're starting to see more and more of those around.…It's a big cash inflow for a ranch and maybe the only way they can afford to stay on the ranch….Some ranchers…take care of our environment, and it kind of goes hand in hand with [what] they want….They don't want to overgraze it. They don't ever want to see it subdivided. But then a lot of ranchers are like, 'Don't tell me what to do on my property.' And they would never do an easement. People are pretty hot or cold on the issue. (*Custer County Residentialist)*

I'm sure if we wanted to [sell our property] it would be worth quite a lot of money to some people,…[to] some of the outside interests, as I call them….They pay a lot of money for access to the river. It's getting tougher all the time to get access because so much of it is…leased…for hunting and whatever….If you…[have] access for half a mile of river frontage, they'd pay a lot of money. (*Treasure County Residentialist)*

People moving in, the out-of-staters—we always talk about the Californians moving to Western Montana—we want to send them home….We like rural Montana….Not that we don't have drug problems, but they have a lot more. *(Rosebud County Residentialist)*

We're getting people from out-of-state. People with a lot of land…that are financially well-off. People that guide hunters and things like that….I've seen the amount of hunters increase quite a bit, and I'm not saying that's bad or anything. It's good for the economy, [and] animals are overpopulated. It's good for the herds, too….[But,] in the old days, you used to be able to just go hunting and now it's going to cost. (*Rosebud County Residentialist)*

A lot of the older people are moving out, selling out and moving to Billings. We are getting a lot of new people out here….coming from the western part of the state….They are driving up our house prices….[They are] selling for big bucks [in Western Montana] and coming down here. And they can afford to buy it, and people around Eastern Montana can't. *(Rosebud County Residentialist)*

[Homes built by outsiders]…tend to be larger….You'll see more of those pretty nice homes, $200 to $500 thousand. Where the ones being built [by] locals are $100 to $200 thousand at the most….They're buying…and building their houses…and having access….That's hard on the local communities. A good portion of them don't have this as their local community. They come part-time, or come during hunting season, or just own it and lease it. So it takes a little bit out of the area. *(Rosebud County Residentialist)*

D. Public Access versus Private Property

Access—that is complicated….I would like to see just two accesses but…it would be better for the public to have one more….There have been times, especially during deer season, [when] they keep hounding me… to put a boat in. So far, I haven't let anybody use it except my own family. There can be hard feelings over it. It is private property so they should understand that….I am not real comfortable with [them going] right by my house….You are going to have people throwing stuff out and littering. You think they won't, but they will. (*Treasure County Residentialist)*

I think there should be places people can go, like state land and stuff. That way at least everybody can have access to the river. Might not be as private as they like, but it will keep more people from breaking the law and just sneaking onto people's places. *(Rosebud County Residentialist)*

Fish and Game controls [Block Management], and the landowner gets paid so much per person, per day. And it's trying to keep more of the acres open for the average Joe that can't afford to lay out a few thousand bucks to tie a chunk up so nobody can hunt on it for years. (*Treasure County Residentialist)*

I think the Block Management thing is a good deal….When the rancher signs up for that he's agreeing to let people hunt or whatever….There's a booklet of all the ranchers that are in the program,…[and hunters] can go to the rancher's house and sign this piece of paper…getting permission. And the rancher signs it, and it's for a certain day, and the rancher gets so much money per person, per day….That way people get to go there….The ranchers should get something. I mean, they're the ones that invested in the land. They pay taxes on it. *(Rosebud County Residentialist)*

I guess when you're that close to the river, there's always traffic and people that want to get to the river. And you probably have more traffic than if it was not on the river. (*Treasure County Residentialist)*

As long as they ask permission, that's the main thing. The same thing is true of the river….As long as they're law abiding and ask for permission. *(Rosebud County Residentialist)*

There's quite a few campgrounds….The access is pretty good public wise, and there's plenty of landowners, too, that are very willing to let you in….I think [the amount of access is] adequate….They all seem to be pretty clean and well kept. The roads aren't too bad going into them. (*Rosebud County Residentialist)*

III. The River as a Physical Element

A. Living with the River's Force

The Yellowstone is always there. It can get low, and I mean really low, and it can get really high. I've seen it in flood stages, flooding over on the north side, way over. But, it's always there; it's always flowing. In the winter time it freezes over,…but you know it's there. It's a constant. I like that. I need that in my life. *(Rosebud County Residentialist)*

Well, it's flooded here twice when we had to move out. It came right down through here once. Another time, it came around down here…The first time was about '97 or something. And then the other time was a few years ago. (*Treasure County Residentialist)*

I think erosion is a natural thing, and that we should live with Mother Nature. I mean, the river's supposed to meander, so we'll have to live with it. (*Rosebud County Residentialist)*

On this part of the river I don't know how much you can really do. The Yellowstone is so powerful that at some point it will undo everything you can do. The ice does more damage than high water. It will freeze to the rock and move out and take the rock….We have as much damage as anyone….It is an interesting place to live. The benefits outweigh the negatives. *(Treasure County Residentialist)*

The tricky thing about the Yellowstone River is it's very swift, but very shallow in places. So even the fishermen have to have a jet boat so it…[doesn't] tear up their props. (*Custer County Residentialist)*

It backed in on me that time, but it still took a lot of riverbank…I actually gained some land from it. See, right here where we live, [and] the river came in and hit us.…We gained some there….I call them islands, but they aren't. Right now, the water is going through the channels, but when the water recedes…we graze it and even drive through it….You do pay some tax on it, but it's much less than irrigated ground or grazing land….But I have gained down below, which I really appreciate, but it's just willows, trees, grazing land is all it is. *(Rosebud County Residentialist)*

We've had four or five [floods], but we haven't had any for several years. Seventy-eight was probably the worst one….It covered the whole thing. (*Treasure County Residentialist)*

You know, we had a big field here that we had beets in, until all the water came down and washed everything out of here, washed it all out [to] the corner. They've moved that road about three times already. It would wash out and they'd have to move it back. (*Treasure County Residentialist)*

The '97 flood took out the rip-rap and 500 yards of dike. I lost about seven or eight acres of irrigated ground. Ice jams are another one. It can go from a nice mild river and within about 30 minutes it will be running over the banks….When it flooded in '97 it deposited gravel over 18 acres of irrigated ground four feet thick of just gravel….We had to get the trees and debris off….[It took] two weeks….We used a tractor, a loader, a Cat, and a dozer. There were a lot of real sandy piles….We had…to spread it out or push it into a hole. It was so fluffy it was hard to get around with it.…I suppose that took a week or ten days. Then we went in with a disk and disked it and chisel plowed and took our own level and leveled the land. We spent a couple of weeks at that. We spent most of the summer getting it so we could plant it the next spring….You don't realize all of the things that happen when you lose that much of a crop….I suppose [it took] ten years to [pay off the expenses]….Of course we lost seven to eight acres of ground that is totally gone. At today's prices, that is worth between $15 and $20 thousand. You still own it, and owe on it, and still pay taxes, but it is in the middle of the river. *(Treasure County Residentialist)*

B. Dike Protects Against Flooding (Probably)

We're actually two blocks this way from the river….We hope [the dike] will hold….That's always a concern. Our house is out of the flood plain; it's built up high….But, with the drought we've had in the last ten, 20, 30 years, it's not a real big concern. (*Custer County Residentialist)*

I don't remember a flood. I remember the river coming up when I was growing up, when I was in grade school. It came up over the road, over the dike. (*Rosebud County Residentialist)*

Yes, everything on the south side of that river has a levee….The only time it's been breached is when one of the farmers…dug through it to get water from the river, it weakened the levee, and that's when we had our big flood year….It was in '44…when the city did get flooded,…but the levees held. (*Custer County Residentialist)*

At the very far end of River Road we had some flooding. There is what's called a flood plain, and the west end of town is part of the flood plain. But where we are, I believe, is out of the flood plain….Like I said, my mom was born here…and lived here all but two years…and she said…the river has never come this far. *(Rosebud County Residentialist)*

[Water] has been right in here, but not on the main floor. It is pretty high here. It is almost as high as the dike. (*Treasure County Residentialist)*

No, they don't [have flooding] because of the dike that's built along there. That took us out of the 100-year flood plain. *(Rosebud County Residentialist)*

We haven't had any [flooding]. This house was built later than most of the houses in the neighborhood, up on the ground, so a flood would still do damage here, maybe the basement….It would have to be a bad flood to damage this house….[It] doesn't really concern us now. There would be plenty of warning for it now….[You] insure your house and leave when they tell you it's going to flood….It's not something I am going to worry about living down here. It's the chance you take. (*Custer County Residentialist)*

[We've had]…ankle-deep water, but it didn't get in the house. We've got a slough that runs parallel to the Yellowstone River down in there, and when it floods that fills up first. You might get three to four feet of water in that, but that's a low area, it's like an old riverbed. But out on the streets and stuff, you might be walking in water ankle deep. (*Custer County Residentialist)*

[It] just flooded in the spring, into basements and stuff. One time, when the river was coming up, and the ice was breaking and was jammed, and [there was a] fear of flooding, they evacuated the people out of River Road. (*Rosebud County Residentialist)*

We see maintenance on [the dike] every few years. If there's ever a spot that isn't very strong, you see them dumping gravel over the bank….So it seems to be maintained very well. (*Rosebud County Residentialist)*

They'd have to build the dike higher. *(Treasure County Residentialist)*

I know there's people here in this town that will dispute the levee being safe because they want the federal government to come in and redo it completely….They've done surveys and different things….It is my impression that they would basically redesign the levee, make it wider and stronger. If they ever did, I was told that they would buy [land near the levee], which would be nice for me….I don't think that will ever come to be…but my thought was, 'Great, I get to sell some property to the government, somebody that's got money.' *(Custer County Residentialist)*

I hear people say…that if they do widen the dike, they will lose their land, or have to sell it….I imagine it would be a great profit….Maybe I'll go buy some. (*Custer County Residentialist)*

If it wasn't for the financial reasons, I would rather not have the dike and let [the river] do its thing….Had it never…had a dike, when the river got high, it would come and spread over the whole area… Maybe it would spread more gradually….You would have a bigger area, but not as much force…and there wouldn't be as much damage as with the dike….It would come up and flood,…and would cause a bit of damage on the bank….You would have junk, but that wouldn't be hard to clean up….If it had been let go, I am sure the channel would be wider than it is now. There would be some islands and…I don't think you would have as much debris.…The high water would carry it away….It wouldn't pile up as bad. I might be wrong, but I think that is what would happen….[However], it is financially impossible [not to have the dike]. (*Treasure County Residentialist)*

The only change I would like to see in the river is a little better dike system. I don't want to give up the trees….If they had to take out the trees to make the dike better, then I would like to see them replanted….The erosion is moderate.…I saw them putting some rip-rap up there this spring….Everybody complained about how it was done…[and that] they tore out the trees….Why can't you leave trees too? It can't hurt, and it's better than big chunks of cement. I didn't understand that. [The trees] were mostly dead, but still their root structure was still [there]….Don't take the root-balls out.…Then, the way they built it back up, it's soft…[and] over time it will settle….[But] with all the trees gone now, when water comes up, soft ground doesn't take it too well. (*Custer County Residentialist)*

C. Flood Plain Maps are Restricting but Potentially Credible

I think many are aware of how the flood plain works….I know if they have financing. They have to address that properly. So, I don't think they're being improperly built….There's surveyors that…can do [an] elevation and determine if it's a flood plain or not.…If there's any financing involved, FEMA will determine it by sending us maps to look at….It's time [to get updated maps], I think. I doubt things have changed a great deal, but they certainly have some. So we know the areas pretty well that are affected….If there's no financing involved, I imagine the contractors bring up that thought [of flood plains] when they're working with some of the folks….They can sure build on them, but they buy flood insurance. *(Rosebud County Residentialist)*

Basically, [flood insurance] means that you're giving your money away to the federal government….It depends on the value of your property, but generally speaking, [it costs] about $300 a year. You're paying for insurance that really probably you or your children will never regain a penny from because…it doesn't really cover anything but the foundation of a house….It's a big waste of money…because you have to have your homeowner's insurance on top of it, and…the federal government always waits until the end. (*Custer County Residentialist)*

I'm concerned about people moving onto flood zones and expecting other people to pay for it [when they] get flooded. Whether it's the insurance companies, which means all of our insurance premiums go up, or whatever….I've seen more houses move near the river….Some of them are not above the flood plain, and that's their fault. If something happens, I don't think anybody should have to pay for it but them….They want to be close to the river. *(Rosebud County Residentialist)*

D. Erosion and Attempts to Control Erosion

I know that it's eating up the bank on this side….The bank has really caved in….They've tried different things, but everything they seem to suggest the Army Corps of Engineers says, 'Nope, you can't do that.' They've tried rip-rap in different areas in different ways, and the Army Corps said, 'Nope…it's not ecologically safe, or it's not economically feasible, or it wouldn't work'.…I would like to see [something] because I don't want my river to go away, and I don't want my town to go away. *(Rosebud County Residentialist)*

There are places where people are driving off on the river side, and making paths on the river side….That's causing some erosion.…I would like them to stop all transportation, motorized vehicles, cars, four-wheelers, motorcycles…. Four-wheelers are always up there and tearing things up….[Imagine] you're out for a nice beautiful walk…[and] it's gravel up there and somebody comes by at 30 miles per hour and blows rocks and dust in your face…I would like them to close it to only foot traffic so you can still walk your dogs….I think more people would walk up there…[and]fish maybe. *(Custer County Residentialist)*

We should have laws that limit erosion control along the banks…and it's going to have to be enforced so that everybody's treated right….It would have to be [regulated by the federal government] to…[encompass] the whole river. *(Rosebud County Residentialist)*

There are quite a few erosion problems that need to be addressed, but it's like anything else anymore. It's so expensive to try….It's a pretty uphill battle when you start bucking Mother Nature. She's pretty much going to do what she wants to do, and if you try to alter her progress, it can get very expensive. (*Treasure County Residentialist)*

Rock, big rock [and] gravel won't stay. There is not enough there. The bigger the rocks, the better. (*Treasure County Residentialist)*

[The dike] was all rip-rapped and I thought I would never have to touch that again in my lifetime. In May [the river] took it all out. Some of it has been rocked since the early 1970s. (*Treasure County Residentialist)*

A long time ago, they'd put in old cars in to reinforce it, but when it got high, it just washed them away….It was temporary. (*Treasure County Residentialist)*

I think it's pretty understood that the river is always a changing dynamic, which is a natural aspect of the river….I've seen projects completed to try to help keep it within its channels a little bit better done with the Corps of Engineers or through the Conservation District….Barbs,…where they fill it with rock…and try to just keep it within the channel [and] from cutting real severely….[Rock is] what's used the most.…It's the most readily available, and maybe the cheapest…and something more natural too. *(Rosebud County Residentialist)*

It is harder to hold the soil in the banks, here in particular. It is so sandy. On my place it would almost have to be cemented to really hold it. The cost is prohibitive to do anything. You can put in $100,000 [worth of rip-rap] and it is not going to stay there. (*Treasure County Residentialist)*

I'm concerned about people trying to control the river by doing what they want to with the banks. I think they should [use] sturdy perennial vegetation, something that stays there instead of something that goes away….The most they should be allowed to do is have a good, sturdy riparian…vegetation….Something beneficial to everybody. (*Rosebud County Residentialist)*

As far as fisheries go, if you try to keep it in one spot for too long, it will just be a big, deep channel. I think that is bad for everything. It is bad for the fish. It is bad for the land next to it. (*Treasure County Residentialist)*

If the guy across the river has enough money to put in all kinds of rip-rap…and the next guy is just struggling to survive, all the erosion goes over to him. That's not right. Let the river be the river. Nobody's forcing anybody to live here….I think that's something people should consider when they're buying a place. Look at the way the meander is going. (*Rosebud County Residentialist)*

IV. Other Problems

A. Water Quantity

Recreation…doesn't use up water….I mean, you're using the water for play but you're not using it up….The growth in the community certainly could use more water, and I worry about agriculture, because I know…people are tending to take a lot more water than they have water rights to. It's a concern….Number one, enforce the water rights that the farmers and ranchers are using….[I know] that's their livelihood, so I'd hate to see that taken away, [yet] we have to have water to drink. *(Custer County Residentialist)*

Personally, I think if we didn't have the river, we wouldn't have the city….If you stop those two rivers, dam them up or something, this town would fold up; it has to. There's no way they could maintain it….You'd have a lot of farmers go belly up if they didn't have the water….We'd just eventually die. I guess it'd be like if…everyday you cut back on your food just a little bit; I doubt if you die of old age. You'd probably die of starvation. (*Custer County Residentialist)*

I wouldn't mind some water being diverted off into a big reservoir, so we can store water. That'd be nice…and I always thought we should try to hang onto as much water as they'll allow us to, instead of just letting it flow into the ocean, because we need it here. We live in a semi-arid desert. And sometimes the river gets so low, we're losing out on species of fish that need water to live in…[and] when the water table goes down there's certain types of trees that can't make it, too. *(Rosebud County Residentialist)*

It would be hard to proportion it….They all need it….Everybody needs the water: the farmer, the rancher, the cities…. It would change things entirely if you didn't have the river for water. *(Rosebud County Residentialist)*

There's an awful lot of water that passes us by at this point…that's long gone. But I guess something that would bother me a lot [is] that…a lot of that water goes for the navigation, probably, and some for habitat of different species. *(Treasure County Residentialist)*

B. Water Quality

I'm concerned about people dumping stuff into the river….I've heard there's still places dumping toxic chemicals. I don't know if it's true or not. That certainly shouldn't be tolerated. *(Rosebud County Residentialist)*

The water and sewer was one big issue that we got over there….If your septic tank goes bad, [the city] won't let you put in another septic tank. But they won't furnish [us] with city sewer….I just believe that…if you're living in the city, they should provide water and sewer. (*Custer County Residentialist)*

You get to some places where the river is so polluted,…[but] I don't think, as far as the Yellowstone River is concerned, that it is a major problem. Maybe it is, but I don't see that as bad as it is in some places. *(Treasure County Residentialist)*

People tend to just throw stuff in the river. It's a good way to get rid of it. I know that somehow our drinking water comes from that and, of course, the fish are in it. Probably the cleanliness of it [is a concern]….I hope it doesn't get worse….I hope it stays clean.…I'd like to see a little stricter laws. (*Custer County Residentialist)*

[I want us to] continue to keep it free of chemical pollutants from manufacturing, which is a divided question, because…manufacturing…would provide better paying jobs,…but I'd rather have the clean river, and the easy living, and the small town feel. I'd like to see my river kept clean…of chemicals and pollutants. *(Rosebud County Residentialist)*

C. Yellowtail Dam

[At Yellowtail Dam] they dumped too much water at one time. It happened in '78, too. The high water had started to recede, the Big Horn [River] was just getting going good [and] they started to panic, and they thought they would have a problem. They dumped way more than they normally do. If they had waited two days we probably wouldn't have lost all the rock and the dike….Conrad Burns was here and looked at it. He said it looked like a good place for a fishing hole now….What could I say? *(Treasure County Residentialist)*

There were a lot of issues on Yellowtail Dam, [including]…how high you let the water come up in the spring, or how low you take it. And [one] year they didn't take the water really low….We thought they let the water stay high in Yellowtail Dam so that by the end of May, the boat recreationists could get in there. Then, with a big snow pack, they let a whole bunch out really fast. [At the same time there was a] great big rainstorm in the Billings area….The combination of all that led to flooding of the agriculture places. The town was OK….If there's a lot of snow way up above, shouldn't the Yellowtail Dam be taken down a little bit more to help hold that back? On the other hand, it provides a great source of irrigation…late in the summer….So, it's a tough issue to balance….I believe…the Corps of Engineers…came down and had some town meetings afterwards, to take the heat, I guess, or to try to explain how they have to balance all these different uses. *(Rosebud County Residentialist)*

I would like to see the state or federal government share in the conservation practices because when it did flood in '97 it was partly because of poor management of Yellowtail Dam….There is no [communication] that I know of. We have tried,…mostly through the Conservation District,…but it didn't seem like we got much response….I would pay a little more attention to what is going on downstream instead of just the dam. You have to look at the whole area more than they do. *(Treasure County Residentialist)*

D. Nuisances—Wildlife, Insects and Invasive Plants

The wildlife [along the river] don't like us, the deer and whatever. *(Treasure County Residentialist)*

Mosquitoes are pretty bad everywhere. (*Custer County Residentialist)*

Problems caused by the river, you mean? Other than mosquitoes? *(Rosebud County Residentialist)*

I see new plants….from the eastern part of the United States and some from the northwest….I think people are moving from other places and bringing stuff in….I see a lot more hound's-tongue and Canadian thistle….The salt cedar has moved in pretty terrible….It sucks all the water out and brings up the salt out of the ground, which goes into their leaves and they drop the leaves each winter creating a salty ground where nothing but it can live…. It's…chasing other plants out, willows [and]…cottonwoods. *(Rosebud County Residentialist)*

There's so many large patches [of salt cedar]….You would have to [spray it] by backpack in order not to kill everything else around it. The best way to spray it is a little bit on the trunk with…[a] remedy mixed with…oil….There's a type of vegetable oil that works just fine. The red stuff is lighter and easier to carry….You don't have to use so much. Some people take the herbicide that doesn't really work so well [and] spray the whole thing. They're killing all the little bushes of different kinds around it. So I think [we need to educate]… people how to do it…And this can also be done in the winter…with pieces of solid ice along the edges of the river. That way we wouldn't get so much dissipating into the water….It still works…[and] when it's not such a busy time. *(Rosebud County Residentialist)*

E. Safety: Debris and Undercurrents

[The Yellowstone River] is a little too dangerous for water skiing. *(Treasure County Residentialist)*

It wasn't fun raising three boys on the river….You couldn't trust them….They might get drowned….They'd go on the first ditch, and they had a tire in the trees that they'd swing [into the river]. *(Treasure County Residentialist)*

I guess we always talk about kids' safety and we haven't had any problems with kids swimming where they shouldn't. I think there's a lot of training and teaching and an indoor swimming pool helps a lot of them get lessons and understand a lot more about water. It's not necessarily a problem, but something to be aware of living close to a river. (*Rosebud County Residentialist)*

Yellowstone River Cultural Inventory—2006

Part IV: Laurel to Springdale

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The Significance of the Yellowstone River

The Yellowstone River has a long history of serving human needs. Native Americans named it the Elk River because of its importance as a hunting environment. William Clark explored much of the river in the spring of 1806 and found it teaming with beavers. By 1906, the US Bureau of Reclamation was sponsoring diversion projects that tapped the river as a source of irrigation waters. The river then enabled “twentieth-century progress” and today it supports many nearby agricultural, recreational and industrial activities, as well as many activities on the Missouri River.

Management of the shared resources of the Yellowstone River is complicated work. Federal and state interests compete with one another, and they compete with local and private endeavors. Legal rights to the water are sometimes in conflict with newly defined needs, and, by Montana law, the public is guaranteed access to the river even though 84 percent of the riverbank is privately owned.

Interestingly, in spite of the many services it provides, the Yellowstone River in 2006 remains relatively free-flowing. This fact captures the imaginations of many people who consider its free-flowing character an important link between contemporary life and the unspoiled landscapes of the Great American West. As a provider, as a symbol of progress, as a shared resource, as a management challenge, and as a symbol of our American heritage, the Yellowstone River is important.

Purpose

The Yellowstone River Cultural Inventory—2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.

There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants’ views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river’s resources. Special attention is given to the ways

in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

Identification of Geographic Segments

The Yellowstone River is over 670 miles in length. It flows northerly from Yellowstone Lake near the center of Yellowstone National Park in Wyoming. After exiting the park, the river enters Montana and flows through Paradise Valley toward Livingston, Montana, where it turns eastward. It then follows a northeasterly path across Montana to its confluence with the Missouri River in the northwestern corner of North Dakota.

Five geographic segments along the river are delineated for purposes of organizing the inventory. These five segments capture the length of the river after it exits Yellowstone National Park and as it flows through eleven counties in Montana and one county in North Dakota. The geographic delineations are reflective of collaborations with members of the Yellowstone River Conservation District Council and members of the Technical Advisory Committee and the Resources Advisory Committee.

Working from the confluence with the Missouri River towards the west, the first geographic segment is defined as Missouri River to Powder River. This geographic segment includes some of the least populated regions of the entire United States. This segment is dominated by a broad, relatively slow-moving river that serves an expansive farming community whose interests blend with those folks living along the seventeen miles of the Yellowstone River that traverse North Dakota. Here the Yellowstone River is also important as a habitat for paddlefish and Pallid sturgeon. At the confluence with the Missouri River, the size of the channel, significant flow and substantial sediment carried by the Yellowstone River makes its importance obvious to even the most casual of observers. Prairie, Dawson and Richland Counties of Montana are included in this segment, as well as McKenzie County, North Dakota.

The second geographic segment, Powder River to Big Horn River, is delineated to include the inflows of the Big Horn and Tongue Rivers as major tributaries to the Yellowstone River and to include the characteristics of the warm-water fisheries. This segment is delineated to recognize the significant agricultural activities of the area and the historical significance of the high plains cowboy culture. This segment includes Treasure, Rosebud and Custer Counties.

The third geographic segment, Big Horn River to Laurel, essentially includes only Yellowstone County, but it is a complex area. To begin, important out-takes near Laurel divert water to irrigations projects further east. Additionally, it is the one county along the length of the river with a sizable urban population. Billings is known as a regional center for agriculture, business, healthcare and tourism. This area is notable for its loss of agricultural bottomlands to urban development. Irrigation projects are important east of Billings, especially in the communities of Shepherd, Huntley and Worden. These

communities and Laurel also serve as bedroom communities to Montana's largest city, Billings. It is in Yellowstone County that the river begins its transition to a warm-water fishery.

The fourth segment, Laurel to Springdale, ends at the northeastern edge of Park County, Montana. The river in this area is fast-moving and it supports coldwater fisheries. While there is little urban development in this segment, there are some rather obvious transformations occurring as agricultural lands near the river are being converted to home sites for retirees and vacationers. The geographic segment includes Sweet Grass, Stillwater, and Carbon Counties.

The last geographic segment is defined as Springdale to the boundary with Yellowstone National Park at Gardiner, Montana and is within the boundaries of Park County. The river leaves Yellowstone National Park and enters Montana at Gardiner. It flows in a northerly direction through Paradise Valley and is fast-moving. It supports a cold-water fishery that is well-known for its fly fishing potential. Near Livingston, Montana, the river turns easterly and broadens somewhat thus losing some of its energy. However, severe floods occurred in 1996 and 1997, and local groups have since spent many hours in public debates concerning river management.

Recruitment of Native Americans

Native Americans also have interests in the Yellowstone River. They are active in maintaining the cultural linkages between their histories and the local landscapes. For the purposes of this study a number of Native Americans from the Crow tribe and the Northern Cheyenne tribe were included. Native Americans were recruited by means of professional and personal contacts, either as referrals from state agency personnel, from Resource Advisory Committee members of the Yellowstone River Conservation District Council, or from other project participants.

Recruitment of Geographic Specific Interest Group Participants

The participants represent a volunteer sample of full-time residents of the towns and areas between the confluence of the Yellowstone and Missouri Rivers in North Dakota and the town of Gardiner, Montana at the north entrance to Yellowstone National Park. Participants were recruited from four major interest groups: agriculturalists, local civic leaders, recreationalists, and residentialists living near the river. A database of names, addresses and contact information was constructed for recruitment purposes. Nearly 800 entries were listed in the database, representing a relatively even contribution across the four major interest groups.

Individuals representing agriculture interests, including farmers and ranchers, were identified and recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of the Natural Resources Conservation Service.

Individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and public works managers, were identified and recruited through public records.

Individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity, were identified and recruited from referrals provided by members of the Resource Advisory Committee. Participants were also identified and recruited by contacting various non-governmental organizations such as Ducks Unlimited, Trout Unlimited, the Audubon Society and by contacting local outfitting businesses.

The names of property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank, were obtained through a GIS search of public land ownership records. Twenty acres was used as a screening threshold to separate people who lived along the river corridor but whose incomes were from something other than agricultural practices (residentialists) from those who were predominantly farmers or ranchers (agriculturalists). The names were sorted by county and randomized. Recruitment proceeded from the county lists. Other people living very near the river and whose primary incomes were not generated by agriculture were also recruited. These additional participants may not have had property that technically bordered the river and/or they may have owned more than 20 acres. In all cases, the recruits did not consider agricultural as their main source of income.

Participants were recruited by telephone and individual appointments were scheduled at times and meeting places convenient for them. Many interviews were conducted in the early morning hours and the late evening hours as a means of accommodating the participants' work schedules.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

A total of 313 people participated in the project, including 86 representatives from agriculture, 68 representatives in local civic roles, 76 representatives of recreational interests, 76 residentialists and seven Native Americans. A relatively equal representation was achieved in each geographic segment for each interest group.

Description of Interviews and Collection of Participant Comments

A master protocol was designed from questions provided by the US Army Corps of Engineers and approved by the Office of Management and Budget (OMB approval # 0710-0001; see example in the appendix to this volume). Questions were selected that would encourage participants to describe the local environs, their personal observations of changes in the river, their uses of the river and any concerns they may have had about the future of the river as a shared resource. Open-ended questions were used as a means of encouraging participants to speak conversationally.

The questions were adapted to the participants' interest groups. For instance, interviews with agriculturalists began with the question, "How many years have you been in operation here?" while local civic leaders where asked, "How many years have you lived in this community?" Similarly, agriculturalists were asked, "Are there any problems associated with having property this close to the river?" and local civic leaders were asked, "Are there any problems associated with having private or public properties close to the river?" The overriding objective of the approach was to engage the participants in conversations about the river, its importance and their specific concerns.

Participants were promised confidentiality, and open-ended questions were asked as a means of encouraging the residents to talk about the river, the local environs and their personal observations and concerns in their own words. All respondents were interested in talking about their perspectives, and they represented a variety of views of the river, including: farming, ranching, agricultural science, commercial development, recreation, civic infrastructure, environmental activism, historical views and entrepreneurial interests.

With only three exceptions, the interviews were audio-recorded and verbatim transcripts were produced as records of the interviews. In the other three cases, hand-written notes were taken and later typed into an electronic format. The total resulting interview data totaled approximately 2,700 pages of interview text.

Steps of Data Analysis

The content of the interview texts was distilled by way of analytical steps that would retain geographical and interest group integrity.

Segment-Specific Interest Group Analyses: Taking all audio-recordings, transcripts, and field notes as the complete data set, the research group first set out to determine the primary values and concerns for each geographic segment-specific interest group. The team began with the four interest groups from the segment Springdale to Laurel. Team

members read individual interview transcripts and determined a core set of values and concerns for the individuals represented. As a team, notes were compared and a combined outline of values and concerns was constructed for each interest group in the geographic segment. Quotes were then taken from each transcript in the set to illustrate the particular values and concerns.

Outlines of the interest group analyses for the Springdale to Laurel segment were then used as aids in constructing the interest group analyses in all other geographic segments. Care was taken to adapt the interest group analyses to highlight if, and when, the core values and concerns were different in each geographic segment. The Native American perspective was addressed as an individual analysis with attention to the specifics of those perspectives. Each of the 21 segment-specific interest group analyses was then illustrated with quotes from interviews.

21 Segment-Specific Interest Group Analyses

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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CIVIC	14	14	18	14	8	68
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Segment-Specific Geographic Summaries: A summary of the values and concerns for each geographic segment was constructed using the sets of four geographic-specific interest group analyses. Geographic summaries were written to reflect the concerns that crossed all interests groups of the segment, either as points of agreement or disagreement, and were illustrated with quotes from the four relevant interest group analyses.

5 Segment-Specific Geographic Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

River-Length Interest Group Summaries: River-length interest group summaries were constructed for each of the four primary interest groups. For example, agricultural concerns from the five geographic segments were compared and quotes were taken from the segment-specific interest group reports to illustrate commonalities and differences. Similar reports were constructed for local civic leaders, recreationalists and residentialists.

4 River-Length Interest Group Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
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RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Organization of the Reports

Overall Summary of the Yellowstone River Cultural Inventory—2006: An overall summary of the inventory was written as a means of highlighting the values and concerns that cross interest groups and geographic segments. The segment-specific geographic summaries and the river-length interest group summaries were used as the bases for the overall summary. This report is by no means comprehensive. Rather, it is written to encourage further reading in the reports of each geographic segment and in the interest group reports.

Part I: Missouri River to Powder River: This volume includes the geographic summary for Missouri River to Powder River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part II: Powder River to Big Horn River: This volume includes the geographic summary for Powder River to Big Horn River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part III: Big Horn River to Laurel: This volume includes the geographic summary for Big Horn River to Laurel and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part IV: Laurel to Springdale: This volume includes the geographic summary for Laurel to Springdale and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

***Part V: Springdale to Gardiner*:** This volume includes the geographic summary for Springdale to the boundary with Yellowstone National Park and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Research Team and Support Staff

The project was directed by Dr. Susan J. Gilbertz, Montana State University—Billings. She was aided in data collection and data analyses by Cristi Horton, Tarleton State University and Damon Hall, Texas A&M University. Support staff included: Amanda Skinner, Amber Gamsby, Beth Oswald, Nancy Heald, Beth Quiroz, Jolene Burdge, and John Weikel, all of Billings, Montana.

Laurel to Springdale: Geographic Segment Overview

Interviews in the geographic segment Laurel to Springdale were conducted May 22-26, 2006. A total of 54 interviews were conducted, including individuals with agricultural, civic, recreational, or residential interests as their primary concern.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Laurel to Springdale: Geographic Segment Summary

> *Two things come to mind right now. Although I believe in personal property rights…I believe, too, that…not everybody is going to get everything they want. It just has to be that way.* (*Stillwater County Local Civic Leader)*

Introduction

In the study segment, Laurel to Springdale, three themes emerge as dominant across the four interest groups. One theme focuses on the changing riverbank profile as more and more residential homes are built on the river's edge. The second theme focuses on the river as a powerful and dynamic physical entity. The third is about the changing social profiles of their communities and how those changes influence user practices.

The Changing Riverbank Profile

Nearly without exception, the people of the Springdale and Laurel segment engage in discussions concerning changes they see happening along the riverbanks. Put simply, the riverbanks are becoming noticeably different as agricultural lands become sites for subdivisions or sites for exclusivity. Undoubtedly, the river's captivating beauty and physical forces are key reasons for residential development near the river's edge, but development is complicating conceptions of how to manage the power of the river.

Living near the river is an attractive idea, and those that do are quick to explain how much such locales add to the quality of their lives. Both residentialists and agriculturalists express the importance of living near the river:

> The river to me is kind of mesmerizing, interesting. You never know what it is going to do. It is just nice to be watching it all the time. (*Stillwater County Agriculturalist*)
>
> That Yellowstone River…is really…an exceptionally—well, I don't know quite how to put it, but it's really something….It's quite a deal. (*Stillwater County Agriculturalist*)
>
> We border the Yellowstone. That is important to me,…that we live right along the river. It does affect your life….It is home. Just home, that's all. (*Sweet Grass County Agriculturalist*)
>
> Paradise. It's just great, great living. Private and beautiful. We are so lucky and privileged to live here; it's just wonderful. We have about two and a half miles of riverfront, so we don't have any neighbors close, and it is just great….The river is

> the reason we are here. It's the whole thing. There is constant action going on at the river, whether it's birds, or fishing, or deer, or whatever. There is always wildlife around which is our great love. We cultivate our land for wildlife. (*Sweet Grass County Residentialist*)

> Everyday I walk down my hall, and I have a new picture window. And you know, it's just awesome. The colors in the fall are beautiful, [and] most of the time the sun's shining on the mountains. We can see Granite Peak, we can see all kinds of activity in the river with geese, and we just love it, it's just awesome….My heart just feels so good. This is our place. (*Stillwater County Residentialist*)

For many locals, the new residential developments expose and represent a shift in the economy of land values:

> Land prices are going up all the time. It is tempting for people to sell….You can't buy the land and make it produce enough to make payments. That is changed in my lifetime. (*Sweet Grass County Agriculturalist*)

> It's starting to look like home sites….There will be more houses all along, wherever they can buy small acreage….If [they] could get five or ten acres, if there's access to build a home, then I understand it's for sale, and they're going to subdivide it….The real estate man had called me up about it, says there's a guy from Atlanta, Georgia, who wants to build a house out there. (*Carbon County Agriculturalist*)

> Everybody wants a little piece of land on the river, and then they build right on the river, which kind of sucks….You go up by Livingston, and you see the houses. I mean, house, after house, after house, after house, built right on the river. (*Sweet Grass County Recreationalist*)

> It's people with lots of money coming in,…and [some are] pushing this planning so that the guy down the road that has a ranch [can] break a chunk off [for himself] so that he can stay on his place for the rest of his life, and give [what's left] to his kids. (*Sweet Grass County Recreationalist*)

> You read about the romance of the Old West, and that's why a lot of these rich people come…for the romance. Well, there's romance in an old family farm, too. Their romance [the rich people's] won't buy you breakfast. (*Sweet Grass County Local Civic Leader)*

> My daughter and son-in-law live on a ranch west of town here, and it's not a very big place….A realtor just appraised it at a million and a half….It's out of the question entirely for the kids to buy it. My wife and I have spent all of these years in agriculture, and just like most of the neighbors, whenever you do make a profit, you put it back into something else. So we got a million and a half dollars sitting up there, and nothing to show for it….How are the kids going to make a payment

> and still be able to live there, too? And with an appraisal like that, the government won't let you give it away. You can't sell it for less than the appraisal…and [besides,] the last thing we want to do is sell the place. (*Sweet Grass County Local Civic Leader)*

Not only do residential owners shift land values, they often live in subdivisions that provide exclusive access rights and that shift the ways other locals can or cannot gain access to the river. The residentialists are openly thankful for the privileges provided by their subdivisions as these amenities add to the "paradise" quality of their experiences:

> Well, our place right here, our subdivision owns about an acre and a half of common property right along the Yellowstone. So we have the opportunity to go down there anytime we want, and go down to the river….We have access to the river, and often we float from upriver to our common area and get out….It is just really nice having that access. (*Sweet Grass County Residentialist*)

> This subdivision is unique in that there is a bridle path that follows the river for use by the owners in the subdivision. Anytime you have an easement like that, it is somewhat troublesome because there is no incorporated town out here. But if the towns grew enough, they could make a permanent easement, and everyone could use it. That is what bothers me….That bridle path was meant as a bridle path, and they shouldn't use it as access to the river. It may sound selfish, but I am paying taxes on it, and they don't. My liability covers only me, and if they got hurt, they could sue me. They wouldn't win, but they could still take me to court. That bothers me.…A guy bought a bunch of the land, and is going to put in 100 houses [behind me, away from the river]. That is a huge impact. If those people think they are going to use the bridle path, I will have a problem with that. It was designed for this portion [of the subdivision], not the whole. So, the enforcement problem may be a real problem. (*Stillwater County Residentialist*)

Even in cases where the land is not subdivided into small parcels, new owners do not necessarily share access to the river's resources with locals. Rather, land is purchased as a block and held for limited private hunting and fishing:

> They don't subdivide it, they just come in. They buy it up. They don't put any cows on it, they just let it sit there, and build a great big trophy house on it, and…the land isn't really being used for agriculture any more, it's either someone's personal hunting grounds or river access, you know. So, for me, you've kept people from living on it, so that those [wealthy] people can come in and block everybody off it. It doesn't happen all the time. (*Sweet Grass County Local Civic Leader)*

> We have some [newcomers] that have moved in and their house is right next to the river, and then they want no one else to build next to the river. You know, 'I've got my little piece of heaven, but I don't want anyone else to be able to do that.' (*Sweet Grass County Local Civic Leader)*

> You can see huge, orange-painted signs, meaning ‘Stay off. Private property.’ And the thing is that is coming about. It is not the local people that are doing this. It is the people from out-of-state who are buying these parcels. [They] want that little island as their own, even though they can’t access it, and they can’t use it for agriculture. They just don’t want anybody there. But, from an agriculture standpoint, when they show up to your house to go hunting, they expect you to allow them to do whatever they like. That is the problem with out-of-staters. They want it all for themselves and not let anybody use it. (*Carbon County Recreationalist*)

Deeper into the conversations are illustrations of the need to balance three dimensions of local life. First, locals are interested in the general economic prosperity of the community:

> Development will always occur. [The community] is either going to…grow, or it will demise. You really can’t maintain the status quo. If you aren’t growing, you’re probably going to go down. You can’t maintain the status quo. (*Stillwater County Local Civic Leader)*

> We are trying to figure where any new growth will happen. Most of it is happening west of town. We are looking at extension of power and annexation. The city is in the process of adopting a growth policy and looking at impact fees. Those are the fees charged to developers for the expansion of city services. (*Sweet Grass County Local Civic Leader)*

Second, locals express a great deal of concern for respecting private property rights:

> Montanans don’t like to be told what to do. (*Stillwater County Agriculturalist*)

> It’s your own property and you sell it to someone else. I guess they can do what they want with it. And most of the people that I know are good, but there can be some sour ones. (*Carbon County Agriculturalist*)

> If I want to add a little addition on, I should be able to do it. But you can’t just add on. You got to go pay for a permit. And that’s the same thing with the ranch. You just can’t, not that we were going to do anything, but we had a battle to get permission to build. Because I wanted to put the barn right back in basically the same spot that the barn was. And we fought, and they said, ‘You can’t have it where it was, it will wash out.’ Well, I’m going to put it in cement in the ground. That old barn sat on a wooden foundation and it never floated away in the big flood. If I put this one in cemented foundation, that’s going to float away? I mean, it’s just stupidity. (*Sweet Grass County Agriculturalist*)

Third, they are concerned that development should occur in a responsible manner and that attention should be paid to the potential impacts of development on the river:

> It's very special to have this river here, and, of course, we want to protect it. We want to make sure that any housing developments follow the DEQ rules, [especially] septics should be placed according to DEQ. I guess I don't believe in setbacks. I think the property owners have the right to be as close to the river as they want, without damaging the river. If they do not damage the river, I think it's their property line. (*Stillwater County Local Civic Leader)*

> To the extent that we have state statutes that specify, we do have minimum standards for the flood plain by state law. One of those is public health and safety; you can't permit something if it is a public health and safety threat. (*Sweet Grass County Local Civic Leader)*

> Flood plains are sacred. We just cannot break in flood plains like we used to. There are some things…[that the law requires: that you have to have a three-foot differential, the land where you're going to build your house has to be at least three feet above where the water table is. Well, if that's based on a dry year, and you build your house and then you have average years again, or normal years, you might have a problem. The law doesn't account for that. (*Stillwater County Local Civic Leader)*

Oppositions to developing stricter regulations are not categorically accepted or rejected. Locals approach such ideas with trepidation but also with a willingness to consider how the community might dampen development at the river's edge:

> I think that sort of thing is critical: to leave a fringe on the river undeveloped, to keep the water as pure as possible, to try to work on the tributaries, be sure the ranchers have adequate water, but don't have any more than they need at the times they need it. I think they're working on all that. But I think it'd be great to get people to sign a voluntary thing that we won't build within 200 feet of the river. (*Sweet Grass County Agriculturalist*)

> Septic systems [are a concern]….They're too close together, and [too close to] their wells, and it's just a mess. And [there's] nothing you can do about it. Some were put in as, 'Oh, we're going to be using it for summer homes, so we'll just have storage. We'll just have a holding tank.' Well, it turned into year-round living, and a hole got poked in the tank, you know. So, probably, it's flowing out the bottom into Rock Creek…and there is not much we can do with them. Just don't want any more of them. We're trying to…put their feet to the fire, and say, 'Now, you've got a holding tank. We want records, public records.' So, we're working on that area. We don't allow any holding tanks any more. (*Carbon County Local Civic Leader)*

> I'm not saying we're ready for [zoning]….Over time,…that may not be a bad idea….I think folks are more and more receptive. A lot of the people are coming in….It's a nice place to live, so they're coming from everywhere. You know, Californians,… Texans,…and they're drawn here because it's not like where they're coming from, yet they want to make it like where they're coming from….But they also have good ideas. They come from areas where they have more progressive local governments…and are wondering why [not here]? (*Stillwater County Local Civic Leader)*

> Roads are probably the biggest thing. They take a relatively big part of the budget. Roads are something that everybody uses, and we have a lot of problems with them. We can't afford to do all of the graveling we need,…[and we can't afford] to replace all the bridges that should be replaced. (*Stillwater County Local Civic Leader)*

> It's changing rapidly….I was talking today to a man selling his ranch who has two offers on it right now. And I think that a lot of people don't realize how quickly it's changing….I think Montana needs to decide, do they want tourists?…Montanans need to sit down and decide the future of Montana, plan it. What do they want it to be? Want it to be this? How do you keep it this way, or make it this way?...It's going the other way….[Montanan's have] got to be the author of the future. They've got the opportunity, now, because it hasn't been ruined like many places in America….Seize this opportunity, and do it together, work in a cooperative way, and work out the future. Well, that's a lot to say,…[and] hard to do. (*Sweet Grass County Agriculturalist*)

The changing riverbank profile generates a great deal of discussion among the people in the Laurel to Springdale segment of the study. There is an apparent desire to manage the development along the river's edge so that the historic agricultural sense of these communities is not wholly lost to a residential dominance. At issue are private rights, community prosperity, and deep concerns about developing rules for protecting the river. As the individual communities grow, there is recognition that a community consensus is unlikely but that rules are necessary.

The Yellowstone River is Dynamic and Powerful

While the Yellowstone River is an especially attractive site for residential development, many people are more impressed by its power. The river is known for its ability to flood and erode its banks. The floods of the mid-1990s are important illustrations for understanding the power of the river. Such events are reminders that the river is powerful, but they also serve as the impulse for wanting to control the river.

Local understandings of flood plains are complicated. Many people understand major floods are difficult to predict, challenging to control, and that they result in change:

> It is meander-land, and nobody can own that….There were river changes in that ’98 flood, and, of course, some islands were created, and it washed down banks….Some people lost acres and acres of land….I know of one group who ended up with an island, and they claim it’s theirs, because the river ran right through their property and created an island….Nobody pays taxes on it….For example, if this is a lake, and the water comes up in high water years to cover most of [the land], you wouldn’t think that would reduce your taxes, [and] it doesn’t. Or, if it goes down, and you can farm this for a while, you still don’t pay taxes on it. But, you can’t claim it either;…its no-man’s land….[It] used to be that the Corps of Engineers could come in and just change things at will, and that caused its own set of problems, here and there. I don’t like the idea of changing the direction of the river….It has its own set of problems that come with it. It might help this guy who lost some acreage to reroute the water away, but it ultimately, someplace else, will cause a problem….I think rivers should meander wherever they naturally go. (*Sweet Grass County Local Civic Leader)*

> [After] I took office, in the southern part of the county, there were some ice build-ups and there were primarily summer homes, and they were concerned about flooding, so they called me, the new commissioner in their district, and said we’ve got this ice, come and help us out. It sounds like a reasonable request to me, [but] I’ll have to ask and get back to you. I talked to our road and the other commissioners and, no, we can’t do that. Really? Why? Well, three things. First, it’s on private land and there’s liability….Another one is the Fish and Game is responsible for the fish habitats [and] would have some problem if we took heavy equipment and messed around with the river. And the other thing [is]...an insurance company would look at this ice jam as a natural event, call it an act of God or something. So if we go in there with our equipment and undo that, we’re just pushing the problem downstream and then it’s our fault; it isn’t an act of God, it’s an act of the County Commissioners. So, we just would like to help people, but we can’t, and when we explain why, they accept that. (*Stillwater County Local Civic Leader)*

> I think in certain spots you can prepare a little bit for [floods], but nobody knows what’s going to come and how big it’s going to get. When it hits 37, or 38, or 40,000 [cubic feet per second], there’s only so much you can do. At that point, you’re not stopping it. You might try to do something to fix it or stop it from the next time, but it will do what it wants to. (*Sweet Grass County Recreationalist*)

Residentialists speak in a variety of terms concerning the possibility of flooding and erosion. While most will admit to certain eventualities, some hold that events capable of causing major destruction are unlikely within their own lifetimes. Those holding that view are referred to here as NIMLYs, individuals who understand that flooding can happen, but they generally hope, or assume, “Not In My Lifetime/Years.”

Others are convinced that their particular locations are quite safe as compared to nearby locations, and many residential owners are frustrated by flood plain maps:

> As far as flooding and such? No, we don't [worry]. The town's going to flood before we would. We're higher than that, so we don't have a problem with that. I think if we're going to flood, I'd better call Noah in because, you know, it's going to get pretty high. (*Stillwater County Residentialist*)

> I don't know if during our time down here we will [see change]….But there again, it depends on the number of floods. That is going to have the biggest impact on it every time. If that happens there is something different every time….But I don't think we will see a major change. I don't expect a new channel to be going across the hills or something. If it does that, we will be out of here! We will be building a big boat with a lot of animals on it. And one thing down here where the river runs, there is that big hillside there, so if it is going to change, it isn't going to impact this way….It was a big flood we had in 1996, 1997, and we weren't living here prior to that, but we floated it a lot, and it didn't make huge changes. That was a good-sized flood. (*Sweet Grass County Residentialist*)

> The last time they did a survey for the flood plain was probably over 20 years ago, and it is something that needs to be done and upgraded….If you look at the flood plain maps they have got, they show us in the flood plain, and that is wrong. We are not in the flood plain. We are too high for a flood plain, but that is the federal government. What are you going to do about it? As far as people building low, I don't think they should be allowed to build in the flood plain. All it does is cause problems for everybody concerned. And for people not in the flood plain, we are being penalized….If there are not enough regulations, or if they have not been reviewed, when the river changes over the years [the maps are not accurate]….Anybody along this side of the river is required, if you refinance, to have flood insurance, and you can't fight it. If you pay cash, you don't have to have it, but if you finance, [it is required]….I mean, there need to be regulations, and people need the proper insurance, but it needs to be looked at closer and more often. (*Stillwater County Residentialist*)

Based on years of experience, agriculturalists have a great deal of respect for the power of the river. Others, too, are fully cognizant of its power:

> It's a big river. And at flood stage, it's really big. Like I said before, August to September, it gets really low…[but] I always liked that there was a source of water for the livestock. It never went dry. I don't think it ever has. (*Carbon County Agriculturalist*)

> That river is a powerful force. It is a powerful, powerful thing. I don't care what man does, if [the river] decides it is going to go, it is going to go. (*Sweet Grass County Agriculturalist*)

> I never know where my property line is at….The river takes a little every year. In real high water years, it's more aggressive. It takes fertile soil real fast….I'm not whining, I'm resigned….I've resigned myself to this in sadness. (*Stillwater County Agriculturalist*)

> The river is going to do what it is going to do, and you have to live with it the best you can. (*Sweet Grass County Agriculturalist*)

> Between our place and Laurel, the land spreads out and they can farm on that side of the river…and I know they've had trouble. They get flooded out. They're in the flood plain, and it gets real bad sometimes. It's a lot of trouble for them. (*Carbon County Agriculturalist*)

> In some places [erosion] is tremendous. It depends on the topography and it depends on the river….In some places erosion is a problem; in other places, because of the rocky bottom ground, not so much….Can I say it is a huge problem in the county? No, but it is a problem in certain, specific areas. (*Sweet Grass County Local Civic Leader)*

> One thing about the river right now, it is fast, and it is dangerous. People get on it, and they don't know what they are doing. [There are a] bunch of undercurrents. It will take a boat quick. (*Carbon County Recreationalist*)

> We saw damage down here with ice. The ice just all of the sudden broke, and spread and knocked down trees….We had an ice jam, and it backed the river up, and it floated ice out all over this area. There were ice chunks, clear over to the bank, the size of Volkswagens. It happened while we were sleeping, and we didn't hear it, but we got up the next morning and were like, 'Holy crap.' (*Sweet Grass County Residentialist*)

> The river took that island out in about a week and a half. It had 50 to 60 feet cottonwoods. It was just covered in trees. It just took it right out, you know. That is what the river does. We just expect it is going to happen. (*Stillwater County Residentialist*)

In terms of managing that power, a number of priorities emerge. For participants in the Civic category, the priorities center on roads, bridges, public safety and a desire for better flood plain maps:

> Public safety has to be number one. Number two is probably…protection of property rights….I would put a high premium on property rights. (*Sweet Grass County Local Civic Leader)*

> One of our obligations is to keep the roads and bridges open, and that would be for emergency services primarily but also, for…school buses. (*Stillwater County Local Civic Leader)*

> The good old Yellowstone is a cantankerous old thing. That river is wonderful, but it's also wonderful to watch it. It's going to go wherever it wants to go. I'm kind of torn…because we have people [who] defy us to do any rip-rapping, or to save a public structure, or anything like that. We're not supposed to do that, I guess. That's what I'm hearing. But, darn it, you've got a two million dollar bridge sitting there, and the thing's washing out, you better do something. We can't shut all the traffic off….This bridge down here was in jeopardy. So, they brought in a lot of rock and fixed it. It's fine. We had it protected.…We've, [also] had some subdividers that have gone on their own and put in some Mickey Mouse things, jetties. But it really didn't upset the river a whole lot; it's got a mind of its own. (*Stillwater County Local Civic Leader)*

> I would like to see a lot better mapping on the Yellowstone River. Most of our maps are 1982 FEMA maps. Some of the Yellowstone has had some updating, and…that is helpful, but there needs to be some better mapping and better understanding of activities in the flood plain, and how to best undertake those, both from a safety issue and also trying to protect the resource. (*Sweet Grass County Local Civic Leader)*

For agriculturalists, the priority is the desire to protect productive land, which is tempered by a sense of futility:

> Watching will convince you that nature will take its course….It has worked its way into my meadows…and I've lost productive ground. (*Stillwater County Agriculturalist*)

> In some ways, the river is a pain in the neck. You go down there and it [has] taken off five acres. Every year…it just keeps taking more and more. And so, that's why I'd say it's a pain in the neck. Nothing you can do about it. Just watch it go. (*Sweet Grass County Agriculturalist*)

> Well, it was about '96 or '97 when it flooded….All of this was under water because it was up about 30 feet. We couldn't get into our buildings or anything over here; it was all under water. We had about four feet of water….It damaged the trees in the meadow. It took three years to get it back in shape….We have probably lost 30 acres in that flood, and it is still taking ground. (*Sweet Grass County Agriculturalist***)**

> We see ice jams come instantly, like we had thrown a dam right across the river. The same year we saw the 500-year flood, 1998, that winter, we had two ice jams right behind our buildings and in three to five minutes, there were probably 50 acres with two feet of water and icebergs along. One wasn't too bad. The other one really did the job on us—tore out a lot of pens and stuff. I mean, the river is kind of amazing. And, when it forms ice in just 24 hours, ice will start stacking up and look like the Yukon River. (*Stillwater County Agriculturalist*)

Most people recognize that erosion is a natural process and difficult to control. Recreationalists often argue that attempts to control erosion are themselves problematic, but others will also argue that attempting to control the river may not be wise or economically feasible:

> That guy spent tens of thousands of dollars rip-rapping it, to protect it. Since the flood, he has done more rip-rapping. (*Sweet Grass County Residentialist)*

> When we're talking about the Yellowstone, we're not talking your normal Montana river. I mean…there's a lot of power in this bad boy….It will do what it wants. So…to keep it from eating stuff up, you've got to get pretty tough with it. (*Sweet Grass County Residentialist*)

> I'm not sold on whether we should try to engineer the river with rip-rap….I think that's very unnatural. And, yes, [the river] will eat your property. It was eating into our land….but we never rip-rapped it. It's a natural thing. And I guess that's another thing: you got to let these streams be natural. I think you got to let them have their natural habitat, if you will. It's like an animal; a stream has a habitat, doesn't it? (*Sweet Grass County Agriculturalist*)

> I don't see that the erosion itself is a huge problem, unless you are a farmer that is losing ground, which is big. I don't think there is much fighting [erosion]. I think rip-rap is a mistake. I think rip-rap is almost an arrogant way that man tries to control a force much bigger than himself. (*Sweet Grass County Recreationalist*)

> In '97 to '98, [flooding] changed the Yellowstone River in a lot of places….Pools I used to fish in are not there. The islands I used to mushroom, are not there….[One] man wanted to armor it, and they wouldn't let him, and then when this big flood hit…I don't know how many acres it devoured at that one man's place. (*Carbon County Recreationalist*)

The issues involved in attempting to control the river are complex. One set of complexities is introduced when discussing rip-rap as a remedy. This method is considered effective, but at odds with the notion of a free-flowing river:

> Certainly, I understand the people that have property, and they want to try to preserve their property, and I respect that. But the fact is, the Yellowstone is a wild river, and,…to me, it sort of comes with the territory….[We should] try to achieve [a] balance, and not be overly regulatory with citizens [as far as]…what they can and can't do with their property, but, on the other hand, realize that, hey, you're not just doing something that's going to perhaps impact a little piece of property; you're doing something that could have potential impact on a resource that has significant economic impact, [and] social impact…on a whole bunch of people. So, people need to understand [it is] a lot broader than their little piece of property on the river. (*Stillwater County Recreationalist*)

The Yellowstone is, just….It's really cool that it doesn't have a big dam somewhere….It's free.…You can see where it starts, and where it ends, and there's nothing stopping it. (*Sweet Grass County Recreationalist*)

Free-flowing at whose cost? The people who want the river to run where it wants to run don't pay for it….I should be getting an award from the free-flowing folks because I've contributed a half-million in the form of lost land. (*Stillwater County Agriculturalist*)

It's the longest free-flowing river in North America, and there's nothing else like it….It's a natural fishery…and it's scenic and it's just an amazing place. The length, the variety, and the types of fishing are unsurpassed anywhere. (*Sweet Grass County Recreationalist*)

You know, there is a lot of agriculture that is being affected by what the river is doing….if it takes its course, it moves all over the place…It is going to do what it well pleases, but maybe we can stabilize it….We put a lot of rip-rap in since [the flood] I have been here. Probably close to 500 to 1000 feet worth of rip-rap and we have applied for more. *(Sweet Grass County Agriculturalist)*

The rip-rap and the ironclad are the most effective if it is done right….I am more for the agriculture and saving your property. (*Sweet Grass County Agriculturalist*)

The man who owned it before me…spent a great deal of money on it….But, you see, [my losses] all could have been avoided because right at the Yellowstone River Bridge, after the water would go down each year, there was debris and a few rocks, and we would go in with a back hoe and put it back where it was….Then the government made a practice where you couldn't remove that again, so the river swung, and just ate it out…. We should go back to the Army Corps of Engineers, and I should be reimbursed for that rock jetty, because, when I bought the property, that is supposed to be taken care of. And it's very expensive….Everything is so expensive….I don't plan to do anything. I don't have a great deal of faith in the Corps of Engineers. I think they should come out and justify what they did. (*Stillwater County Agriculturalist*)

We certainly have. There is a lot [of erosion] right down on the corner of the subdivision….I suppose [our neighbor] has lost about a quarter of the lot. The river makes a turn in there and just digs. A lot of that bank is leaving, and below there, too, because the owner had to have them rip-rap it along there….And certainly with the flood we have notice….And, that was major. That was major. (*Sweet Grass County Residentialist*)

Yellowstone River is the longest, free-flowing river in the United States, un-dammed. That is pretty neat, and to do too much to it, [such as rip-rapping], would be sad, too. To do too much, would take away from it….I don't know, just a thought there. (*Sweet Grass County Residentialist*)

Additionally, many people understand that rip-rap potentially propagates erosion problems downstream:

> When the river is flooding and eroding land it is trying to relieve itself. If you tighten up down here, someone downstream is going to get it. It is almost impossible to get permission to rip-rap. (*Sweet Grass County Residentialist*)
> [Rip-rap] can definitely have an effect downstream. It re-energizes the river. You definitely have to take a look at that….I'd be very concerned if I was a landowner downstream and somebody put in some rip-rap. They should definitely have a say, too, and there should be some remediation, if [those downstream] lose land as a result of rip-rap upstream. (*Sweet Grass County Recreationalist*)
>
> You can see it takes some planning. If you rip-rap one side of the river it, it'll start eroding, and it makes channels, and it'll bleed off this side over here. (*Sweet Grass County Agriculturalist*)
>
> Sometimes there is an embankment of some sort, whether it is rip-rap, or those barbs that go out into the river with the rock….Maybe the best thing would be to recognize that it is going to happen, and [that]….you can't fix every problem. Putting in some fake retaining wall or rip-rap may exacerbate it instead of fixing it. I am not advocating a specific solution. (*Sweet Grass County Local Civic Leader)*
>
> The north side has a railroad track that has an affect on the hydraulics….Also, things done upstream have made a difference….[The river] works the course of least resistance. (*Stillwater County Agriculturalist*)
>
> You can't go in and interfere with the river anymore. I agree that if you're going to go in and flood someone else, or hurt something—fix mine and flood you—that's not good....[But] when the road washed out a few years ago, they could have stopped that. (*Carbon County Agriculturalist*)
>
> The river is the river, and you are not going to control it. If you are doing something here, it is going to affect something, or someone, down there. High school geology taught me that. (*Sweet Grass County Residentialist*)

Nonetheless, there is a sense that some projects are worth doing:

> Projects should be based on merit.…[But] the scale that would be effective will never be approved.…The 'controlled stream' won't happen….The massive concept won't happen. (*Stillwater County Agriculturalist*)
>
> This bridge here just south of Columbus, it used to have a lot of rip-rap on it. And, four or five years ago, when we had the high water, it took that rip-rap away. And it was big rip-rap. And now, I'd say it's underneath that bridge someplace….That whole bank—it's just a small piece of private property—but that's going to just

> keep eroding away to the road. And that's a pretty important road….I think they have to have an aggressive rip-rap program. We've got infrastructure that needs to be protected….Let us get in there to protect [it]….[Let us] put some large rocks, rip-rap, in there to protect those things. Most ranchers cannot afford to rip-rap…and the river just eats away and takes away, but roads need to be protected. (*Stillwater County Local Civic Leader)*

Another issue involves questions regarding rip-rap and the health of the fisheries. Even among recreationalists there is no agreement regarding whether rip-rap does, or does not, impact the fisheries:

> It's a real fine balance, in my opinion. I have the utmost respect for other interests….I know we have to work together. So I think that's why it's important that we do strike a balance in terms of some of the things people are looking at. For example, putting the rip-rap on the banks…may prevent erosion of their property and their interests, but, if its not done properly, it could have some sort of adverse impact on the fishery, which concerns me. And then it takes away from that pristine environment….I like the fact that,…in this section [of the river, in] very few places do you see any man-made changes to the river. It meanders, it's pretty natural, and, as you can see [today], it's really roaring….When it starts to lower itself down, some new side channels will [form], there'll be new obstructions,…new fish habitat, and so on. (*Stillwater County Recreationalist*)

> It's such a meandering, naturally flowing river; it seeks all these little braids and channels and so on….I'm not sure, but my suspicion is that when you start to mess around with it too much, then it's going to perhaps eliminate or degrade some of that natural structure and…habitat. (*Stillwater County Recreationalist*)

> I always figured rip-rap made habitat for the fish….They say it's [only for] the big fish, but you can have two people with the same study, one for one group and one for the other, and you will never have the same answer. (*Carbon County Recreationalist*)

> They say rip-rap is bad for the fish and all that crap, and [then] you watch the guides take people where the rip-rap is. The fish love it in there. It is habitat for them. They can get under the rocks and hide. I don't understand [the objection]. (*Sweet Grass County Residentialist)*

Many land owners talk about the expenses involved in trying to stabilize a bank as "quite an investment":

> I have no education on how to tame a river, how to keep a river in its boundaries. I think it can be done but it would take quite an investment…The last I heard, rip-rap was $125 a foot. It doesn't take long to eat up a life savings. There is no guarantee. It has got to be something on a larger scale than an individual can do. The government will have to do it or nothing can be done. The county can just

> hold a little here and there….I am sure there is engineering out there that can fix it, but just putting a little bit here and there isn't going to do it. (*Sweet Grass County Agriculturalist*)

> Had I substantial resources, there might have been things that could have been done….[But,] the scale is overwhelming.…To restructure an old jetty and rip-rap was three to five times the cost of the land….I didn't have enough money because I had just bought the land. (*Stillwater County Agriculturalist*)

> We have the permit and everything, but we didn't have the money to. [It] costs too much. (*Sweet Grass County Agriculturalist*)

> I remember reading in the paper, after the 500-year flood in Livingston, there was a guy that went ahead and saved some ground. I can't remember how many miles it was, but it costs him $600,000. That's what he put into it….He must have had a lot of money to invest, because it would take a long time to ever get it back. If it was for agriculture, I don't know if you ever would [regain that money]. (*Stillwater County Agriculturalist*)

> Rip-rapping is the cheapest form of erosion control….Some people will use steel plates, and pound in bridge pilings, and make a wall if they are trying to protect a house. Concrete walls are very expensive. (*Sweet Grass County Residentialist*)

> That guy spent tens of thousands of dollars rip-rapping it to protect it. Since the flood, he has done more rip-rapping. (*Sweet Grass County Residentialist*)

Also, the permitting process with regard to rip-rap generates lively discussions:

> It's got to be a commission that balances everybody. I don't think it should be totally up to the Army Corps of Engineers, or anybody else that permits it. I think you really have to show a need and [show] why this river needs to be armored at this point. There's some very good reasons,…but [no one should] have *carte blanche* to go ahead and place rocks. (*Sweet Grass County Recreationalist*)

> We've got a bunch of rip-rap that we got put in before all of the environmental regulations….I don't know…if we can even rip-rap now or not. It's a touchy situation….A lot of these…environmentalist seem to have a problem with it….They said it can create sediment problems….I think it all boils down to they think that if the stream wants to move, it should be able to,…even [if] some guy's paying the taxes on the land….If the river wants to take it all out, they don't care. I think that's the way they look at it. (*Sweet Grass County Residentialist*)

> We did a little rip-rap on Bridger Creek last fall, and there were six or seven agencies involved in that permitting process. The county was involved in it. We were working for the county. They were trying to protect county roads. It took months. (*Sweet Grass County Residentialist*)

> I think it's a good thing that it's hard to get the permits, but I think they just have to start addressing some different ideas on how to control the river during high water and how to keep a lot of the water in Montana instead of letting it go on down to the Mississippi to support barge traffic. (*Stillwater County Agriculturalist*)

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> I've worried a time or two about some of these regulations that the government has on it to where you can't get some very simple things done in a timely fashion. By the time you wrestle with them, why, the condition has changed, or gotten worse, or whatever. That would be one of the complaints:….by the time you deal with all these government agencies, you can get a little bit goofy, you know. And then you get disgusted, and then you get discouraged, and then you quit,…[and] just say, 'The hell with it, they're going to do what they want to do anyway'.…But there's got to be communication. There's absolutely got to be communication. And you['ve] got to have it from the engineer, and the hydrologist, and the old farmer/rancher, and grandma and grandpa, and everybody. And you got to talk about it, and discuss it, and see what you can come up with. That's just that simple. (*Stillwater County Agriculturalist*)

> Oh, the regulations….The hoops you have to jump through to get a permit to do anything….I wish [the Corps of Engineers] were more accessible….We have a perfect example….We're having a problem on Bridger Creek with some people not complying with…stream regulations, and took them a long time to pay attention. But now they are coming. It just seems like it takes a lot to get them. (*Sweet Grass County Local Civic Leader)*

The use of weirs as an alternative to rip-rap was discussed only by a couple of people. They argue that weirs work well, but that they may not work in every situation:

> Bendway weirs. They go into the upstream about a 45-degree angle maybe. You dig them in, and you run them back into the bank….When the high water comes, it flows over the top actually, and it pushes that stream [away from the bank].…[The weir] doesn't cause that scouring effect on the edge. Where, if you put rip-rap out on the edge of the bank, it tends to scour and get deeper and deeper next to the bank,…[the weirs are] much better than armoring. We've had experience with it—made a believer out of me. And these are high,…pretty fast-moving waters. Yeah, it's been used a lot over the years. I think a lot of people weren't really thinking they would work, but they do. They actually do work. If they're put in correctly, and you have a big enough rock, and they're dug in so they're in deep, and the angle is correct on them, [then] they sure do work.…[And

> they are] cheaper than armoring….You only have to have them every 150 or 300 feet, whatever it might be. So you just build them and we put in three or four....The first year, high water actually ran over them, but they survived. It worked good; it worked just the way it's supposed to. You know, everything doesn't work the same everywhere, but a combination maybe—I was sure impressed with them. (*Carbon County Local Civic Leader)*

Changing Social Profiles and User Practices

A third major discussion among locals is the apparent shift in community values concerning recreational access to the river via private property. Most residents of the area remember when the "old school rules" were abided by among property owners and recreationalists, meaning that recreationalists asked for permission to gain access, the landowner would grant permission, and in return the recreationalist would be respectful of the landowner.

Some Agriculturalists still operate according to the "old school":

> All the time I have had it…everyone was welcome to come down and fish, the same way with deer hunting….I've always shared it. [It] never cost me anything to let them go down and fish….It was fine with me. (*Carbon County Agriculturalist*)

> There are a lot of local people that use it. It isn't uncommon to see boats along here….We have had people ask to fish here that come from Billings or whatever….I figure if they are good enough to ask, they are good enough to use the river. We haven't had any problems. (*Sweet Grass County Agriculturalist*)

> We're pretty liberal with letting people go down on our individual place. But then, the neighbors don't, so, consequently, you get the rush. You know, you get the people….You hate to see it, somebody with a couple little kids, driving clear to Livingston to wet a line. (*Stillwater County Agriculturalist*)

Many recreationalists also discuss the informal "rules" of sharing the river. They, too, notice that not all users are respectful of others or of the resources:

> People are usually pretty congenial at the take out. I don't know…you just have to have some etiquette. You have to come from parents that taught you to give a shit. (*Sweet Grass County Recreationalist*)

> All in all, the garbage, the campgrounds, everything is pretty neat and tidy….When I was a kid, I saw tires burning along the shore, beer cans. Oh, yeah, it is a lot more clean than it was 30 years ago. (*Carbon County Recreationalist*)

> I have given this overcrowding thing a lot of thought. Generally, on weekends, I don't do guiding. If I have to, I get out early, and get in early. Everyone goes out

> on the weekend to get away, and they take their dogs. When I first came here, the Yellowstone wasn't really used. Now there are people camping out. People need to take care of their waste. That is another issue. The one thing is, they have put potties in at access [sites], but how do you deal with it on an island? I don't know. There will be a lot more people camping out on that river. That is what I see in ten years. (*Sweet Grass County Recreationalist*)

However, property owners have dealt with abuses; and in response, some have posted their property as private, with the intention of not allowing public access:

> [There's] the world-famous hand gesture….[And,] I've had trouble with vandalism. You know, people pouring water in my fuel tank…and being cursed at for taking water out of the river and killing the fish. (*Stillwater County Agriculturalist*)

> We had no problem when I was younger. People didn't do that; they respected you. If they wanted to go fish, they came in and asked. You know, they respected people that they don't anymore….That's right; they would even come in to our place and ask if they could put their boat in. I mean, it was all done decently, and it isn't anymore….I mean, we had no problem with it. As long as they come in and ask permission and, you know, did things right. (*Sweet Grass County Agriculturalist*)

> Fishers leave everything from defecation to beer cans….Public access does not come with respect….I defy you to keep the fence up that is posted with private-property signs. (*Stillwater County Agriculturalist*)

> With the fishing access law, people cannot get to my property if they stay within the boundaries where they're supposed to, but…I catch them coming up, and that really makes me angry. If I decided to go into Billings and camp in someone's yard, you know what would happen? It's the same thing, and it is worse….They put their sanitary napkins on the bank. It's horrible, [dealing with] their garbage. (*Carbon County Agriculturalist*)

Some recreationalists are beginning to think in terms of controls:

> It would be really nice if people would regulate themselves, but they just don't do that….I'm really not big on government getting hugely involved in things….Well, I definitely go for regulation, but there'd have to be some forethought. (*Sweet Grass County Recreationalist*)

> We don't have to be so greedy. Put some self-limits. We have to start thinking as stewards, not as businessmen. (*Stillwater County Recreationalist*)

> All I know [is] I want [to] get these stupid, big boats off the water….The way it used to be, the people you would see on the river were fishermen, not just people

> running up and down the river. Now we have the jet skis on there, which I am seeing more and more up in my little turf….Twenty-five years ago…you never heard the sound of the jet boat, and, now, everybody seems to have a jet boat.…Certain times of the year, there should be restrictions…[especially in] places where the [water] is real, real low. (*Carbon County Recreationalist*)

Locals position the shifting social dynamics in terms of legalities, while at the same time they lament the changes. Tension is apparent in these communities as they continue to advocate private property rights while they deal with community members that no longer know, respect, nor choose to engage with one another.

> As far as out-of-towners locking their places up and not allowing any access, do I like that? No, but I think it is their legal right to do it. (*Sweet Grass County Local Civic Leader)*

At the same time, sympathies across interest groups are easily found:

> It's landowners, and sportsmen, and everybody. Basically,…everybody has to work together to make a decision. Most of the time, it's the Army Corps of Engineers that makes the decision….They have a big hand in it…[There] should be more [people involved] than them,…[and] it should be more than the landowner, in a lot of cases, too. That's a tough one, too, even in Montana. Look at some of the old ranchers, 'It's my land, and I'll do what the hell I want with it.' And they're right in a way. It is a tough one. The use and everything has grown so much on the Yellowstone. Montana has gone from agricultural to basically tourism, and the Yellowstone is a huge part of that….But you don't want agriculture to go away, because that's what made Montana attractive in the first place….[We've] got to keep some of the wide-open spaces. (*Sweet Grass County Recreationalist*)

> I think that preserving the agricultural aspect of the community is really important and a lot of it can be done through education. I don't think it is a win-lose situation….I think, for the most part, ranchers are pretty responsible. I think that they can do things better, but that is more of an educational process than intent to harm the resource. (*Sweet Grass County Local Civic Leader)*

> I think even the people that live in Billings, and Yellowstone County to the east consider us their playground, which is fine. If I lived over there, I'd want to come over here, too. (*Stillwater County Local Civic Leader)*
> A little guy down on the river said, 'I have seen the elephant and heard the owl.'…He had been to town, he had seen the city, and he liked the rural part. (*Stillwater County Local Civic Leader)*

> They want to do what's right. They want proper sewer and water system and they don't want to affect their neighbor's either. So they want to make it work; in most

> cases some people don't, but most people do. Most people want to protect the environment. (*Stillwater County Local Civic Leader)*
>
> Is the tax structure the way it should be? Or should the tourists pay more and give Montanans better…schools, roads, etc.? I think taxes are too low. And, under that argument, they should raise the taxes, and tax these new owners. Now, I hate to say this, but I know of municipalities that tax the non-resident owners more than the resident owners. Now I don't know whether that's legal, but they do. (*Sweet Grass County Agriculturalist*)
>
> I think the State of Montana is changing a lot, because there are a lot of people coming in concerned about the river, concerned about the environment….And, I would have to say that you get some out-of-towners, like the people up and downstream from us that frankly have done a great job taking care of things, because they have enough money that they don't have to worry what the hay is selling for and what the cattle is selling for. (*Sweet Grass County Agriculturalist*)
>
> I do think there's another side to it….[Outsiders] bring a lot of money into the community. And, like it or not, they cause property values to increase, meaning that if anybody wants to sell their property, they're going to get a good price for it. And, in many respects, [the new buyers] don't abuse the land. (*Sweet Grass County Agriculturalist*)

In the face of changing contexts, participants from all interests groups maintain a desire to see the issues addressed locally. Attention is paid to the notion that one answer will not fit every situation. Yet, it is apparent that guidelines for making local decisions would be appreciated. Three quotes from Sweet Grass County illustrate that persons in virtually all groups understand that local control will work best if it is guided by helpful information:

> I am an advocate of local control. I think it should be a local thing….They know that community best. They understand the needs of the community and the different constraints. It should be a ground up focus. I don't think you can say it is 100 percent local. If you are dealing with a river like the Yellowstone, you are dealing with something that affects other states and areas.…Local control should be primary, but not the only consideration. (*Sweet Grass County Local Civic Leader)*
>
> It's a totally different river and environment five miles upstream of Livingston than it is five miles below Big Timber. It almost has to be a special case. I don't think you can adopt a policy for the whole river. It's a different fishery downstream. Below Forsyth and all that, it's an unbelievable warm water fishery…that probably isn't being utilized. Decisions being made down there shouldn't necessarily be the same decisions made up here. It has to be a case-by-case….For one thing, it's a lot bigger river down there. It's a lot flatter, less gradient. I don't think they have some of the rip-rap issues that we do, but, boy, I don't know. It's almost on a case-by-case basis. You really have to look at it. It's

> a tough one, especially since you're looking at the river all the way down. (*Sweet Grass County Recreationalist*)
>
> Maybe there needs to be a type of educational thing….It is like building in New Orleans, and building below sea level, and then not expecting water to get in….But, you know, maybe that is something that needs to be done in addition to like building codes, etc. Yes, it would be lovely to have your home here, but a recommendation says 30 feet back, or whatever, because at some point in time, over a period of time, there is going to be some gradual wasting away of the property here. I don't know, maybe that is done. (*Sweet Grass County Residentialist*)

Any number of other conversations can be found within and across the interest group analyses. For instance, invasive and noxious weeds are a common concern, as are interests in wildlife and specific concerns regarding water quality. This summary addressed only the three dominant themes in hopes that the readers would be encouraged to further delve into the details of each interest groups' concerns.

Laurel to Springdale: Agricultural Interest Group Overview

Twelve interviews were conducted with individuals representing agricultural interests, including farmers and ranchers. Participants were recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of Natural Resources Conservation Service.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Laurel to Springdale: Agricultural Interest Group Analysis

I. Specifics of an Agricultural Perspective

A. Lifestyle and Way-of-Life

I like it here….I never wanted to do anything besides be a farmer or rancher. (*Carbon County Agriculturalist*)

This is a nice small town. I think the values of living in this area are pretty good compared to living in a big city. And it's what we like to do and what I've liked to do since I was a kid. (*Stillwater County Agriculturalist*)

This little place won't make a living. Everybody likes that life, but you wonder sometimes if it is really worth it. You stay so busy trying to really make it, to make ends meet. (*Stillwater County Agriculturalist*)

We enjoy watching the wildlife. The osprey, pelicans, geese, ducks….[There are] all kinds of birds down there on the river….We see bald eagles quite often, too, in trees along the river. The ospreys have been an exciting thing for the past three years. We look for them to come back every year. And they do. (*Sweet Grass County Agriculturalist)*

I can just kind of hermit-out here. (*Stillwater County Agriculturalist*)

[It's] just my livelihood, I guess. Now, like I say, I was born and raised here, and until I take my dirt nap that's where I plan to be. (*Stillwater County Agriculturalist*)

I think it's part of the American spirit that the land, as Thomas Jefferson said,…is the only pure thing. The only pure way to live was the agrarian existence, and he saw America as an agrarian society, and Alexander Hamilton saw it as a manufacturing city environment, [a] developed environment. Of course Jefferson was wrong. I mean, what developed was Hamilton's. But I still think there is this Jeffersonian spirit in America where the land is fundamental to their happy existence. That's what Jefferson in effect said, and it's changing, of course, isn't it? (*Sweet Grass County Agriculturist*)

[The river] is the difference….It's either you'd have a crop or you wouldn't have a crop. And, if it wasn't for irrigation water, you just wouldn't have a crop….We're in a semi-arid desert region, you know, and so it's the irrigation water that makes the difference. (*Stillwater County Agriculturalist*)

Oh, yeah, we [go to the river], well, at least on a weekly basis….My wife, she was down yesterday with the grandson, and then she was down the day before, and she just loves to go down there, and sit down there all day….You know, [I] call her on her cell phone tell her to get home, fix supper or something like that. (*Stillwater County Agriculturalist*)

Of course they all talk about nature—nature and this, that, and the other thing. But, you know, we're a part of nature anymore, too. You know, rattlesnakes and us, and everybody's got to get along. (*Stillwater County Agriculturalist*)

When farmers 'got their irrigating boots on,' that's their attitude. You know, if you shut his head gate off, you got a problem. (*Stillwater County Agriculturalist*)

It's a perfect little place and just leave it alone. (*Sweet Grass County Agriculturist*)

B. Land Should be Productive

I am not a scenic person.…I will say it is just another hill to me but there are people that it means a lot to….I am not begrudging them, but if I can't use it, why it is just there? (*Sweet Grass County Agriculturalist*)

Production would be one way to describe my place….alfalfa, grains, things like that. (*Sweet Grass County Agriculturalist*)

I know…right where King Avenue exchanges there used to be a big 80- or 90-acre hay field there, and that guy would level that with a huge level on a big bud tractor, and now it's that land where…the Outback Steakhouse and Wells Fargo Bank and all of that is. It just makes me sick to think of how many hours he spent leveling that and first thing they did was come in and make humps and bumps and ponds and everything else. (*Sweet Grass County Agriculturalist*)

Watching will convince you that nature will take its course….It has worked its way into my meadows…and I've lost productive ground. (*Stillwater County Agriculturalist*)

Especially around Billings I hate to see all that good farm land is being paved over and houses built on it. There's going to come a time when they need that land for food production I think. (*Sweet Grass County Agriculturalist*)

There are a lot of people that are buying land on the Yellowstone now, not so much say from Big Timber down, but from Big Timber up. A lot of them are buying the land and they're not doing anything with it. Either irrigating it or not much at all, letting it just go back to wild….It ties up a lot of land that used to be available for leases or for grazing or something like that. And it makes that much more competition for the land that is available to lease. And it drives the price up a lot. Sometimes it doesn't even pay to lease it. (*Stillwater County Agriculturalist*)

C. Rural Ideals

I've become covetous of our privacy….[I want] an uninterrupted viewscape,…a refuge that helps us restore our soul…[and] a sense of natural things that are not disturbed. (*Stillwater County Agriculturalist*)

If you like to hunt and fish and use the out-of-doors, the river is really important. And if it's all rip-rapped, and a bunch of jet skis and everything are going up and down it, to me that would really spoil the whole thing…..There's [still] a lot of solitude out here, although there's less now than there used to be….[Can] we make a living on the place? Probably not…[In the past] machinery was cheaper, and hey didn't have to put fertilizer on everything, which is expensive. Gas is expensive, you know. (*Stillwater County Agriculturalist*)

The land is valuable, very valuable, but I don't want to get rid of it….I think that I should have the right to keep my property. I really do. People that get a lot [in town] or maybe buy an acre, are so proud—they brag about it. Well, what does it feel like to have 35 acres taken from you? (*Stillwater County Agriculturalist*)

There used to be a lot of city people that had either grown up on a ranch or worked on a ranch during the summer, and they understood about agriculture a little bit....I think agriculture is loosing its clout along the Yellowstone. (*Stillwater County Agriculturalist*)

D. Individual Rights are Important

Montanans don't like to be told what to do. (*Stillwater County Agriculturalist*)

It's your own property and you sell it to someone else. I guess they can do what they want with it. And most of the people that I know are good, but there can be some sour ones. (*Carbon County Agriculturalist*)

If I want to add a little addition on, I should be able to do it. But you can't just add on. You got to go pay for a permit. And that's the same thing with the ranch. You just can't, not that we were going to do anything, but we had a battle to get permission to build. Because I wanted to put the barn right back in basically the same spot that the barn was. And we fought, and they said, 'You can't have it where it was, it will wash out.' Well, I'm going to put it in cement in the ground. That old barn sat on a wooden foundation and it never floated away in the big flood. If I put this one in cemented foundation, that's going to float away? I mean, it's just stupidity. (*Sweet Grass County Agriculturalist*)

I think we need really good agricultural zoning around here, but I don't think that's going to happen. I just don't think the old ranchers will ever accept zoning, someone telling them what they can do with their land. (*Sweet Grass County Agriculturalist*)

[Concerning public access,]…the courts took our riverbank without compensation. (*Stillwater County Agriculturalist*)

We can't do anything with our rip-rap until August 15th because there is an eagle's nest across the road, and we can't disturb the eagle's nest. But, the damn eagle's nest is above the railroad. What is our construction over here going to do? But you can't do anything from, I think, April 15th to August 15th because you will scare the eagles. (*Sweet Grass County Agriculturalist*)

E. Outsiders Have Obvious Wealth and Different Values

There's so much money-pressure anymore for the folks who are out of town and got the bucks and they think they can do just about anything they want to. (*Stillwater County Agriculturalist*)

For some people, they can afford acreage like that and keep it for themselves for hunting and fishing….They put a gate across the road and locked it up. I called them…but they said they were going to let it go green….They've probably got enough wealth that they don't need that rent…[but the] people that went down there for years, they're disappointed, really disappointed they can't get to the river to fish….If they own it, I guess they don't have to give access. (*Carbon County Agriculturalist*)

I think the recreationists tend to think we don't respect the land or honor the land or agriculture people and they think they know a lot about it. But we manage it as it's our living. (*Stillwater County Agriculturalist*)

I think the State of Montana is changing a lot, because there are a lot of people coming in concerned about the river, concerned about the environment….And, I would have to say that you get some out-of-towners, like the people up and downstream from us that frankly have done a great job taking care of things, because they have enough money that they don't have to worry what the hay is selling for and what the cattle is selling for. (*Sweet Grass County Agriculturalist*)

I do think there's another side to it….[Outsiders] bring a lot of money into the community. And, like it or not, they cause property values to increase, meaning that if anybody wants to sell their property, they're going to get a good price for it. And, in many respects, [the new buyers] don't abuse the land. (*Sweet Grass County Agriculturalist*)

I think a community can have expectations, and can convey those expectations to new owners. And some of the locals want them to divide land up, get more tax money, but they don't realize that they're just transferring money from hand to hand. You get the tax money here, but you have to build more schools and more roads here for the people who are paying the tax, so where do you stop? (*Sweet Grass County Agriculturalist*)

So many of these ranches change hands. One guy has it two or three years and he is gone. The next owner is in Chicago. You don't get to know your neighbors. There is a tremendous turnover of wealthy people buying and selling. It is hard to keep track. We don't associate with them like when I was a kid. (*Sweet Grass County Agriculturalist*)

Free-flowing at whose cost? The people who want the river to run where it wants to run don't pay for it….I should be getting an award from the free-flowing folks because I've contributed a half-million in the form of lost land. (*Stillwater County Agriculturalist*)

But there a lot of agencies that want [the river] to takes it own course. Let nature take its course. It *is* doing it. (*Sweet Grass County Agriculturalist*)

II. Agricultural Descriptions of the River

A. The Yellowstone is Big and Powerful, but Abundance is Threatened

It's a big river. And at flood stage, it's really big. Like I said before, August to September, it gets really low…[but] I always liked that there was a source of water for the livestock. It never went dry. I don't think it ever has. (*Carbon County Agriculturalist*)

That river is a powerful force. It is a powerful, powerful thing. I don't care what man does, if [the river] decides it is going to go, it is going to go. (*Sweet Grass County Agriculturalist*)

There are about two of those big sandstone rocks left. If the river wasn't so high, you could stand on them….And I wonder where those [other] big rocks went. Where did my big tree go? It was just massive. Whoever's yard that landed in, it sure made a mess. (*Stillwater County Agriculturalist*)

It's a force; it's a force to deal with. (*Stillwater County Agriculturalist*)

The thing about the Yellowstone River, with such force that it has, with the snow pack that it can contain, and one thing or another, is that even some of these things that you can do, it can undo them. (*Stillwater County Agriculturalist*)

It seems to me that, with more population all the time, it's going to put a lot of pressure on the water that's in there. I think these big cities, and their primaries and all that—they use a huge amount of water. Maybe the river's big enough; I don't know. (*Carbon County Agriculturalist*)

It's clear. We would water our livestock at the Yellowstone a lot. (*Carbon County Agriculturalist*)

B. Ambivalent Sentiments about the River's Character

Absolutely beautiful....It is a wild and uncontrolled river. (*Stillwater County Agriculturalist*)

It is a trashy river. After that flood, there were refrigerators and picnic tables [in the river]. After the boat float goes down, it is a nightmare and you have everything from beer cans to convertibles….So, it has its own problems. I know it is an old damn river but it needs some attention somehow. (*Sweet Grass County Agriculturalist*)

What is so interesting about the river [is that] sometimes, you glorify it and sometimes you think, boy, that is a monster. I just learn to accept what it does. If you worry about it, you can't do anything, especially when it is really doing stuff, everybody is helpless. Once it is on a rampage, you can't control it then. And you could put in a lot of work ahead of time and it still does what it wants to do. It tears out what you put in. (*Stillwater County Agriculturalist*)

I think the important thing is to recognize the importance of the Yellowstone River, nationally, but mainly for the future of Montana and its people. (*Sweet Grass County Agriculturalist*)

The river is a nuisance….The river is beautiful to look at if it's not eating at you. I pay taxes on something I'm losing. (*Stillwater County Agriculturalist*)

In some ways the river is a pain in the neck. You go down there and it [has] taken off five acres. Every year…it just keeps taking more and more. And so, that's why I'd say it's a pain in the neck. Nothing you can do about it. Just watch it go. (*Sweet Grass County Agriculturalist*)

We border the Yellowstone. That is important to me,…that we live right along the river. It does affect your life….It is home. Just home, that's all. (*Sweet Grass County Agriculturalist*)

The river to me is kind of mesmerizing, interesting. You never know what it is going to do. It is just nice to be watching it all the time. (*Stillwater County Agriculturalist*)

That Yellowstone River…is really…an exceptionally—well, I don't know quite how to put it, but it's really something….It's quite a deal. (*Stillwater County Agriculturalist*)

III. Living with the Yellowstone River

A. Memories of '96 –'97 Flooding, Ice Jams and the Power of the River

Well, it was about '96 or '97 when it flooded….All of this was under water because it was up about 30 feet. We couldn't get into our buildings or anything over here; it was all under water. We had about four feet of water….It damaged the trees in the meadow. It took three years to get it back in shape….We have probably lost 30 acres in that flood, and it is still taking ground. (*Sweet Grass County Agriculturalist*)

When I moved here, you couldn't see the river. By our turn off, it was over against the rock ridge. Since the flood, the whole channel has changed. I wouldn't touch what it is going to look like in ten years. This may be an island again in ten years. You just don't know. (*Sweet Grass County Agriculturalist*)

Then, about 1998, we had those ice jams and they kind of jarred the rocks loose….Not knowing what was going to happen, maybe we could have done something, [maybe] added more rock. I don't think it would have helped. But it loosened those up and when the flood came, it wiped the jetty out. That was a pretty firm jetty. It lasted from the early '50s to the '90s. So, it lasted a pretty long time. (*Stillwater County Agriculturalist*)

The river is stronger than I am. I used to think I could fix it up….It was so pretty before, honest. It had meadows and trees, and I had it all cleaned up, but it's gone. But I said I wasn't going to do it again, but I've kind of cleaned up….I spent 12 years cleaning it up. It had a rock jetty, and after the flood came, the big flood, it ruined everything. It took 35 acres….I don't think you can stop it….I stood and looked and I thought 'that's just coming straight towards me,' and I was right. It was like you can't imagine….I'm not kidding you; it was kind of eerie….You see the river come, it was like somebody's mad at me—just cut me out. Have to laugh about it….But you shouldn't have a government organization that takes your money and then doesn't work. And they're well-paid and no one is responsible or accountable. (*Stillwater County Agriculturalist*)

A few years ago the river had been cutting quite a bit and they had an ice jam and it deepened the channel and it was pretty stable for a while. Now it is back to ripping and tearing and getting wider and shallower out here….It was more stable in this stretch out here until 1997 when it flooded. (*Sweet Grass County Agriculturalist*)

In the winter, because the river ran right behind our place, we would get ice from ice jams which would flood our place. The river would then flood, and we would wear hip boots all winter. (*Sweet Grass County Agriculturalist*)

But the other thing nobody ever thinks about is what goes on in the winter time with the ice….I mean, we knew about the floods when we built here, but we didn't know about the ice. The ice to me is a lot scarier. Well, like this last winter, November, the river froze….Everything backed up; the main channel on the other side of that island completely jammed up with ice. And then it got warm so all at once all the ice was breaking free. And in the middle of the night it must have really jammed because when we woke up in the morning, all the ice was gone, but the ice was piled maybe five or six feet higher than the top of our barbed-wire fences out there. And if I had been awake at the time, I would have been scared to death. (*Sweet Grass County Agriculturalist*)

We see ice jams come instantly, like we had thrown a dam right across the river. The same year we saw the 500-year flood, 1998, that winter, we had two ice jams right behind our buildings and in three to five minutes, there were probably 50 acres with two feet of water and icebergs along. One wasn't too bad. The other one really did the job on us—tore out a lot of pens and stuff. I mean, the river is kind of amazing. And, when it forms ice in just 24 hours, ice will start stacking up and look like the Yukon River. (*Stillwater County Agriculturalist*)

B. *The River Takes What it Wants Via Erosion*

I never know where my property line is at….The river takes a little every year. In real high water years, it's more aggressive. It takes fertile soil real fast….I'm not whining, I'm resigned….I've resigned myself to this in sadness. (*Stillwater County Agriculturalist*)

The river takes what it wants. I don't know how you can stop it….Part of my property is across the river [now], which is inaccessible to me or any good, and I can watch from my farm as people go get what they want. They get rocks for their flowerbeds, and that's just how it is. I pay taxes on those rocks. (*Stillwater County Agriculturalist*)

The river is going to do what it is going to do, and you have to live with it the best you can. (*Sweet Grass County Agriculturalist*)

Between our place and Laurel, the land spreads out and they can farm on that side of the river…and I know they've had trouble. They get flooded out. They're in the flood plain, and it gets real bad sometimes. It's a lot of trouble for them. (*Carbon County Agriculturalist*)

If you don't control it, all this bottom ground they call river frontage from the river to where it starts up the hill [will erode away]. Pretty soon, Montana ain't gonna be beautiful anymore. It will be down the river.…It may take 200 years to do it, but it could do it. (*Sweet Grass County Agriculturalist*)

Continuously, every year [the banks change] a little bit….On our particular place…in the last 20 years, we've actually gained a little ground, where our neighbors on either side of us have lost a little ground. And why that is, I'm just not exactly sure. But that's just the way…the water flow was, or is. (*Stillwater County Agriculturalist*)

It floods, and houses go down because the ground gives out. People build because they want to live close to the river. Well, the ground gives out. (*Sweet Grass County Agriculturalist*)

My neighbor accused the other neighbor of stealing his fence, and I said, 'You're standing on the top wire, on the silt'….It's a continual thing, maybe of 27 posts there's two left, and the rest is gone….Now I think it's about ready to wash out my corner posts. I see the gate the last time I was down there, hanging over there. (*Stillwater County Agriculturalist*)

What could I do? What should have I done? (*Stillwater County Agriculturalist*)

People need to leave the river alone, and put up with whatever it does. Because if you lived with it for as long as we have, it changes, and there's no way of getting around it. I don't care how much messing around they do in it, it's going to do its own thing. (*Sweet Grass County Agriculturalist*)

C. A Desire for Control and a Sense of Futility

There are good projects that the Corps can and should do….Philosophically, as I look back 30 years, I'm not sure we could have stopped the natural shift of the river….Nature has its way.…It sounds contradictory because the best design at the time might not work. (*Stillwater County Agriculturalist*)

You just live with…[the Yellowstone River]. You can kind of control the fire but you can't control the earth. I don't care what you do, you can't control the water. A fire may switch back on itself but a river is just going to go. (*Sweet Grass County Agriculturalist*)

I think there could be some small dams and things like that to slow the run off, and maybe support some of the streams a little better. You know, the smaller streams. And I think that would help control a lot of it. (*Sweet Grass County Agriculturalist*)

We need some stream bank stabilization in this area. That is all there is to it.…[The river] will erode roads and bridges, etc. There is quite a difference in the way it is now from the way it was. (*Sweet Grass County Agriculturalist*)

The dam is a way to control the water, but I personally don't want to see a dam on it, especially if it's up above me. If they're going to build one, then build her on down the way. Hopefully this place would remain an area that would benefit the wildlife, and we can get along without setting right on the river's bank, you know; we can live without doing that. (*Stillwater County Agriculturalist*)

They need to study the stream bank preservation stuff that can be done to keep the river where it belongs, I guess. (*Sweet Grass County Agriculturalist*)

The river should be left …in it's natural flow…[to go] where it goes. I agree [with] putting rip-rap along the side where you're not changing the flow of the river….You know all you're doing is protecting your land; the water flows the same. You're not sticking it out any, you're just putting it against your bank to keep it from eroding, but you're not changing the channel. (*Sweet Grass County Agriculturalist*)

IV. Controlling the River with Rip-rap

A. Rip-rap Seems to Work in Some Places

The rip-rap and the ironclad are the most effective if it is done right….I am more for the agriculture and saving your property. (*Sweet Grass County Agriculturalist*)

The man who owned it before me…spent a great deal of money on it….But, you see, [my losses] all could have been avoided because right at the Yellowstone River Bridge, after the water would go down each year, there was debris and a few rocks, and we would go in with a back hoe and put it back where it was….Then the government made a practice where you couldn't remove that again, so the river swung, and just ate it out…. We should go back to the Army Corps of Engineers, and I should be reimbursed for that rock jetty, because, when I bought the property, that is supposed to be taken care of. And it's very expensive….Everything is so expensive….I don't plan to do anything. I don't have a great deal of faith in the Corps of Engineers. I think they should come out and justify what they did. (*Stillwater County Agriculturalist*)

Projects should be based on merit.…[But] the scale that would be effective will never be approved.…The 'controlled stream' won't happen….The massive concept won't happen. (*Stillwater County Agriculturalist*)

You know, there is a lot of agriculture that is being affected by what the river is doing….If it takes its course, it moves all over the place….It is going to do what it well pleases, but maybe we can stabilize it….We put a lot of rip-rap in since I have been here. Probably close to 500 to 1000 feet worth of rip-rap and we have applied for more. (*Sweet Grass County Agriculturalist*)

I think that you could spot control some of that, if they would let you in there to do, you know, a particular project. I mean, not major, not to change the river completely…but just kind of hit here and there and give it a little guidance. You know, I think that would help. (*Stillwater County Agriculturalist*)

I'm not sold on whether we should try to engineer the river with rip-rap….I think that's very unnatural. And, yes, [the river] will eat your property. It was eating into our land….but we never rip-rapped it. It's a natural thing. And I guess that's another thing: you got to let these streams be natural. I think you got to let them have their natural habitat, if you will. It's like an animal; a stream has a habitat, doesn't it? (*Sweet Grass County Agriculturalist*)

B. Rip-rap and the Potential for Shifting the Problem of Erosion to Elsewhere

The north side has a railroad track that has an affect on the hydraulics….Also, things done upstream have made a difference….[The river] works the course of least resistance. (*Stillwater County Agriculturalist*)

You can't go in and interfere with the river anymore. I agree that if you're going to go in and flood someone else, or hurt something—fix mine and flood you—that's not good....[But] when the road washed out a few years ago, they could have stopped that. (*Carbon County Agriculturalist*)

You can see it takes some planning. If you rip-rap one side of the river it, it'll start eroding, and it makes channels, and it'll bleed off this side over here. (*Sweet Grass County Agriculturalist*)

Secondly, it just changes the direction of the water and turns it.…I'm saying that knowing that we've got a half-mile of rip-rapping that's been here since 1950. You know, I'm sure it's protected the place, but I don't know what's it's done downstream. It may be partly responsible for what's gone on down along that corner. (*Sweet Grass County Agriculturalist*)

The most problems we've had have occurred since the people started messing with the river above us….They've made ditches, they've dug in the river, and it's changed the channel completely. And this happened before the flood….They just take it upon themselves to do what they want to do on their property. The main river used to run right beside our place. Now we get the overflow. It's made channels clear on the other side. (*Sweet Grass County Agriculturalist*)

We have a lot of nice river bottom down here and I suspect it will be gravel bar depending upon too many more floods. The river is making a big 'S' and it keeps digging here and it is rip-rapped over by the road and now it comes down in a big curve and that is what takes the dirt away. (*Sweet Grass County Agriculturalist*)

They rip-rapped the whole thing, and it…[sped] up the river [so] that it created a whole wet land where ever it wasn't rip-rapped you know, and it came out, and that's what the rip-rapping does. You know, before there was any of that, it had spread out a little bit everywhere, and it would fill channels and fill sloughs along the way. And I think that filling those sloughs and the channels, during high water is what helps to recharge the river in the wintertime. Because the river in the wintertime is lower than I've ever seen it last year. And it just seems like it keeps getting lower. And I think a lot of that's due to those sloughs and things not getting filled from flooding. (*Stillwater County Agriculturalist*)

C. Rip-rap and Difficulties Getting Permits

It's getting so difficult to get your permits, and this that and the other thing, that it's a little difficult to implement some of the plans that you might have or you think would work. (*Stillwater County Agriculturalist*)

I think it's a good thing that it's hard to get the permits, but I think they just have to start addressing some different ideas on how to control the river during high water and how to keep a lot of the water in Montana instead of letting it go on down to the Mississippi to support barge traffic. (*Stillwater County Agriculturalist*)

So, yes, there has to be some control as to how it's done, and [yet] not turned off completely. I don't think the bank stabilization should be shut down completely, but it is going to come to that. (*Sweet Grass County Agriculturalist*)

I've worried a time or two about some of these regulations that the government has on it to where you can't get some very simple things done in a timely fashion. By the time you wrestle with them, why, the condition has changed, or gotten worse, or whatever. That would be one of the complaints:….by the time you deal with all these government agencies, you can get a little bit goofy, you know. And then you get disgusted, and then you get discouraged, and then you quit,…[and] just say, 'The hell with it, they're going to do what they want to do anyway'.…But there's got to be communication. There's absolutely got to be communication. And you've got to have it from the engineer, and the hydrologist, and the old farmer/rancher, and grandma and grandpa, and everybody. And you got to talk about it, and discuss it, and see what you can come up with. That's just that simple. (*Stillwater County Agriculturalist*)

D. Rip-rap is Costly and Few Can Afford it at an Effective Scale

Had I substantial resources, there might have been things that could have been done….[But,] the scale is overwhelming.…To restructure an old jetty and rip-rap was three to five times the cost of the land….I didn't have enough money because I had just bought the land. (*Stillwater County Agriculturalist*)

We have the permit and everything, but we didn't have the money to. [It] costs too much. (*Sweet Grass County Agriculturalist*)

I have no education on how to tame a river, how to keep a river in its boundaries. I think it can be done but it would take quite an investment…The last I heard, rip-rap was $125 a foot. It doesn't take long to eat up a life savings. There is no guarantee. It has got to be something on a larger scale than an individual can do. The government will have to do it or nothing can be done. The county can just hold a little here and there….I am sure there is engineering out there that can fix it, but just putting a little bit here and there isn't going to do it. (*Sweet Grass County Agriculturalist*)

I remember reading in the paper, after the 500-year flood in Livingston, there was a guy that went ahead and saved some ground. I can't remember how many miles it was, but it costs him $600,000. That's what he put into it….He must have had a lot of money to invest, because it would take a long time to ever get it back. If it was for agriculture, I don't know if you ever would [regain that money]. (*Stillwater County Agriculturalist*)

I had a local contractor come down and look at it, and he said it costs a hundred dollars a foot to put rip-rap or stream bank preservation in there. And then there's no guarantee it's going to stay there. (*Sweet Grass County Agriculturalist*)

E. Rip-rap and the Question of Fish

The rip-rap, they say, is going to scare the fish. The big fish are going to lie on the side of it and the little fish are going to come by. They are going to get them. That was the explanation I got. (*Sweet Grass County Agriculturalist*)

Well, it's not nearly as attractive, and you know it changes the fish habitat, too….Well, depending on the time of year. If it gets very hot, they need the rapids….And you do get fish that will kind of hide in the big rocks of the rip-rapping. It just kind of turns the Yellowstone into a big irrigation ditch in my opinion. (*Sweet Grass County Agriculturalist*)

F. Rip-rap and the Question of Aesthetics

I know everyone is against rip-rap but the one we…[have] is a pretty high tech rip-rap system. You would hardly even know it is there….Basically what we are doing will hardly be noticeable. It will have a mat over it and trees planted….It will be effective, hopefully….I guess you would say it is supposed to beautify the river so if you are floating down the river you say, ‘Boy, how did that form that way?’ Not, ‘What damn fool put that rock in there!’ (*Sweet Grass County Agriculturalist*)

[The current rip-rap] sure beats car bodies…used along the river. The people that are floating down don’t want to see car bodies. You got to have a little scenic. (*Sweet Grass County Agriculturalist*)

Well, number one, it’s pretty ugly. (*Sweet Grass County Agriculturalist*)

Some people don’t like the looks of it but 90 percent of the time when they go down the river they are two-thirds shot and they wouldn’t know what it looks like anyway especially during the boat float….You can go in and throw in some rock but we just put some in down by the riverfront which is no big deal and I have seen bricklayers not do as cute a job as I did with the track hoe—just lay them in there and they just look like they are natural just all laid in there nice and even. (*Sweet Grass County Agriculturalist*)

V. The Public Demand for Access is More and More Problematic

A. Abiding by “Old School” Rules of Accommodation

All the time I have had it…everyone was welcome to come down and fish, the same way with deer hunting….I’ve always shared it. [It] never cost me anything to let them go down and fish….It was fine with me. (*Carbon County Agriculturalist*)

There are a lot of local people that use it. It isn’t uncommon to see boats along here….We have had people ask to fish here that come from Billings or whatever….I figure if they are good enough to ask, they are good enough to use the river. We haven’t had any problems. (*Sweet Grass County Agriculturalist*)

We’re pretty liberal with letting people go down on our individual place. But then, the neighbors don’t, so, consequently, you get the rush. You know, you get the people….You hate to see it, somebody with a couple little kids, driving clear to Livingston to wet a line. (*Stillwater County Agriculturalist*)

Trespass[ing] might be a problem, but I don’t have that problem….Hell, if people want to fish, I don’t care. I’ve never put up a ‘No Fishing’ sign or a ‘No Hunting’ sign. (*Sweet Grass County Agriculturalist*)

B. Access and Abuses

We had no problem when I was younger. People didn't do that; they respected you. If they wanted to go fish, they came in and asked. You know, they respected people that they don't anymore….That's right; they would even come in to our place and ask if they could put their boat in. I mean, it was all done decently, and it isn't anymore….I mean, we had no problem with it. As long as they come in and ask permission and, you know, did things right. (*Sweet Grass County Agriculturalist*)

Fishers leave everything from defecation to beer cans….Public access does not come with respect….I defy you to keep the fence up that is posted with private-property signs. (*Stillwater County Agriculturalist*)

I think, [in] the past ten years, the recreational use has really increased. And not just for fishing, but for hunting, too, on islands, and gaining access to your property and poaching from boats and stuff, whether it's waterfowl, deer, elk or mushrooms it seems like. (*Stillwater County Agriculturalist*)

What drives me nuts is a people problem….People have—and they're getting worse—absolutely no respect for private property….They shoot game from rafts….We can't patrol and we shouldn't have to. (*Stillwater County Agriculturalist*)

I used to love the river when I was a child, but now it brings in recreationists….They build campfires on [my] property. I found a bunch of marijuana,...And sometimes I wonder if I'm safe there. We had…an ex-con; he lived down there for six months….And last summer, in the middle of the night, I got a call that a girl on those motor skis had come off, [and] could the search and rescue go down there? I immediately said, 'Yes.' [Well,] they left the gates open with the cows. They couldn't do anything right….Not everyone, I don't mean that everyone's bad. (*Stillwater County Agriculturalist*)

With the fishing access law, people cannot get to my property if they stay within the boundaries where they're supposed to, but…I catch them coming up, and that really makes me angry. If I decided to go into Billings and camp in someone's yard, you know what would happen? It's the same thing, and it is worse….They put their sanitary napkins on the bank. It's horrible, [dealing with] their garbage. (*Carbon County Agriculturalist*)

I can understand that the river is a force of nature you can't do anything about. The human nature is what you can't…understand. They tell you now, pack it in, pack it out, and there's a lot of good people. I'm not saying everyone's that way, but there's always a few that have no respect for anything. And I'm sure you've seen it. (*Sweet Grass County Agriculturalist*)

There again, you'll have another person who'll kind of look after the one who's chucking the beer cans. You'll have another one pick them up, so there's that kind of deal. (*Stillwater County Agriculturalist*)

[There's] the world-famous hand gesture….[And,] I've had trouble with vandalism. You know, people pouring water in my fuel tank…and being cursed at for taking water out of the river and killing the fish. (*Stillwater County Agriculturalist*)

I don't like to hear the loud…jet boats….We go there for the peace and the quiet and tranquility. They're disturbing all the natural habitat….[Also,] there are a lot of the people that don't obey the laws. You're not supposed to go above the high water line…[but] they pull off and…go wherever they want to go. They don't care. I understand you've got to stop and go to the bathroom once in a while. That's a different thing….[But] garbage laying all over [is different]….And we've had people take things….There's no respect for the law. There's no respect for anyone who owns any property. (*Sweet Grass County Agriculturalist*)

It's the people that are the biggest problem, not the river. It's nature; there's nothing you can do about that, and it's going to come down whether you want it to or not. (*Sweet Grass County Agriculturalist*)

C. Denying Access: Avoiding Abuses and Liabilities; Generating Income

It isn't about trespass; it's about respect. (*Stillwater County Agriculturalist*)

We don't allow big game hunts down on our place anymore. And one of the reasons is that a couple of houses are fairly close to our property. (*Stillwater Agriculturist*)

The first year I was here, I didn't know the area and I let people in to rifle hunt. Since that time, I just confined it down to bow hunters. You've got to be pretty careful where you're going to shoot or you're going to be shooting at somebody's house or the interstate or something. I don't want that liability. (*Sweet Grass County Agriculturalist*)

I have one...I let hunt, and I finally said, 'You need to do some work.' And he said, 'I'll help you with anything.' And he didn't show, and didn't show. Next year he called and said, 'Can I go?' I said, 'Yeah, but you owe me for two times, now.' I caught him in there last year. So, I'm not going to let people hunt. If you want to hunt and fish, go buy your own place. They've made it that way. (*Stillwater County Agriculturalist*)

My hunting rights are leased out,…mainly whitetail and turkeys. Maybe sometime in the future it will be for elk if they become more of a resident herd, but right now, they just come in during the summer time and eat up all my alfalfa in the fall. (*Stillwater County Agriculturalist*)

We have clients that come down and hunt on the place. (*Sweet Grass County Agriculturalist*)

VI. Life-forms of the River

A. Wildlife

Oh, we've got any amount of blackbirds, robins, sparrows. Just about any thing you want out there, we've got it. We've got two sets of eagles that share a cliff dwelling there. They stay...there every year….And there's a golden eagle and a set of bald eagles, also. Then we got all the ducks, and geese, and what have you. We've got these swans, now, here the last few years. And those…with the big bill, that catch all the fish.…We saw 12 pelicans….about two weeks ago. Oh, we got lots of turtles, fish of all sorts: carp, trout, suckers….We've got whitetail deer. Last fall we had a little black bear, and we get a few elk that cross through there. Usually, the elk come in, and they'll calve out there in the spring. We even had a moose or two. And they pretty-much are the same thing—they come across from the Clarks Fork Valley, and calve out there, and go back over and up toward Yellowstone Park, by that drainage area. And we've got pheasants, and, oh, very nearly anything you can call wildlife. (*Stillwater County Agriculturalist*)

The type of animals that are there, that hang in there, I mean that's where they want to be. You know, evidently it has everything that they need. Especially where the ducks and geese [stay]….Although they do migrate some; we've got some I know that just stay there because we've got them year round. (*Stillwater County Agriculturalist*)

I support the herd. I just don't get to harvest any of them….We have 80 acres of hayfield down there, and it's all into alfalfa. In one night I saw 77 whitetail, 55 mule deer, and 38 head of elk on there. So, I was wondering why it wasn't growing faster….By fall, I think the mountain lion, or something, moved in, and it chased them all out of there….Yeah, we found two or three carcasses that were buried, and that's usually a lion. And then the wildlife left pretty quick….We've even had lynx down here. (*Stillwater County Agriculturalist*)

B. Cottonwoods

When these erosions begin to take place, these big cottonwood trees that are along the Yellowstone River start to hang out over the water, and another year or two they will get washed out and when they tip over, they come out with roots and all, and there's where you cause a lot of erosion right there. If they were to come along and catch those trees as they get in the leaning position, a year or two ahead, and stump them off, and either float the tree on down the river somewhere or hook onto it and drag it out, and deposit it somewhere, they wouldn't lose near the ground that they can lose now….Like I say, when those big cottonwoods go over, they cause a lot of turmoil….They bring out a lot of that old mud and dirt and everything just goes on down the river. (*Stillwater County Agriculturalist*)

Well, you know, if you look at our trees, they're all mature trees. Go down along the river there, there aren't any young trees anymore. Because the only time you get any natural cottonwood reproduction is during the flood years. The seeds come down, they flow down, they get imbedded in the mud from the floods, and that's how you get the cottonwood stands….Flooding is necessary for the regeneration of the cottonwoods. That's a good reason why not to do anything, from my point-of-view. A lot of people disagree with me. (*Sweet Grass County Agriculturalist*)

And right now, the cottonwoods are seeded and the entire place is cottonwoods, and I am not going to do anything about it….Cottonwoods reseed with the flood, and it's almost solid cottonwoods now….I'm going to have all those cottonwoods. I just say I'm growing firewood for my grandson. The weed man is concerned, says you need to spray those. Why? I'm not putting money into those; it's hopeless. (*Stillwater County Agriculturalist*)

Well, [cottonwoods] give a lot of shade, and, at one point in time [we used them]. For instance, our old barn, the floor in it is made out of, probably four-inch slabs of cottonwood….It's in the old barn, in the old horse barn.…And then from the fact of shade, and this type of thing, and habitat for the birds and one thing and another.…And like I say, at that time way back it was used for lumber, and fence lumber, slab lumber. A lot of our corral fences were slab lumber, cottonwood and this type of thing. But, right at this point –in time, lumber-wise, they're not a thing of value, so to speak. (*Stillwater County Agriculturalist*)

C. Exotic Invasive Plants—Noxious Weeds

Any body of water is a weed source. So, it's just a given that that's the way it is and it's not a problem necessarily, but it's something that you just got to deal with continuously. (*Sweet Grass County Agriculturalist*)

The flood of '97 brought in the weeds,…foreign weeds….If you don't cut them every year, they just turn into a weed patch….It is basically a place for spotted knapweed and leafy spurge. Every time there is high water there is a new batch brought down. (*Sweet Grass County Agriculturalist*)

Well, if you don't graze it, it will just be more brush. I feel that way about it….The sheep, they used to clear brush,…mainly to control leafy spurge, which is a bad weed. (*Carbon County Agriculturalist*)

Spurge destroys everything else.…Knapweed is hard to find, for me, until it blooms….I'm using Cimarron. I haven't used it before, but it's supposed to sterilize the seeds. I have a thing with weeds. I have it under control….[Sometimes] the bears kept me from spraying up there. I can't get by her babies. (*Stillwater County Agriculturalist*)

I have to tell you, the first 20 years I spent a lot of time spraying, but you never seem to get ahead. So the sheep we're putting in now will be eating the spurge. Frankly, the spurge beetles we put out in some parts of the ranch have gotten rid of 95 percent of the spurge; in other parts of the ranch, I can't tell that they've made any difference. And I'm sure it's just a difference in habitat. The island right across this channel right here, we can look at it when we get done, but this time of year there would just be a field of yellow with all the spurge. And we've put some beetles over there, and it got rid of 90 percent of it. I don't quite understand why it worked there and it doesn't other places. But bio-controls make a huge difference. Not only that, they're really cheap. (*Sweet Grass County Agriculturalist*)

VII. Visions of the Future

A. Visions of Change

[Did you sell the land for agricultural purposes?] No, [for] recreation….They just leave things natural, not disturb anything, and not farm anything….It doesn't bother me any. (*Carbon County Agriculturalist*)

It's starting to look like home sites….There will be more houses all along, wherever they can buy small acreage….If [they] could get five or ten acres, if there's access to build a home, then I understand it's for sale, and they're going to subdivide it….The real estate man had called me up about it, says there's a guy from Atlanta, Georgia, who wants to build a house out there. (*Carbon County Agriculturalist*)

I think it's going to grow; more and more people are moving into the area….People are moving out of the cities to find decent property, get out of the rat race and come out here and develop this. There's a lot of construction going on in this county, but the population doesn't increase that much. They're mostly people that are putting in second homes. They'll come here in the summer for awhile and then they're gone. These people over here are building five brand new houses….They're only here just every once in awhile. They fly in their jet, stay for a weekend, and then they're gone. There's a lot of that going on. (*Sweet Grass County Agriculturalist*)

I hate to see the way it's going up, not just up here, but when you get down to Billings, and it seems like Billings just keeps creeping west farther and farther, taking valuable farm land and really putting some people out of business just because of zoning. And, all of the sudden, they were in agriculture trying to grow crops and they're having to pay taxes and you know they are a lot higher than they used to be, and they just can't afford it. (*Stillwater County Agriculturalist*)

See, that'll make it worse for me, and the less land we have to absorb moisture, which we don't get anymore, now as we start paving, then that makes it worse, too. I think probably the parts that man is trying to interfere with made it worse, too. It doesn't work….I think it will get worse, because there's no place to absorb the runoff as we build up. Some fool will build near it. Anywhere near it where you could see it, that's too close. I had some people want to trade me their yellow house in town for that pasture, and they were going to build on it. (*Stillwater County Agriculturalist*)

Recreation is coming on faster and faster; every year there…[are] more boats. In fact, I wonder sometimes if it's going to get to where it has so many boats in some places that they'll have restrictions for motors, and it'll be just float boats. I think maybe in the future, something might happen like that, just because of the impact and the noise. I don't know if it will, but I look for something like that maybe to happen. (*Stillwater County Agriculturalist*)

Land prices are going up all the time. It is tempting for people to sell….You can't buy the land and make it produce enough to make payments. That is changed in my lifetime. (*Sweet Grass County Agriculturalist*)

I would kind of hope that it wouldn't change a lot. I hope that they keep the building and residential developments away from it. A certain distance, anyway. (*Stillwater County Agriculturalist*)

There are other things out there besides agriculture that they need to be worrying about. The Conservation Districts, including Sweet Grass County, have always been just concerned with just irrigation practices, diversion dams, and rip-rapping. They've never looked at it from any other point of view. (*Sweet Grass County Agriculturalist*)

Well, I think the county commissioners…have to realize that there's a lot of money that's in the county because of recreation and not just agriculture….The tourists are coming because of the scenery and the recreation and, frankly, part of the beauty of the land are these big unspoiled ranches. But the ranchers aren't being able to make a living on it. So, somehow or other they have to be able to cash in on the recreation too....Most of the old ranchers look at…the people who are interested in recreation as being a bunch of environmentalists, which is kind of a dirty word around here. (*Sweet Grass County Agriculturalist*)

It's changing rapidly….I was talking today to a man selling his ranch who has two offers on it right now. And I think that a lot of people don't realize how quickly it's changing….I think Montana needs to decide, do they want tourists?…Montanans need to sit down and decide the future of Montana, plan it. What do they want it to be? Want it to be this? How do you keep it this way, or make it this way?...It's going the other way….[Montanan's have] got to be the author of the future. They've got the opportunity, now, because it hasn't been ruined like many places in America….Seize this opportunity, and do it together, work in a cooperative way, and work out the future. Well, that's a lot to say,…[and] hard to do. (*Sweet Grass County Agriculturalist*)

I think the attachment to the land is what's going to save Montana from over-development. It's what's going to be the thing that will make more people to give donations to conservation easements or try to protect their land or try to sell it to someone they don't think is going to kill it—that kind of thing. (*Sweet Grass County Agriculturalist*)

Is the tax structure the way it should be? Or should the tourists pay more and give Montanans better…schools, roads, etc.? I think taxes are too low. And, under that argument, they should raise the taxes, and tax these new owners. Now, I hate to say this, but I know of municipalities that tax the non-resident owners more than the resident owners. Now I don't know whether that's legal, but they do. (*Sweet Grass County Agriculturalist*)

B. Management Priorities

I think that sort of thing is critical: to leave a fringe on the river undeveloped, to keep the water as pure as possible, to try to work on the tributaries, be sure the ranchers have adequate water, but don't have any more than they need at the times they need it. I think they're working on all that. But I think it'd be great to get people to sign a voluntary thing that we won't build within 200 feet of the river. (*Sweet Grass County Agriculturalist*)

Being an Ag individual,…of course I'd want agriculture to have a priority. But I do know from when I was on a Conservation District, that drinking water comes first, then Ag water, which kind of makes sense, too. (*Stillwater County Agriculturalist*)

A lot of people are switching to center pivots and sprinklers that have no recharge to the ground water. It will put on just enough to feed the crop, and a lot of the moisture they do put on goes up in the air to evaporation. That's all water that should go on the ground, I guess. Normally we would irrigate with flood irrigation. (*Stillwater County Agriculturalist*)

I don't know if those programs [for rip-rap] are available anymore. Well, if you signed up, you could sign up with the local ASCS office, and jump through the hoops and their engineer would come out and look at the project. They would do all the cost analysis. Then they would cost share it a certain percentage. (*Sweet Grass County Agriculturalist)*

I really do believe in protecting the river as far as pollution goes….I haven't gone right up to the stream bank and sprayed weeds. I've got sprinkler irrigation so I don't have any waste water from my irrigation that goes back into the river….Everybody's got to have water. It gets messed up and it's not good…because wildlife and everything is affected by it. I think that it is our lifeline for everybody….If there was an individual that was polluting the river, intentionally or whatever, water quality probably would be higher priority than their property right. I would think at least equal….It concerns everybody if somebody's messing up the water; nobody has the right to do that. (*Sweet Grass County Agriculturalist*)

Laurel to Springdale:
Local Civic Leaders Overview

Fourteen interviews were conducted with individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and water/wastewater treatment managers. Participants were identified through public records.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Laurel to Springdale: Local Civic Leaders Analysis

I. Community Complexities

A. Thinking in Terms of Priorities

Two things come to mind right now. Although I believe in personal property rights,…I believe, too, that…not everybody is going to get everything they want. It just has to be that way. (*Stillwater County Local Civic Leader)*

Public safety has to be number one. Number two is probably…protection of property rights….I would put a high premium on property rights. (*Sweet Grass County Local Civic Leader)*

Montana has a lot of small communities.…I don't think they will survive unless they invest a lot of time and you start to use the Yellowstone as an asset. You have to get [the young people] to come back instead of leave. There are some really neat communities. I think those along the Yellowstone have a better chance than those away from it. I grew up in a community that I loved enough that I wanted to come back to it. I would hope that my kids and grandkids would have that opportunity….I just would like to see all our communities…keep the Yellowstone as pristine a river as they can. I really think we need to utilize it more. (*Stillwater County Local Civic Leader)*

I think we're going to see a lot of change because we have endless amounts of subdivisions going in. That brings a lot of problems with it. And they're wonderful people. We have doctors, and veterinarians, and all kinds of people living out in the hills here. They just want to be left alone, but they're going to get terribly bored after a couple of years. And we just wait for that, so we can put them to work as a volunteer. They're really wonderful people. (*Stillwater County Local Civic Leader)*

I do have a concern for the next ten years….We're losing our ranching community to subdivisions, and many of those were subdivided without proper roads, proper review, without water. They're hauling water. (*Stillwater County Local Civic Leader)*

In regard to this Yellowstone River study, years ago they got a grant, somebody did, [and] people began looking after the Yellowstone. I went to a couple of their meetings, and I couldn't believe what I was seeing. There were a bunch from DNRC [Department of Natural Resources and Conservation] and those groups—that was all that was at the table—there were people from the university, people from the City of Billings, the fishing people, Ducks Unlimited, all these nonprofit groups. They had a token rancher there who lived 30 miles north of Big Timber and he didn't even live on the Yellowstone. On the way home I thought, 'What kind of a deal is going on here?' I made a list of all the folks who lived on the Yellowstone River, and checked, and not one of them were called. Yet, they were setting the future of those people. (*Stillwater County Local Civic Leader)*

I want people to get along so that, in the end, we have a free-flowing Yellowstone River that behaves itself—if that's possible. But I really believe in people respecting others' thoughts, and not doing things just because the law is on their side, or [because] they can [afford] a lawyer. They can threaten people and get away with it….There isn't a problem that can't be solved if we work on it and reach a little consensus, but some people are so ticked-off that they won't come to the table. They know that they won't be treated properly….There's enough of these high rolling dudes in the country that they intimidate folks….Meanwhile, the river runs. I'm going to start a new soap opera series and call it *As the Still Water Ripples*. I tell you, we could keep that thing running for years. (*Stillwater County Local Civic Leader)*

Oh, yeah, sure we can [have management]. You know, private property rights are hard to…step on,…but there's sometimes when, maybe, you have to do something, or [you have to] mitigate,…or hope, or give them a carrot, or whatever. (*Carbon County Local Civic Leader)*

[We] try to protect the people that have been here with their agriculture. You know, irrigation ditches. Things that have been there will be there. And [we] try to make sure that nothing infringes on that. (*Carbon County Local Civic Leader)*

We own five acres down by the river, and they want to tax you really high even if you don't develop on it, because it is near the river. That is not necessarily an asset. It could disappear. (*Stillwater County Local Civic Leader)*

B. Roads and Bridges are Central Concerns

Roads are probably the biggest thing. They take a relatively big part of the budget. Roads are something that everybody uses, and we have a lot of problems with them. We can't afford to do all of the graveling we need,…[and we can't afford] to replace all the bridges that should be replaced. (*Stillwater County Local Civic Leader)*

Well, the river keeps washing the roads out…and we're trying to get…funding to…keep [the river] away from the road. It's very frustrating trying to deal with the different agencies that don't want to see any rip-rap or any protection. They want to let the river go wild. But that sounds good, but it doesn't really work in real life….We know how to fix it….We could fix it, but…you have to get permission, [and]…they won't allow you to put rip-rap in it. (*Sweet Grass County Local Civic Leader)*

One of our obligations is to keep the roads and bridges open, and that would be for emergency services primarily but also, for…school buses. (*Stillwater County Local Civic Leader)*

The road washed on the Clarks Fork. We had to haul a lot of rip-rap in, and, what we did was, we just armored the bank…a little bit, and put a couple of those weirs in, the Bendway [weir]. We did that in two different places to save the road. The Clarks Fork is a wild river. (*Carbon County Local Civic Leader)*

If they would have listened to the old-timers they could have saved a few billion dollars and kept the Joliet Road from washing out. They put in a dike with big boulders and logs, and it diverted the river. Eventually, it eroded, and the county didn't pay attention to it, and it washed the road out and took farm ground out. That is the problem that is inherent everywhere. They like to use, and ultimately abuse, the assets. You have to invest time, and money, and effort to help the river survive. (*Stillwater County Local Civic Leader)*

When this lady developed this huge holding out here, 4,500 acres, she just kind of put in a narrow little road that's rocky and it's like negotiating the Yellowstone River when the water's down. It's rough, terrible. You can't get emergency vehicles in, you can't get people out and when we have a fire, we really worry. (*Stillwater County Local Civic Leader)*

The good old Yellowstone is a cantankerous old thing. That river is wonderful, but it's also wonderful to watch it. It's going to go wherever it wants to go. I'm kind of torn…because we have people [who] defy us to do any rip-rapping, or to save a public structure, or anything like that. We're not supposed to do that, I guess. That's what I'm hearing. But, darn it, you've got a two million dollar bridge sitting there, and the thing's washing out, you better do something. We can't shut all the traffic off….This bridge down here was in jeopardy. So they brought in a lot of rock and fixed it. It's fine. We had it protected.…We've, [also] had some subdividers that have gone on their own and put in some Mickey Mouse things, jetties. But it really didn't upset the river a whole lot; it's got a mind of its own. (*Stillwater County Local Civic Leader)*

C. Flooding and Safety Concerns

In '97, when we had high water, it was about six inches over the road. That caused a problem down here. I have had it surveyed. There is just a low spot in the road. It came really close to trying to take out the bridge. Maybe seven, eight or nine years ago, they were dumping huge boulders to try to stop that from happening because they were afraid of losing the bridge. If you look at the river, it is coming straight at the bank. That is a tremendous amount of force in that area. If the bridge washes out that is catastrophic for these people. Stillwater Mine, agriculture, even getting to work for people would be a burden. The road they built has already gone to pits. (*Stillwater County Local Civic Leader)*

[Ice jams] cause flooding….They dammed it up, and [the water's] going to go somewhere….[In the past we would] blow them up….I don't think they hardly do that anymore…because it could just move the ice jam down to the neighbors. (*Sweet Grass County Local Civic Leader)*

In the winter you can have ice jams that will block things, and there can be flooding in the wintertime as a result of that. Or damage from the ice itself. It's something that concerns us, and we are looking out for it every winter and every spring. (*Stillwater County Local Civic Leader)*

Some ranchers and farmers [might be] flooded. I don't know if they are or not but that's the potential, and some years they do. (*Stillwater County Local Civic Leader)*

Well, the river's pretty darn high now, and this is the time of year when we can easily get calls from people playing on the river in their jet boat, and…somebody's overboard. And our county has to initiate a search and rescue effort with our sheriff's department. (*Stillwater County Local Civic Leader)*

I don't think people should build too close to the river, for their own safety. By the same token, I am a strong believer that the river belongs to the people, and they should have access to it. It is limited access now. (*Stillwater County Local Civic Leader)*

They're demanding county services,….[but the people in subdivisions] don't want us around normally. They don't want to pay these 'high' taxes,…[when, really,] our taxes are cheap. (*Stillwater County Local Civic Leader)*

Subdivisions are fine, but they've got to think a little bit and not depend on local government to bail them out or…to come and get them. (*Stillwater County Local Civic Leader)*

We don't have any setbacks here. In my view, the reason we don't is that,…once you get beyond safety,…whether 300 feet or three miles, setting an arbitrary number doesn't give you flexibility. Some people want to address it for more of an aesthetic point of view. It is strong in this county. That is a local issue. You aren't dealing with the public safety, or resource damage [due to] bank channelization. You are dealing, very much, with local issues and [with] what importance people put on specific criteria in their community. (*Sweet Grass County Local Civic Leader)*

D. Water Quality Concerns

Septic systems [are a concern]….They're too close together, and [too close to] their wells, and it's just a mess. And [there's] nothing you can do about it. Some were put in as, 'Oh, we're going to be using it for summer homes, so we'll just have storage. We'll just have a holding tank.' Well, it turned into year-round living, and a hole got poked in the tank, you know. So, probably, it's flowing out the bottom into Rock Creek…and there is not much we can do with them. Just don't want any more of them. We're trying to…put their feet to the fire, and say, 'Now, you've got a holding tank. We want records, public records.' So, we're working on that area. We don't allow any holding tanks any more. (*Carbon County Local Civic Leader)*

We try to be real careful on the subdividing….Of course, the 'perc' tests [determine] both: how the water flows through…[and] how high the water table is. The testing is supposed to be done over a year's time, so you have your whole season.…[Regarding septic systems in] wetlands, we try to, naturally, stay away from that because that's a DNRC or a DEQ situation. (*Carbon County Local Civic Leader)*

There's also problems with cattle contaminating in the river, because they drink at the river….And that's a problem all over Montana. Livestock feeding or drinking in the river, and, of course, the sewage runs in. (*Stillwater County Local Civic Leader)*

It's better if the cattle are not running in the stream. You know, that just makes sense. Erosion-wise,…I don't think they really do any harm, except where there's an overgrazing situation….It's like anything else, it's not bad, unless it's overdone. (*Carbon County Local Civic Leader)*

Probably the biggest problem, no matter where you live, is the runoff from agriculture, either from runoff with the pesticides…[or] runoff from the cattle waste. And if it's a private property, they have to be aware that [runoff from their] private lands can get into the river systems. (*Sweet Grass County Local Civic Leader)*

Fortunately, fast-running waters are self-cleaning….We use the water and [we] make sure we take care of the sewage and [we] don't pollute the river. It has been years since we have flooded enough to cause problems. (*Stillwater County Local Civic Leader)*

E. Growth is Necessary and Demands Some Caution

Development will always occur. [The community] is either going to…grow, or it will demise. You really can't maintain the status quo. If you aren't growing, you're probably going to go down. You can't maintain the status quo. (*Stillwater County Local Civic Leader)*

We'll grow at a rate of two or three percent a year. Maybe a little bit more because some of that becomes geometric after a time….[The growth will affect the river] indirectly only….As [our] infrastructure improves, and things grow, this county will just have more visitors, more tourists, and more people from surrounding areas coming to visit and play on the river. (*Stillwater County Local Civic Leader)*

We are trying to figure where any new growth will happen. Most of it is happening west of town. We are looking at extension of power and annexation. The city is in the process of adopting a growth policy and looking at impact fees. Those are the fees charged to developers for the expansion of city services. (*Sweet Grass County Local Civic Leader)*

I would like to see the continuation of the small businesses, the economic base that we have now. Columbus could be bigger, but I would hate to see it four times the size it is, in this little valley. [There] are two areas of new building in the city limits, recently,…[but] most [of the growth] has been out in the trees….Columbus, the town, has grown by 400 people in ten years, [yet] there are 2,000 [new] people within a ten mile radius. (*Stillwater County Local Civic Leader)*

There is a guy from Portland…looking at this area [as a place] to build 200 homes. That is going to County Planning, first, for a subdivision [ruling]….We have to know if the system will handle [200 new homes]. (*Stillwater County Local Civic Leader)*

It's very special to have this river here, and, of course, we want to protect it. We want to make sure that any housing developments follow the DEQ rules, [especially] septics should be placed according to DEQ. I guess I don't believe in setbacks. I think the property owners have the right to be as close to the river as they want, without damaging the river. If they do not damage the river, I think it's their property line. (*Stillwater County Local Civic Leader)*

II. Sympathies for Historic and Newer Activities

A. Farmers are Historic Base and Generally Good for the River

Ranching and farming:…that's probably the oldest base. The Stillwater Mine… is well-received by most people….I don't want to imply that [the residents] are mostly ranchers, probably not—they're probably in the minority.…[And] now, it's expanded beyond agriculture and mining….Recreation is growing, and I think there's a correlation with that and the subdivisions, the population growth that we're experiencing. It's a low percentage, but it's growing, and probably at a rate that we can manage, so that's good. (*Stillwater County Local Civic Leader)*

I think that preserving the agricultural aspect of the community is really important and a lot of it can be done through education. I don't think it is a win-lose situation….I think, for the most part, ranchers are pretty responsible. I think that they can do things better, but that is more of an educational process than intent to harm the resource. (*Sweet Grass County Local Civic Leader)*

[The] ranch population, they've been here, but they're dwindling off. The kids still want the place,…but it's awfully hard….And I do notice a difference—those [ranch] people really cared. They didn't want to destroy our streams, or pollute them, or anything like that. They respected it. And now we've got a group of people who also respect it, but with a different set of values….They're coming here from another state [where] they found out what it's like when something happens to pollute the stream, or when sewage runs in there, or whatever it might be. They come here with that bit of knowledge, and their values based on that, so they're demanding a different use of the stream. [Also, they want] more access, better places to dump their cans and garbage, and all that sort of thing.…I just think there's a difference in values and a difference in cultures. (*Stillwater County Local Civic Leader)*

There was an independency that was so important, and a hard-work ethic, and a real caring attitude toward the land, the ecosystems. If there hadn't been, they wouldn't have survived. They tried to eke out a living, and it was very tough. They did the best they could with nothing….I think our values go back to some of those things, a real caring way to eke out a living. So there's an economic side to it. (*Stillwater County Local Civic Leader)*

If you have more development, you're going to have less agriculture, and less irrigation. And the flood irrigation recharges the aquifer. So, if you have more development, [you have] less farming, and less water going into the aquifer. (*Stillwater County Local Civic Leader)*

I know it's the last free-flowing river in the United States, but [keeping the water in Montana] would be one thing I would like to see….Water is so precious here.…It's sad that they didn't do it in the past….If it was for power thing, maybe it would happen—but not for agriculture. (*Stillwater County Local Civic Leader)*

B. Desires to Experience Nature are Understandable

[There's] fishing, the peacefulness of the river….Like right now it's high and muddy, in a month it'll be calming down, clearing up, and then in the fall, you get your brown trout spawning and, you know, lots of different things going on. You have your big geese out now, which just hatched, cranes, and everything out here now. It's a beautiful place to visit. I think we're lucky here. It's so close; we're right here. (*Sweet Grass County Local Civic Leader)*

[It's used for] boating and fishing, primarily. There are a lot of photographers, but they're doing that in conjunction with something else. They're just on the river, enjoying the scenery, or they're fishing from the shore or from a boat. (*Stillwater County Local Civic Leader)*

I think even the people that live in Billings, and Yellowstone County to the east consider us their playground, which is fine. If I lived over there, I'd want to come over here, too. (*Stillwater County Local Civic Leader)*

A little guy down on the river said, 'I have seen the elephant and heard the owl.'…He had been to town, he had seen the city, and he liked the rural part. (*Stillwater County Local Civic Leader)*

They want to do what's right. They want proper sewer and water system and they don't want to affect their neighbor's either. So they want to make it work; in most cases, some people don't, but most people do. Most people want to protect the environment. (*Stillwater County Local Civic Leader)*

If you lived somewhere where you didn't have rivers then maybe you would realize how valuable they can be. It never stops and you have the wildlife that needs the river and a lot of the cover that rivers provide. It is what it has always been. Nature and we have to live in harmony as much as we can for everybody's benefit and everything. You can't always look at it…financially. Is it financially profitable for you to do something that may harm the river? You can't do things to harm the river. (*Stillwater County Local Civic Leader)*

C. Boat Floaters Generate Revenues and Liabilities

We have had a boat float; it was called the Mayors' Boat Float that started way back. It was sponsored by the mayors from Livingston to Billings. That put a lot of people on the river. Columbus was actually a stop and it got out of hand….The kids wanted to come and party and we weren't able to cope with it. It wasn't the floaters, it was the spectators….The Old Time Fiddlers...they wanted them to get a million dollar liability policy to use the park….I wish there was a way that a town could manage that. (*Stillwater County Local Civic Leader)*

But there are some differences of opinion that I hear, especially when the water's low, and you hear complaints….That's the only time there's a problem….When the water's low, that's the time when you start hearing stuff….Well, the fisherman come long distances and pay a great deal of money to fish, and if you tell them that they can't fish during certain hours of every day, then they're upset….They spent money to get a good fish in the Yellowstone River, and by golly, they should be able to get one. (*Sweet Grass County Local Civic Leader)*

We have lost money here in Columbus because we lost the boat float. That was our own fault. It brought too many people partying but it was a tremendous source of income. (*Stillwater County Local Civic Leader)*

D. Recreational Access Problems

Access to the river is very important, but in places, I guess especially this bridge in Reed Point, there has to be cooperation between the county, the landowner, and the recreationist, as to what we can provide. What counties are legally required to provide, and sometimes that's not clear. I don't see 'No Trespassing' signs where the fence meets the bridge. I've never seen that, so access to the water through that way is possible. (*Stillwater County Local Civic Leader)*

[One] family, they had it for years and years. Well, in fact, I think it was probably from homestead days, and they allowed a certain amount of fishermen to access the Yellowstone…through their property. Well, it sold, and that's no longer available because [the new] folks didn't want to give access, and they don't have to. So…there was an area that used to be accessed, that it's gone. And, the new people that come in, they more or less locked the gate, and they're very territorial. (*Carbon County Local Civic Leader)*

I would like to see nice fishing access, accesses developed that Montana Fish, Wildlife and Parks might have to spend some money to preserve the appreciation of the river. And good parking….They need to step up and get some good spots, and they're going to have to pay for them. (*Stillwater County Local Civic Leader)*

Part of it is the public needing to police themselves, [but] there have been some places that have been shut down without provocation.…I think there are more and more fishing access sites and recreational groups realize these problems and are trying to establish cooperative working relationships. (*Sweet Grass County Local Civic Leader)*

One way [the river is important] is for agriculture…and the other is recreation. I like to float the river. I like to fish the river. Another important thing to me is the property rights of the people that go right up to the river, that their rights are honored….I think they have to respect each other, where they're all coming from. Agriculture is trying to make a living, and it's very difficult….We all want to use the river, but sometimes the recreationist is not respectful of the river….There's garbage and feces….They don't take care of it. Property owners see that happening occasionally. (*Stillwater County Local Civic Leader)*

I think people in Montana and this area would like to have the river accessible to the public, and not have a lot of private ownerships. We have good accessibility now with the fish accesses and whatever, but I think that most people in this area would like to not see too many homes near the river. (*Sweet Grass County Local Civic Leader)*

III. Attentiveness to Legal Frameworks

A. Thinking Like an Official

We're responsible for all of the Montana statutes, whether we know them or not. (*Stillwater County Local Civic Leader)*

I fully support the laws that we do have….The river itself and the water quality and quantity needs to be protected. (*Stillwater County Local Civic Leader)*

Flood plains are sacred. We just cannot break in flood plains like we used to. There are some things…[that the] law requires: you have to have a three-foot differential, the land where you're going to build your house has to be at least three feet above where the water table is. Well, if that's based on a dry year, and you build your house and then you have average years again, or normal years, you might have a problem. The law doesn't account for that. (*Stillwater County Local Civic Leader)*

For example, [with] a bridge, you go through a permitting process. You make an application to the flood plain administrator and you will require a 310 permit and you may need one from DNRC and Fish, Wildlife and Parks. You are likely to need a permit from the Army Corps of Engineers. This is one aspect and primarily the local area. We look at the FEMA maps and see if it is zoned for that area. What is the base flood elevation? What effect will it have on the base flood elevation? We prohibit anything that will increase the base flood elevation by more than one-half foot or more. It depends on what kind of materials is used, what kind of rip-rap, what kind of channelization, what kind of fill material. We require an engineer certification. It is a process of gathering the plans, gathering the engineering analysis, the hydrology analysis, and the information from DNRC if they have it and then site inspection and review and then issuing a permit. Those permits are issued on condition of certain requirements. (*Sweet Grass County Local Civic Leader)*

My biggest concern is it is so hard to keep businesses in Columbus where they are profitable and stay in business. When that happens, a lot of the lifestyle that used to revolve around the smaller communities starts to disappear. It is hard to stay in the community, even if you like it, if there is no employment….There were big businesses that wanted to come and we didn't invite them. We need to change that attitude. The city council and the city and county government both will start changing their attitudes and policies to invite and help businesses try to make it….We sit in too nice of a place for it to keep deteriorating. I don't know how we will do it and how it will affect the river. We have lost a lot of opportunities with the Yellowstone. (*Stillwater County Local Civic Leader)*

The Conservation District, they issue [the permit] for any activity within the flood plain. They have certain jurisdiction and they have beds and banks. Flood plain is broader. Usually there will be a 310 and a flood plain permit required. It could happen that they need a 310 permit and no flood plain because the base flood elevation is low enough that we are not concerned with the 100-year issue. (*Sweet Grass County Local Civic Leader)*

There are laws, but they aren't enforced. We lose a lot of water. There are people that say we have water rights. There are a lot of mistakes in the past that have been made with regard to that. Most of that watershed is on federal lands, I would imagine. If that is the case, then it is everybody's water. In a way you can say it is everybody's water. You go back to laws that have been forever and need to be changed and you won't see that in my lifetime. I think the old-timers care more about it. They would get out and work and spend weekends trying to correct something they saw that was wrong. (*Stillwater County Local Civic Leader)*

B. Local Values and Local Control

What happens sometimes is the state legislatures will say counties should do this, however if they want to apply it locally, they have to pass an ordinance. What that allows you to do is enforce it. Without the ordinance, even though it's a state statute, if somebody's violating it, we can't send the sheriff out. (*Stillwater County Local Civic Leader)*

I am an advocate of local control. I think it should be a local thing….They know that community best. They understand the needs of the community and the different constraints. It should be a ground up focus. I don't think you can say it is 100 percent local. If you are dealing with a river like the Yellowstone, you are dealing with something that affects other states and areas.…Local control should be primary, but not the only consideration. (*Sweet Grass County Local Civic Leader)*

This county does not have zoning at this point….I'm not opposed to zoning, per se, if it's done properly. I think there's a lot of people here who are outright opposed to zoning,…but I don't know if we're at the point where we need that. There are good things as a result of zoning….I don't know if I would predict that for the next ten years, but there will come a time when zoning will be needed and people will be clamoring for it. So I would say future generations will have it better in that regard. So, if you buy property in a certain area, you can kind of predict some stability. (*Stillwater County Local Civic Leader)*

I'm not saying we're ready for [zoning]….Over time,…that may not be a bad idea….I think folks are more and more receptive. A lot of the people are coming in….It's a nice place to live, so they're coming from everywhere. You know, Californians,… Texans,…and they're drawn here because it's not like where they're coming from, yet they want to make it like where they're coming from….But they also have good ideas. They come from areas where they have more progressive local governments…and are wondering why [not here]? (*Stillwater County Local Civic Leader)*

When you are dealing with regulations in a local community, I think there needs to be some minimum standards that would apply across the board so you can't have something happening in one community that would be detrimental to another community. Beyond the minimum standards, you have to let the local governments make some judgment. I think in many different areas those voluntary considerations can be beneficial. It has to be a combination. You can't have the local stuff in a vacuum because it affects other areas. You have to take into consideration the needs of the community. (*Sweet Grass County Local Civic Leader)*

Locals can often [offer] the best solutions because they have a vested interest in the land, in the community. They have, often, known each other for a long time. We have a lot of non-residents that live here three months at a time, [but] when locals sit around and have a cup of coffee, talk things over, they will often lead to the best results. It is a long, drawn-out process, and I think that is one of the better ways to go about things. You can talk to your neighbor, even if they are different than you are. (*Sweet Grass County Local Civic Leader)*

Keep the feds out of it. It should be done on a local basis. The people that have the most clout in the county are the county commissioners. They are local people. For the most part they know what has happened. They are accessible. They are common sense individuals. They should really have the final say on it. Community planners…[are] part of it….[It's] like designing a sewer system. You could get a local guy [to] do it for $100,000. No, you have to get engineers and all the other stuff, and pretty soon it is two million. (*Stillwater County Local Civic Leader)*

Some of these things have gotten so expensive to do. We have done it to ourselves in a lot of ways. The state can be involved but when the fed gets involved, the feds see that one route is supposed to cover everything. There are so many strings attached with federal bucks. (*Stillwater County Local Civic Leader)*

That's one thing that affects the river itself is the ability for people downstream, in Iowa, Missouri, Louisiana, places like that, to dictate what we do with our water here….They claim previous water rights; all they want it for is to float their barges so they can move their product less expensively. And I don't think that's a good enough reason to tell somebody, 'You release your water to us.' That lowers our dams; it hurts our fish populations. (*Sweet Grass County Local Civic Leader)*

IV. Regulating Activities On and Near the River

A. Flood Plain Maps are Credible Means of Regulating

It is meander-land, and nobody can own that….There were river changes in that '98 flood, and, of course, some islands were created, and it washed down banks….Some people lost acres and acres of land….I know of one group who ended up with an island, and they claim it's theirs, because the river ran right through their property and created an island….Nobody pays taxes on it….For example, if this is a lake, and the water comes up in high water years to cover most of [the land], you wouldn't think that would reduce your taxes, [and] it doesn't. Or, if it goes down, and you can farm this for a while, you still don't pay taxes on it. But, you can't claim it either;…its no-man's land….[It] used to be that the Corps of Engineers could come in and just change things at will, and that caused its own set of problems, here and there. I don't like the idea of changing the direction of the river….It has its own set of problems that come with it. It might help this guy who lost some acreage to reroute the water away, but it ultimately, someplace else, will cause a problem….I think rivers should meander wherever they naturally go. (*Sweet Grass County Local Civic Leader)*

To the extent that we have state statutes that specify, we do have minimum standards for the flood plain by state law. One of those is public health and safety; you can't permit something if it is a public health and safety threat. (*Sweet Grass County Local Civic Leader)*

We're actually still working at it…but it's fairly good. We've got pretty good history on Rock Creek and not bad on the Clarks Fork, so it's not too bad. The Yellowstone—…they've been working on that, too….Yeah, I think it's mapped fairly good. (*Carbon County Local Civic Leader)*

A lot of the summer homes that I'm talking about are quite old. And they were built where we wouldn't allow it today, they are in flood plains. It was [done] at a point where nobody cared. There were no regulations, no statutes, no ordinances. It was your property, [and] you do what you want. (*Stillwater County Local Civic Leader)*

I think the flood plain is…expansive along the Yellowstone….We've got maps that would show that, and it's all elevation relative to high water mark that occurs over so many years back. I think we probably depend heavily on the state for that information, so we would have maps. (*Stillwater County Local Civic Leader)*

They discourage building in the flood plain. It has been years since I have seen any problems with flooding on the river. A lot is taken out for irrigation and that controls it somewhat as long as it doesn't get out of hand….That irrigation that runs the whole west side of Billings comes from here. (*Stillwater County Local Civic Leader)*

B. The Practical Limits of Flood Plain Regulations

A lot…is determined by our growth policies…..This county is traditional and conservative enough that a lot of people would oppose [a setback requirement]…for practical reasons….There's a lot of stretches…where they have their cabin between the road and the river…[so] you have to be relatively close to the river. (*Stillwater County Local Civic Leader)*

If you get flooded out and lose your home, why would you rebuild there? Because it only happens every 100 years? Can you get insurance? No. I do think that if you are going to take the risk, *you* should do it....As long as you handle your sewage properly, and you know that you can't get insurance, and the feds aren't going to have to bail you out, if you want to do it and it isn't hurting anybody else, you can do it and take the risk. That is what our country is built on—…people that were risk takers….Your home is your castle. You should be able to do that. (*Stillwater County Local Civic Leader)*

I would leave the river alone and let it do what it needs to do because, when you start changing different things in nature, you're going to lose something else. That's why we have the trees there; it's just the way it's supposed to be. That's my opinion. (*Sweet Grass County Local Civic Leader)*

C. Updated Maps Would be Helpful

I would like to see a lot better mapping on the Yellowstone River. Most of our maps are 1982 FEMA maps. Some of the Yellowstone has had some updating, and…that is helpful, but there needs to be some better mapping and better understanding of activities in the flood plain, and how to best undertake those, both from a safety issue and also trying to protect the resource. (*Sweet Grass County Local Civic Leader)*

Primarily, the problem is, [the maps] are so inaccurate. They are this blanket, 'Here is where we think it is.' I shouldn't say they are always inaccurate because sometimes we have information submitted in a site specific area and they are right on. They don't take into consideration differences in topography. When they were done it was based on information that was from 1982. They couldn't go every 200 yards down the river. Since then, there is a lot more information. They are useful, but they could be more useful by being more site-specific. (*Sweet Grass County Local Civic Leader)*

There needs to be better mapping and more compilation of the flood plain. With the flooding of ’96 and ’97, there is more information that wasn’t there in 1982. More of a site-specific analysis….From the planning perspective…[we need] a better understanding of the hydrology, ecology, the geomorphology,…the safety features, irrigation facilities, bridges and abutments, a better understanding of the river and how the river changes, and the kind of things you need to anticipate. (*Sweet Grass County Local Civic Leader)*

D. Attention to Erosion and Changes on the River

In some places [erosion] is tremendous. It depends on the topography and it depends on the river….In some places erosion is a problem; in other places, because of the rocky bottom ground, not so much….Can I say it is a huge problem in the county? No, but it is a problem in certain, specific areas. (*Sweet Grass County Local Civic Leader)*

Big rocks, rip-rap, [stops] the erosion. It stops the soil from washing away. They are available. Today they …have fork lifts and grapplers. The river doesn’t get as high as it used to….The railroad is a big, huge dike that keeps it out of this side….[But] when it was flooding and running high, it would change its course. That hasn’t happened in ten years. (*Stillwater County Local Civic Leader)*

If [erosion occurs] by a bridge or public facility, you have safety issues, issues with the health of the water, and sedimentation issues. What is the cause? Is it caused naturally or by some sort of use of the banks? If it is a use of the banks, is it something you can mitigate to some extent? If it is natural, you probably can’t do much about it. You have to recognize the different factors. Some are man-made and some are naturally occurring. (*Sweet Grass County Local Civic Leader)*

I’m thinking about the irrigation head gates to the river right now. The river is always changing, and sometimes…[farmers], in order to protect their head gate and get the water they need for irrigation,…need to get into the river, so to speak, to [perhaps] clear a gravel bar up against their ditch. So, they need to be able to get out there and clear that away for irrigation. (*Stillwater County Local Civic Leader)*

Where they built the silversmith’s, they raised it out of the flood plain. That would be a great spot to erode. There is a pretty sharp curve there. That is the only one I am aware of that was a problem. (*Stillwater County Local Civic Leader)*

I am not personally aware [of erosion problems]. The river fluctuates so much that it’s bound to occur at times, but I’m not personally aware if we have it and where that might be….I suppose there would be a certain amount of erosion that could occur naturally…and that might be because the vegetation is not there. That could be due to several things. It could be that it’s over utilized by a combination of livestock and wildlife. It could be because of the drought cycle we’re in. Some of the plants that took a lot more precipitation aren’t getting it so they die. It could be…[a] physical disturbance immediately along the riverbank….where it’s private land. Today in this state, folks have a lot of latitude of what they do. There are undoubtedly some controlling statutes there. (*Stillwater County Local Civic Leader)*

My grandfather [dealt with erosion] years ago….You can see the curve where the bank erosion was. There might be some abutment out there that they used to try and stop that. That is the only one that I am aware of. [They used] car bodies, lots of car bodies. Not anymore…because they are unsightly. You still see them in spots. There was a time that they thought the car bodies would cover up and fill up with silt and rocks and they didn't. (*Stillwater County Local Civic Leader)*

This bridge here just south of Columbus, it used to have a lot of rip-rap on it. And, four or five years ago, when we had the high water, it took that rip-rap away. And it was big rip-rap. And now, I'd say it's underneath that bridge someplace….That whole bank—it's just a small piece of private property—but that's going to just keep eroding away to the road. And that's a pretty important road….I think they have to have an aggressive rip-rap program. We've got infrastructure that needs to be protected….Let us get in there to protect [it]….[Let us] put some large rocks, rip-rap, in there to protect those things. Most ranchers cannot afford to rip-rap…and the river just eats away and takes away, but roads need to be protected. (*Stillwater County Local Civic Leader)*

I am saying where it is a man-made problem, it should be mitigated. For example, if erosion is occurring because the cattle are watering at the river, can you reroute the cattle. Is it that bad?…I don't think people should be told you absolutely cannot let your cattle go to the creek. That is ridiculous. That is the way most cattle are watered in the state. You have to look at the kinds of costs you impose on people when you require these types of things….You have to look at the cause of it. What are the remedies? Are the remedies worse? (*Sweet Grass County Local Civic Leader)*

Sometimes there is an embankment of some sort, whether it is rip-rap, or those barbs that go out into the river with the rock….Maybe the best thing would be to recognize that it is going to happen, and [that]….you can't fix every problem. Putting in some fake retaining wall or rip-rap may exacerbate it instead of fixing it. I am not advocating a specific solution. (*Sweet Grass County Local Civic Leader)*

[We have] a few subdivisions along the river. I guess I can only think of one in Stillwater County….You know, it's not easy to build along the river, because it moves all the time, so it can take your house away. (*Stillwater County Local Civic Leader)*

E. Alternatives to Rip-rap

You have to look for the spots that are a potential danger and you really have to do something to [keep the river] where it is now. That probably means some really big boulders going in, some rip-rap, but it shouldn't stop there. You have to support it behind there. Make sure there is good growth of trees. If that is all you are going to do, you have to look at it. Someone that really understands erosion needs to study it and make recommendations to the county or cities. (*Stillwater County Local Civic Leader)*

It's a free-flowing river, so no dams or anything. I'd have liked to have seen dams years ago….[but a dam] probably won't happen [now]….What I see should have been done on the Yellowstone is off-river storage. There was a couple different places around Laurel area, Park City area, that could have been used as a dam, and just use it as a high water [storage]….But you won't see any on-stream storage on the Yellowstone or the Clarks Fork, either one. The days of the dam are gone, I guess. (*Carbon County Local Civic Leader)*

Bendway weirs. They go into the upstream about a 45-degree angle maybe. You dig them in, and you run them back into the bank….When the high water comes, it flows over the top actually, and it pushes that stream [away from the bank].…[The weir] doesn't cause that scouring effect on the edge. Where, if you put rip-rap out on the edge of the bank, it tends to scour and get deeper and deeper next to the bank,…[the weirs are] much better than armoring. We've had experience with it—made a believer out of me. And these are high,…pretty fast-moving waters. Yeah, it's been used a lot over the years. I think a lot of people weren't really thinking they would work, but they do. They actually do work. If they're put in correctly, and you have a big enough rock, and they're dug in so they're in deep, and the angle is correct on them, [then] they sure do work.…[And they are] cheaper than armoring….You only have to have them every 150 or 300 feet, whatever it might be. So you just build them and we put in three or four....The first year, high water actually ran over them, but they survived. It worked good; it worked just the way it's supposed to. You know, everything doesn't work the same everywhere, but a combination maybe—I was sure impressed with them. (*Carbon County Local Civic Leader)*

F. Timeliness of Permit Process is Questioned

Oh, the regulations….The hoops you have to jump through to get a permit to do anything….I wish [the Corps of Engineers] were more accessible….We have a perfect example….We're having a problem on Bridger Creek with some people not complying with…stream regulations, and took them a long time to pay attention. But now they are coming. It just seems like it takes a lot to get them. (*Sweet Grass County Local Civic Leader)*

I wish they would be more responsive when there was an emergency. We've had some rip-rap that's been washed out in two spots by the Grey Bear Fishing Access. We would like to have got it repaired before flood season. And we still haven't heard back on our permits….[The river] just washed out two pieces probably: one was probably about 15 feet long and the other one was probably 20 feet long. But there's a good chance with high water now it will probably all be gone….So it's one of those deals where we could have got to it right away when we found out it was…and part of that is our problem for not really looking at it close enough until we started thinking about high water. (*Sweet Grass County Local Civic Leader)*

Well, if you've violated the law, it doesn't take…[the Corps of Engineers] too long to get here. If you really need them for a permit, sometimes it takes forever. (*Sweet Grass County Local Civic Leader)*

V. A Common Sense Approach

A. Maintaining a Balance within the Community

What shakes out first is public health and safety. I would say you are balancing those other factors. Beyond public health and safety, I wouldn't give a number to any of the others. I am not suggesting that if an irrigation project required rip-rap [that you shouldn't do it].…You look at the pros and cons in any kind of planning [and] I think you are looking at a potential for impacts and how they can be mitigated, rather than a choice of either/or. It is a balancing act. (*Sweet Grass County Local Civic Leader)*

It should be a live and let live area…[to] make it easier. I would love to see more 'Park Here' signs instead of 'No Parking.' There is a fine line between doing it right and doing it too right. You [need to] get a feel for the community. (*Stillwater County Local Civic Leader)*

[People here are] still somewhat conservative in their mindset, but pretty independent people, good work ethic, a pleasant community [with] a lot of cooperation and participation, whether it is putting together a new library or the new hospital. There is a lot of interest into protecting our historical background, and our cultural resources, and [its] a balanced place to be from. I have lived here a long time. (*Sweet Grass County Local Civic Leader)*

To some extent, [with] any decisions made by any permitting agency or any board when dealing with planning, you weigh all those factors. You have to. Whether it is in the back of your mind or a particular line item issue, I think individuals…look at those factors and decide what to do or how to operate. That is a common sense approach. (*Sweet Grass County Local Civic Leader)*

We're a team that has to work together. We strive hard for consensus, but realize at the same time we won't always get that. I think we have enough respect for each other, and want to maintain a high level of trust among us to where we know that we have to….But, more often than not, we do get the consensus, because we value that. We try. Sometimes it may not happen. (*Stillwater County Local Civic Leader)*

I guess at one time we had some terrible thieves in the area, butchering cattle, stealing cattle and horses, and whatever they could get their hands on. So, we formed the Stillwater Protective Association. It meant nothing, didn't have by-laws, but we had the ability to paint signs, and all they said was 'Stillwater Protective Association.' Scared the holy jiminy out of the whole country because we'd put them on our gateposts [and] on our pickups. Anybody who would carry one. We had a series of meetings….[We] called the leader in each [individual] community, and said, 'Would you gather your neighbors, and make some cookies, we'll be at the house at seven o'clock, Tuesday?' [Then they asked,] 'What are you doing?'…'Well, we want to look at the thievery in the county.' We had a 98 percent turnout in rural Stillwater County doing that. I called it, the Kitchen Table Deal. Kind-of another model. But, boy, those were productive meetings. They looked after themselves because they knew the sheriff was getting old and he couldn't look after them. So, they looked after themselves, and the stealing went down to nothing. It really worked, but that was when we had those [individual] communities. (*Stillwater County Local Civic Leader)*

Irrigation in this county is a huge deal. From the county's perspective, we are trying to construct facilities that are safe for the river, in terms of fish habitat, etc., but [also] trying to protect the agriculture users. They are a huge part of this community. Some people say they don't care about Ag, they care about the 'viability of the river.' Once you get past the base minimum standards, those are local decisions. I think a locality can choose to be more protective.…I understand that can be messy, but I can't think of anything that isn't [messy] when you are doing grassroots planning. You can't exist in a vacuum and say that it has no effect on anyone else. You can't say that with the Yellowstone. You can't have this over-arching 'we know what is best for you.' (*Sweet Grass County Local Civic Leader)*

I like to have all of the interested stakeholders work together and try and come up with something that they can walk away with something that is workable….I think every interested group out there needs to get educated about the other party's point of view….[and,] depending on any given situation, there may be one group that needs more education than the other or they need a better understanding of what the other's constraints are….DNRC did a study that showed that the lower part of the valley is much worse off than the flood irrigated areas because the aquifer didn't recharge….Conservation easements:…do they protect the land or not?...Is grazing beneficial or harmful? There are valid points on both sides….Out-of-state landowners [should know] what to expect coming into a community….[Give] education to recreationists about some of their bad habits, [like] not cooperating with landowners [and] recognizing that they have an impact on the resource, too. (*Sweet Grass County Local Civic Leader)*

The Stillwater Protective Association is a member of the larger group that—I don't know everything about that, but there's a lot of ranchers on that, there's a lot of ranchers that see them as an environmental group, and therefore bad, but there are a lot of ranchers on that, and I think it's kind of middle of the road. They see opportunities to conserve our natural resources, but not preserve them, not lock things up. I guess the Stillwater Protective Association is the group that has worked hard with the mine….They have what they call the Good Neighbor Agreement, which is a wonderful document, and it's been used in other parts of the country. [Other] mines have used it as a prototype. (*Stillwater County Local Civic Leader)*

The impact on the river….I think if Columbus can grow and they can use common sense with the growth that is one thing with the council. They grew up here and they all have common sense. (*Stillwater County Local Civic Leader)*

More than anything else I think…we live in a society that creates a lot of pressure and tension. People work 24/7, almost just to try and make ends meet, and they need a way to get away. Right down here [at our park,]…all summer long, you will see people there come in just to get away and replenish the soul. I just feel as along as you set reasonable policies I think you can let people have access to even your smaller tributary areas that feed the Yellowstone. (*Stillwater County Local Civic Leader)*

I hate to see the environmentalists go to extremes on certain issues and that happens. (*Stillwater County Local Civic Leader)*

B. Addressing Subdivisions, Laws and Taxes

I think the city will continue to struggle with subdivision. Whether they should or shouldn't be allowed. We only have one zoning district outside of the city limits and it is voluntary. We are going to put our land into a zoning district and in this district you can't carve off less than 160 acres. By voluntary, I mean when they created that district that carved out anyone that didn't want to be part. County or city can come in and say we are going to zone. Outside of the city limits Sweet Grass County is un-zoned except for that one area. I think in ten years there may be more zoning, either private, although there has been more discussion if there would be interest in county zoning for a certain distance. I am not advocating or suggesting it is a bad or good idea. I am just saying that these are being discussed. I don't know that I know what I think of it yet. (*Sweet Grass County Local Civic Leader)*

You just have different policies in the county, in the state, in the city, and pass regulation that is for the best of the community, and then people will fill in around that, you know what I mean? It is a growth plan….The main concern would be in the county where ranches are being sold off and then people are coming in and buying up ranches and building on the land there, which I think is… a real sensitive area that needs to be really looked at for the long term of the county here….Once you have an area and it gets overpopulated, your road, your water, your police, your fire, your schools, everything is affected by people, population. And when you need to present more services, taxes go up. It's like a snowball going downhill and it's hard to stop. The more people you have, the more services you need, and then you wind up with more vehicles, and that process happens. We've all seen it happen in different areas in the United States over the past 100 years. Beautiful areas that all the sudden are still beautiful, but just over populated, where it's hard to go there anymore. (*Sweet Grass County Local Civic Leader)*

[After] I took office, in the southern part of the county, there were some ice build-ups and there were primarily summer homes, and they were concerned about flooding, so they called me, the new commissioner in their district, and said we've got this ice, come and help us out. It sounds like a reasonable request to me, [but] I'll have to ask and get back to you. I talked to our road and the other commissioners and, no, we can't do that. Really? Why? Well, three things. First, it's on private land and there's liability….Another one is the Fish and Game is responsible for the fish habitats [and] would have some problem if we took heavy equipment and messed around with the river. And the other thing [is]...an insurance company would look at this ice jam as a natural event, call it an act of God or something. So if we go in there with our equipment and undo that, we're just pushing the problem downstream and then it's our fault; it isn't an act of God, it's an act of the County Commissioners. So, we just would like to help people, but we can't, and when we explain why, they accept that. (*Stillwater County Local Civic Leader)*

I think within ten years we will have a sales tax. People want no new taxes, period, and I don't want more taxes but I think that we've got two legs of a three-legged stool. A sales tax would provide that third leg…and property tax…It probably wouldn't be a case overnight, initially a sales tax and totally eliminate one of the others….and I think any state has a lot of tourism is foolish not to have it…but that requires an education. They have to see…you can't afford not to have a sales tax. (*Stillwater County Local Civic Leader)*

I don't think every piece of land should be subdivided, but yet, [with]… private property rights, there is a fine balance….I don't think you should be able to subdivide good resource land into small acres and have houses on it. I think there's some way you could work around that, maybe subdivide undesirable resource land and still accomplish the same thing. Like if a rancher needs to for financial reasons, to keep doing what he's doing, he should be allowed to do some of that, but I just think chopping up good resource land is not the right thing to do. (*Sweet Grass County Local Civic Leader)*

I do like our new subdivision regulations that we allow for people that might be in jeopardy of losing their ranch. It allows them to sell off some acreage. (*Sweet Grass County Local Civic Leader)*

And I guess I should clarify. I'm not for subdividing everything either, but I just believe that personal property rights are that person's. Whoever owns the land should be able to decide what to do with it. That's my opinion. (*Sweet Grass County Local Civic Leader)*

Because I just think people, maybe with the education, they won't build along the river. I just don't see…the Yellowstone [as being] like the Stillwater, where people can get right next to it.…The Stillwater is pretty stable and doesn't change that much, but the Yellowstone does….Probably the State of Montana, maybe the Army Corps of Engineers, maybe the Fish Wildlife and Parks [should provide that education]. (*Stillwater County Local Civic Leader)*

VI. Evidence of Changing Local Values

A. Challenges to the Local Idea

As far as out-of-towners locking their places up and not allowing any access, do I like that? No, but I think it is their legal right to do it. (*Sweet Grass County Local Civic Leader)*

Look at Billings, for example. The Yellowstone River runs through there, and I can remember 35 to 40 years ago, when I was out there hunting….The town was about 15,000, 20,000 at the most, and now it's over 100,000 if you include all the suburbs. And all of those thousands and thousands of acres that were providing…food—…nobody's worried about that because they think they can import it. But I guarantee, one little war would end that in a hurry. And they've taken this land…and put cement on it, for God's sakes. (*Sweet Grass County Local Civic Leader)*

The way the ranches go and the farmers go, there's not a lot of money in it. It'd be hard to see what this town would really look like if [the miners] didn't come in…ten or 12 years ago. Because with their money they brought homes…The mine gives a lot of money to the schools and different projects that go on here, and it's basically what made this community what it is today. The bonding of that industry and the ranch industry. (*Sweet Grass County Local Civic Leader)*

You read about the romance of the Old West, and that's why a lot of these rich people come…for the romance. Well, there's romance in an old family farm, too. Their romance [the rich people's] won't buy you breakfast. (*Sweet Grass County Local Civic Leader)*

What we have to remember is, the generation that really cared about the environment and really cares about protecting their places against the elements, is the generation that is dying-off. I call this [current] generation the convenience generation. They are going to do what they want because it is convenient to them. They do not care what it does to anybody else, or the environment, or anything. They could destroy a lot. They care about nothing. When you see the t-shirts that say 'It's all about me,' that is not much of a lie. That is so different from the generation that built this area and developed this area. The community spirit isn't here, like it used to be. It is in pockets, but not like it was. (*Stillwater County Local Civic Leader)*

My daughter and son-in-law live on a ranch west of town here, and it's not a very big place….A realtor just appraised it at a million and a half….It's out of the question entirely for the kids to buy it. My wife and I have spent all of these years in agriculture, and just like most of the neighbors, whenever you do make a profit, you put it back into something else. So we got a million and a half dollars sitting up there, and nothing to show for it….How are the kids going to make a payment and still be able to live there, too? And with an appraisal like that, the government won't let you give it away. You can't sell it for less than the appraisal…and [besides,] the last thing we want to do is sell the place. (*Sweet Grass County Local Civic Leader)*

We bought my husband's ranch from his father at, what was at that time, probably a hugely reduced amount. It was enough for them to retire…at that time. And we're doing the same on the next generation….We have to get it appraised, and we're going into the gifting…[with] a limited family partnership so that our son and my brother can buy our share out. And we'll be able to retire and have a little bit of an income. (*Sweet Grass County Local Civic Leader)*

My dad is at a point where he wants to retire, and there's not enough money off the income of the ranch to allow him to retire. I have two brothers that want to stay in agriculture, so the only way we can do that is to sell the ranch here and…buy a bigger ranch somewhere else. (*Sweet Grass County Local Civic Leader)*

I just hope my family can get a chance to appreciate the river like I have, and get a chance to float it and fish it, and look at everything that I've seen. That's what I would like to see happen to the river….[But] I could [also] see big corporations buying up property along the river, and it not being agriculture anymore. (*Stillwater County Local Civic Leader)*

B. Newcomers

'Welcome to Culture-Shock-Big-Timber'….Most of the counties in Montana have a code of the west. It is a document…[and] we have one being put together primarily by the Cottonwood Resource Council. It is a 'what-to-expect-when-you-buy-property-in-this-county' document. A number of counties have them. They are trying to educate people on what to expect, weather-wise, service-wise, [and] neighborly things. You had better know what your water rights are before you start taking it….Here is what to expect; here is how to behave yourself. (*Sweet Grass County Local Civic Leader)*

I think that, in some respects, local people have a greater appreciation for water. It is the life blood of an agricultural community. It is aesthetic for out-of-staters more than something they need for their livelihood….In general, they are looking at aesthetics and they are not doing a lot to protect the resource. They can say because we built our house back and we are going to clean up this irrigation dam that is better for the river. It isn't if you are still going to put a pond there and are going to put fish that will get into the river….The ranchers that don't have easements on the property are incredible stewards of the land because they depend on it for a living. And I think they get short-shifted and short recognition sometimes. (*Sweet Grass County Local Civic Leader)*

Newcomers immediately put up 'No Trespassing' signs, 'No Hunting' signs, 'No Fishing' signs, 'Stay Off My Property' signs. Maybe they have never had land this beautiful, and they want to not share with anyone. They come in, and don't know the country, and don't know where to build or buy. After they pack water for two years, they put the place up for sale. (*Stillwater County Local Civic Leader)*

Small tract owners….We have people who bought their 40 acres and don't have a clue what to do with it because they've lived in town all their life. So what do we end up with—a whole bunch of weeds. Don't allow anybody on it, 'This is mine. Let's not graze it, let's not do anything with it so the fireman will have something to look after.' That's really real out here. They don't allow any grazing or anything to use that tall grass that's out there waiting to burn. That's hard for me. We need to harvest things if we expect them to grow. I've watched an awful lot of pastures [and] when they're managed right, you get good strands of grass and a good ecosystem. And if you don't manage it, you've got a mess. And we have subdivisions that are a mess, although we've had a really active weed department, and they finally realized that there are other ways of controlling these weeds, biological, do little with livestock, spray the perimeters so we don't spread it over the neighbors. If somebody is highly allergic, or their value system says I don't want anything to do with pesticides, far be it for us to suggest to use it. Let's give them a few bugs and they're tickled to death. We've got a real diversified sort of a weed management system, or we don't call it weed management, it's plant management. (*Stillwater County Local Civic Leader)*

I basically retired…and moved here. It was October…and I'm in my front room, the wind's howling, it's 31 degrees out, and I think I'm going to go crazy, so I went down to the IGA store and got a job there. So [now] I know everybody in town—just by sight, not by name, and I've worked there for three years….That was a good way to be introduced to the town, where everybody knows everybody….So I was accepted well here, and the town's changed from what I understand. It used to be a ranch/farm community, and I don't know when the mine came in…[but] I think there was a problem then….I think that took time for people to get used to…and now they have a lot of people retiring. There's a lot of people moving here from the south and east, and west. (*Sweet Grass County Local Civic Leader)*

C. Empty Castles and Trophy Houses

They don't subdivide it, they just come in. They buy it up. They don't put any cows on it, they just let it sit there, and build a great big trophy house on it, and…the land isn't really being used for agriculture any more, it's either someone's personal hunting grounds or river access, you know. So, for me, you've kept people from living on it, so that those [wealthy] people can come in and block everybody off it. It doesn't happen all the time. (*Sweet Grass County Local Civic Leader)*

We have some [newcomers] that have moved in and their house is right next to the river, and then they want no one else to build next to the river. You know, 'I've got my little piece of heaven, but I don't want anyone else to be able to do that.' (*Sweet Grass County Local Civic Leader)*

I expect more development to happen. People love it out in the hills. They're building new homes and have their piece of the rock and a castle. They love it here. We'll have changes in the infrastructure, more pavement, a stronger hospital system, not the kind that does all the surgery and stuff, but to bring people in and help them heal up after the folks in Billings have looked after them for a while. (*Stillwater County Local Civic Leader)*

I have a real concern, because mom and dad move up here and build a $500,000 house. Do the kids want that? I talk to a guy that runs a landfill that buries tires the other day, and he had an interesting concept about this country. Way back when, the Spaniards and the French folks came over here and gathered up all our gold and silver and hauled it home. They were very rich so they built these huge castles. Now, many of them are empty. I equated that to our castles. What do they even do with them? They're trying to earn a living and raise their kids. How do you pay the taxes on these things? How do you keep the lights on? Do they really want them or are we going to end up with a bunch of places for retreats? It makes you wonder. They're beautiful, big homes, huge things, million and a half, two million? And for us, that's a castle. Especially when most of us were raised in these little old farmhouses. Those things really ring my bell because I don't know where we're going and I guess I'm too old to really worry about it. (*Stillwater County Local Civic Leader)*

I just feel development is probably our biggest worry. And [we need to] be careful of how we do our developing. I'm not so much worried about what the farmer or rancher has done over the years, because he's done pretty well taking care of things. That's his life. But…we've got some old subdivisions…on Rock Creek [that were built] in the '70s, and they're terrible. (*Carbon County Local Civic Leader)*

I had a lady…[who] bought into this subdivision, and they're from Chicago, and,…according to the subdivision rules, you have to fence yourself away from the road because it was open grazing,…but she called and said that the neighbor had his cows out there on the road. And I said that's the way it is there, open grazing, open range. I said 'You gotta fence your land. That's the way it is in the subdivision rules.' There was dead silence, and she said, 'Well, there will be poop on the road.' I said, 'Welcome to the west.' I didn't know what else to say. (*Carbon County Local Civic Leader)*

D. Concerns Regarding Conservation Easements

Some [conservation easements] say that the family can build one house. I mean, they limit how many dwellings there can be on the land. (*Sweet Grass County Local Civic Leader)*

[Conservation easements] pretty much stop any development. I don't agree with conservation easements because it takes away the power of the future generations to make a decision…for no further subdivision. Some of them expand on that to no further development of any kind, either gravel or mineral or oil or gas or timber or feedlots. It just goes on and on.…[The people who set up conservation easements]…have moved in from somewhere else, most of them. (*Sweet Grass County Local Civic Leader)*

Most [conservation easements] are done for the wrong reason. They are done for tax perks….For [land worth] $100 an acre, put a conservation easement on it, and all of a sudden, it's only worth $50 an acre because it can't be subdivided. So they take that $50 as a tax write-off….So they buy land at a…cheaper [cost] than what you or I could because we pay $100 an acre….[For us,] it doesn't do any good,…because you're not in that high of a tax bracket where it's going to save you. (*Sweet Grass County Local Civic Leader)*

The proximity to the river is a huge factor in driving up land prices….We see more conservation easements. So, the river is certainly driving value for conservation easements. (*Sweet Grass County Local Civic Leader)*

There are a lot of old time ranchers who don't have any intention of changing their practices or selling, who may or may not have conservation easements on their property….The out-of-state people are less likely to give access than local people. (*Sweet Grass County Local Civic Leader)*

E. One Comment on Coalbed Methane

One thing that we will have within the next ten years is coalbed methane development. That's coming, and, personally, it can be a good thing. It can be a good thing for the county tax base….We've heard a lot of horror stories about things that have happened in Wyoming…[but] we can learn from those mistakes…. One of my main concerns right now is that private land owners may not have enough say in the how the disturbed land is reclaimed….Also, water quality and quantity is the major issue there; that's the main concern. Now some will say you can take that water. When they're going after the gas that's in that coal, the gas comes up in the water, the gas bubbles up, they capture the gas, and then there's the water. They've got to do something with that. They either pump it back in the ground or give it to ranchers for livestock, and livestock can drink it, and probably you and I could drink a glass of it. It might taste a little strange, but it probably wouldn't hurt us. It might not even taste that bad, but if you poured it on your alfalfa, it would just kill it. There's things like that, and that's what a farmer or rancher doesn't want to contend with. So, I was going back because coalbed methane will be here in a big way within the next ten years. And, personally, I don't mind it.…I could certainly live without that development. But, if it has to happen...if it's done reasonably…[it will be okay]. (*Stillwater County Local Civic Leader)*

VII. Valuing the Yellowstone River

A. The River Supports the Community

Probably the most important thing is that I'd like to see the Yellowstone River stay unpolluted and not over-taxed by people, and managed in a way where it can…be managed. It's doing well as far as I know now, but not overused or polluted. That's my main concern about it. (*Sweet Grass County Local Civic Leader)*

I like water. It's just part of the whole thing here. It's part of the thing that makes it a good place to live. You take the river away, it would be a much different place. That's what it [the river] means to me. I don't think it should be messed with. They should leave it alone—which they're not going to do. (*Sweet Grass County Local Civic Leader)*

First of all, it is magnificent. Second, it is support for ecology and the lifestyle. It is important for agriculture, and recreation, and certainly for fisheries, and obviously for a whole host of reasons that have to do with the environment and ecology. (*Sweet Grass County Local Civic Leader)*

Big Timber is quaint: no stop lights in the town, beautiful views and [it's] where the two rivers come together—the Boulder and the Yellowstone. It is wonderful during the summer and fall, and winters are questionable. (*Sweet Grass County Local Civic Leader)*

I have an appreciation for rivers everywhere, whether they're used in commerce or recreation, or in this instance here, irrigation is very important….Water is the lifeblood. Irrigation is big, recreation is big, and that's whether you're floating it in a raft or fishing it or taking pictures. (*Stillwater County Local Civic Leader)*

I live in the most beautiful part of the county.….Truly the prettiest part….The diversity, the natural beauty, the natural resources, the custom and culture of the people here….We're blessed with a lot of natural resources here. (*Stillwater County Local Civic Leader)*

It's very important, because I believe in irrigated agriculture. I believe in cattle ranching, and that has been our major source of water in the area, for irrigation purpose and also recreation. It's a big recreational stream, huge….Scenic beauty for one thing, and it is a fishable stream. It's a navigable stream when it comes to floating or rafting, or whatever they do best on it. I guess the Yellowstone is the closest recreational point for a heavily populated area. Billings has about 140,000 people in the surrounding area and a lot of them come here for weekend and evening use. It's close to town and they just come up and enjoy our wonderful mosquitoes and everything else that comes with a nice stream. (*Stillwater County Local Civic Leader)*

I like to hike along the Yellowstone, picnic along the Yellowstone, just observe it, drive many, many times to the bridge just to observe it during different times of the year. Like right now, it's at flood stage, which is phenomenal to watch. But other times of the year we can predict….We've been in about a five- to seven-year drought here, so we watch the river because some of the people have to stop using water right off the river when it drops to a certain level, to maintain fish water. So, it's a predictor of our weather. It's a predictor if our ranches can irrigate, it's a predictor of…I don't know…the things that happen from here all the way down, a weathervane in it's own way. (*Sweet Grass County Local Civic Leader)*

A lot of farmers and ranchers use irrigation water from it [the river]. Livestock drink from it. Basically, it's the center of the whole community.…Everyone's kind of drawn to the river. (*Sweet Grass County Local Civic Leader)*

Yellowstone is a lot more public….Anything you do on Yellowstone is a major political thing….I think it's because it's…[a] national treasure.…It's the longest free-flowing river in the United States, and you know that's always brought up anytime….It's just made public. (*Sweet Grass County Local Civic Leader)*

It is very important to the irrigation and the valley….It's right through the heart of Sweet Grass county. (*Sweet Grass County Local Civic Leader)*

There's gotten to be several fishing guides….Floating and fishing in the summer months has gotten to be big deal around here. (*Sweet Grass County Local Civic Leader)*

B. The River Supports Memories and Lifestyle

I just like to see the different turns in the river, the wildlife, the deer and the moose, haven't seen an elk, all the birds that live along the river. I like to see how the railroad has meshed along the river, because we'll be floating and every once in a while the train will go by and we'll wave and they'll honk at us. (*Stillwater County Local Civic Leader)*

This ranch has been in my wife's family forever. You know, when I go out there on the weekends and irrigate or build a fence, I'm irrigating out of a ditch that my wife's great grandfather built over a hundred years ago. Or I'm fixing fences that he put up over a hundred years ago, or a barn that he built over a hundred years ago. And they did things the hard way. I mean, when they first started, and this was long before they had electricity, they cut hay with a scythe. They didn't even have the horse-drawn type—that was later. When I start feeling sorry for myself, like I'm overwhelmed with all these things to do, if I think about that, it helps. They probably had more chores done before breakfast than I get done all day….I like the county. I'm here because I married [a woman] whose family had this neat ranch. That brought me to the area, but, of course, I've got quite a few friends here, and I like the area. (*Stillwater County Local Civic Leader)*

When you grew up back in the '40s and '50s, you found yourself almost always with family and friends picnicking on the Yellowstone or the Stillwater with family. You knew all your cousins. You got together and fried chicken and the kids played baseball in the pastures. It was a lot of fun. (*Stillwater County Local Civic Leader)*

I love to go and sit by the river…because it is relaxing. The birds, the water….snakes, which I don't like, but the wildlife, the deer, and the animals that the river supports. Just the fact that you can skip a rock across it or whatever. It is a relaxing place to be. (*Stillwater County Local Civic Leader)*

C. The River is Easily Taken for Granted

It wasn't just the beauty; it can be such an asset to the state. I think that is something that people really need to look at a little closer than they do. They ignore it and [the] taking care of it is ignored to a certain degree. (*Stillwater County Local Civic Leader)*

People need to be grateful for what they've got and do what you can to help preserve it. (*Stillwater County Local Civic Leader)*

Just the fact that it is there. Cities not far from us are on smaller rivers have rivers that have dried up. We take it for granted but it is always there. (*Stillwater County Local Civic Leader)*

The most important [thing] to me, aside from the river, is the well-being of the town, basically. There are so many factors with that. The economic well being….Keeping it going.…We don't want the river to be polluted [but to] stay like it is…good for fish, picnicking….Just be there. (*Stillwater County Local Civic Leader)*

Laurel to Springdale: Recreational Interest Group Overview

Thirteen interviews were conducted with individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity. Participants were recruited from referrals provided by members of the Resource Advisory Committee of the Yellowstone River Conservation District Council. Participants were also identified and recruited by contacting various organizations such as Ducks Unlimited, Trout Unlimited, and the Audubon Society and by contacting local outfitting businesses.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Laurel to Springdale: Recreational Interest Group Analysis

I. *Valuing the Yellowstone River*

A. The "Remarkable" Yellowstone River

It's a pretty remarkable river. With ten years of drought, you don't hear of problems on the Yellowstone. It's like an old survivor. It's being well used now [and it] can continue very easily. (*Sweet Grass County Recreationalist*)

It's a beautiful river, beautiful. It's a beautiful river. The country around it,…the mountains….When I came back from [out-of-state] and I came around the corner, and the sun…was shining, and the mountains, and the river was flowing, and…it was like I gasped, and then I sighed. Home. (*Sweet Grass County Recreationalist*)

It is [important] for scenic purposes and for recreation. I use it for trapping, mushroom hunting, deer shed hunting, boating, fishing. It is great. It is nice to have a natural swimming hole next to you. (*Carbon County Recreationalist*)

First of all, [the Yellowstone River] is a link to our historical past and…our cultural heritage here in the west. And I'm very much personally oriented towards that concept,…the historical significance....We're floating right down the same river that Captain Clark came down 200 years ago. I think that's important in preserving our western cultural heritage. (*Stillwater County Recreationalist*)

I believe the Yellowstone River is an unusual river. For one thing, it's an un-dammed river. It starts in Yellowstone National Park. It has much different terrain. At the start of it there's a lake [and] the canyons, [then] the rich farmland and the beauty south of Livingston. Then we get into the prairie, and end up into North Dakota. It has a multitude of interests for a lot of people. It isn't all the same. It's a river of variation. And it's a river that's dangerous, but it's peaceful, also. [It is good] to be around the river, to watch that body of water moving away, and to see it usually clear, except in the spring. It's a treasure in itself. (*Carbon County Recreationalist*)

You get on this river and she will carve out a new experience every year. (*Stillwater County Recreationalist*)

Big and daunting….It is bigger than most people are used to, and it is not wader-friendly. That is different from most trout streams. (*Sweet Grass County Recreationalist*)

B. The River as a Refuge

It is the only place I gain my sanity when I need to, and I don't need a bunch of people on it. (*Carbon County Recreationalist*)

[The river is] relaxing to me, it is. That's how I get away. If I'm going to get away, that's where I go. (*Sweet Grass County Recreationalist*)

[The Yellowstone River] is why I came to Montana. I was 18, living in New Hampshire, and I saw the movie *Yellowstone Concerto*….It was kind of an informational movie with classical music….I bought a motorcycle that spring, learned how to ride it, and went 'home' [to Montana]. (*Sweet Grass County Recreationalist*)

The tranquility, the quietness,…actually knowing somebody [lives] over there and, yet, you can still [sit] on the bank and fish, and you don't *have* to see anybody. You won't see anybody. (*Carbon County Recreationalist*)

Even though you're flowing down a river valley that is pretty-much paralleled the entire way by a major interstate highway and a railroad,…it still provides an experience of solitude. The natural environment. That's what I try to convey, too, when I'm using the river commercially. I try to convey that experience to my clients. It's not just about going out and catching a bunch of fish, or whatever. It's seeing the eagle's nest, or seeing the eagles, or seeing the other wildlife, or just experiencing the outdoors and having conversation about the uses of the river, or [conversations about] the historical significance of the river as you float along. Those kind of things. (*Stillwater County Recreationalist*)

C. Free-Flowing and Natural

Leave it alone. Don't dam it….It will take care of itself. (*Sweet Grass County Recreationalist*)

The Yellowstone is, just….It's really cool that it doesn't have a big dam somewhere….It's free.…You can see where it starts, and where it ends, and there's nothing stopping it. (*Sweet Grass County Recreationalist*)

I love it. I mean, I've used it my whole life. And I don't think it would be as grand if it wasn't the way it is….I think of this dam [idea], and think of what you would cover up. Think of the beautiful country you would cover up. I mean, for God's sakes. (*Sweet Grass County Recreationalist*)

Get an appreciation for it…[as] the longest un-dammed river on the continent of North America.…And talk about the diverse interests: agriculture, and recreation, and things of that nature. (*Stillwater County Recreationalist*)

It's the longest free-flowing river in North America, and there's nothing else like it….It's a natural fishery…and it's scenic and it's just an amazing place. The length, the variety, and the types of fishing are unsurpassed anywhere. (*Sweet Grass County Recreationalist*)

It's a volume of water, clear, pristine. It's moving rapidly and it's always refreshing and there's never stagnant water. It's a live stream and it's full of energy....You can't say pure, but it is pretty close. (*Carbon County Recreationalist*)

It's just magic because it's an un-dammed river. They almost had a dam in at one point. I saw the map of where the water would have backed up—unbelievable. We'd have a huge lake, but a lake with the life of about 70 years. It would have soaked it in so fast. It's a remarkable river and if somebody wanted to, he could go float 700 miles and see everything from the sharp mountains to the plains below. (*Sweet Grass County Recreationalist*)

It's important to me [that the river is un-dammed]. I don't know how important it is to other people, but it's important to me. It's more natural. Tail-waters are regulated fisheries, and very fun to fish, but not quite natural. (*Sweet Grass County Recreationalist*)

D. The River's Resources

The unique thing about the Yellowstone is, in order to have a successful fishery, you need to have a ripple and a run and a flat. It is a series of things that happen to the river. When you rip-rap the river, you get a series of jagged turns, big holes, and no ripples, no runs, no flats….It makes everything deep, and it doesn't allow that river to flatten out and create the ripples and runs….From a fishing standpoint, you are much more successful in a ripple, run, or tail-out situation. (*Sweet Grass County Recreationalist*)

The fishing is more challenging on this stretch than anywhere else on the Yellowstone because you are…in a transition area. [Below] Laurel…there is more of a catfish, a sauger, a walleye-type of fishery. Above Columbus is trout fishing. So we are in a transition,…[and] our section is a more challenging area. To catch a lot of fish, you've got to know what you are doing. And that is what draws me to it. (*Carbon County Recreationalist*)

The first thing is, if the water get too low, and too hot in the summer time, [it] poses a real threat to the fish habitat and their survival….Water that's being taken out, or returned, creates a problem….From the recreation standpoint, ensuring that we have an adequate fishery [is important]….Trying to ensure that the water flow and water quality is maintained [is important]. (*Stillwater County Recreationalist*)

The river is where life begins for bugs, fish, and birds. You see pelicans come by in the spring. They are going to the Missouri. When fall comes, the teals show up. You know that weather is going to start changing because the teals are here. It is like reading a book. When the hatches start coming off….it is a prolific place. I can't say I ever get tired of it. Knowing that there are some huge fish in there….It is clean enough to grow fish like this.

Back east, they grow all of them in hatcheries. One of the greatest things is the Yellowstone has all wild fish. A lot of places, they don't get this. It is like going to a game reserve and shooting birds, versus getting your dog out and going hunting. There is no fascination with a refuge. (*Sweet Grass County Recreationalist*)

Probably the most important problem, or challenge, is…just trying to preserve the resource as we have it. I think, currently [the river] is…in a pretty good state….New growth and development are just a natural way that things develop, but hopefully we can do so responsibly and still preserve the use of the river and the resources….so we can [still] enjoy going down the river.…Preserving the fishery is important to me…[and] floating down the river [when] you may not see another boat all day long. (*Stillwater County Recreationalist*)

I was on the growth policy task force, and it is a complicated issue. This is where those trophy homes come in. I believe someone has the right to build whatever kind of home they want. They have the property, and the money, and they are creating jobs for people. On the other hand, I think the river is a public domain, and it is in the interest of all the people to protect it, particularly the edges because people can't develop there. If you have no regulations, people could build their porch out halfway across the river. You have to regulate what is too close. (*Sweet Grass County Recreationalist*)

I think of the riparian zone is…out to the change of vegetation…[When you get to] dryland farming…[and] grasses….you are out of the riparian zone. The flood plain is in the corridor. Everything that has a different type of vegetation than the rest of the valley is the riparian zone. Water is affecting what will grow there even if it doesn't get water every year….It includes the flood plain in most places. There are odd places where it just flattens, and the flood plain officially goes out a half mile. I don't consider that all riparian. (*Sweet Grass County Recreationalist*)

My dad and I argue all the time. He's a religious man, and he says God gave us dominion over the earth. And I say, 'Dad, I know the Bible says that, but that doesn't mean we have the right to use it, and abuse it, any way we see fit.' (*Sweet Grass County Recreationalist*)

[One] invasive species…is a gold-eye. It tends to establish itself in lake-like places. It migrates to warmer water. They look like a piranha; they are an awful, little fish. I am sure they are very vicious. They are very competitive. (*Sweet Grass County Recreationalist*)

A lot of the fish spawn at the tributaries, and so the Yellowstone itself isn't a huge spawning area. You have to take all of this into consideration when you are putting restrictions on things. (*Carbon County Recreationalist*)

I enjoy, [the river]…from the standpoint as a fly fisherman.…But, then, I also get paid as a professional guide, so I derive commercial interest from it as well. So I think I have a lot of the different interests that bring me to the river. (*Stillwater County Recreationalist*)

E. Dangers and High Water

It takes a lot of lives. There’s an undertow, and they used to use old car parts and stuff for protecting banks, and you can get tangled and drown. (*Sweet Grass County Recreationalist*)

One thing about the river right now, it is fast, and it is dangerous. People get on it, and they don’t know what they are doing. [There are a] bunch of undercurrents. It will take a boat quick. (*Carbon County Recreationalist*)

Usually, after high water, you have dangerous places on the water….A couple of years ago we had a big deal,…and a guy [with me] will never float again. He has floated his whole life….If someone had the resources, [it would be good] to go out on the first of July, and screen the river, and make sure there are no dangerous places. Fish and Game wardens are great about getting feedback to you,...[but with] a lot more people floating, [there is] a lot more potential for accidents. Two things happen. It is the big water and the waves that get them, or the water gets low and muddy, and they can’t see. They will jump in the water, and they can’t see. Head injuries are a big deal. I would say those are issues that you probably need to consider down the road. (*Sweet Grass County Recreationalist*)

II. Access Dilemmas: Demands, Limits and Controls

A. Increasing Uses and Overcrowding

I see definite overcrowding, I see Fish and Game having to make some adjustments in fish limits. They’re going to have to make some sort of adjustments…with how many outfitters who come into an area….Something to kind of weed people out of that. (*Sweet Grass County Recreationalist*)

I think it’s going to be used more and more….More recreation. Agriculture is always there with the irrigation and water use. There’s more floaters, [and] there’s more fisherman, all the time. It’s not just the Yellowstone; it’s everywhere. Montana is a big destination spot. You get a lot of people in here to fish it all the time. I don’t think the use of it is going to change, it’s just going to be more and more. (*Sweet Grass County Recreationalist*)

As far as the traffic, the traffic is multiplying every year times two. From a recreational standpoint, I would expect in ten years to see three to four times the traffic. There are already a lot of people using this resource. (*Sweet Grass County Recreationalist*)

[The Yellowstone River] is probably the main source of how we make our living.…We run fly fishing expeditions. It also has attracted a lot of people to the community.… Probably 85 percent of my clients have moved here because of the fishing in the area. So, it’s huge. (*Sweet Grass County Recreationalist*)

I honestly don't believe that…floating…and the fly fishing industry [have] as huge of an impact…as motorboat people. [Motorboat people] tend to be people that take [the fish] ….At the end of the day, if you have 20 fly fishing boats with two people in [each boat], you might come up with two fish that were injured and that were killed that day. (*Sweet Grass County Recreationalist*)

I have to say, it's really different now compared to when I was young….Probably over the last ten years, it has increased dramatically. Motorboat use has become huge. (*Sweet Grass County Recreationalist*)

After I retired and moved back here, there were so many floaters coming down that I kind of quit fishing the river….They come through your fish hole. (*Sweet Grass County Recreationalist*)

B. The Importance of Public Access Laws

I am not talking about condos, or a subdivision, but I can tell you right now that there are people flocking to this country. They are spending everything they have to buy Montana. They can't own the rivers. They will get lawyers, and try to own the rivers, but they can't. The stream access is what separates us from others. (*Sweet Grass County Recreationalist*)

See, the river has changed over the last couple of years….[If some parcel of land] is on your deed, and the river has moved,…[it may be public now]. There are some BLM islands [that,]…20 years ago,…were ours. Now you have to really watch yourself. (*Carbon County Recreationalist*)

That's something that's pretty special about Montana—the streams access—compared to other states. If somebody has to go fishing, it's a pretty easy thing for them to do on the Yellowstone. (*Sweet Grass County Recreationalist*)

Montana has just great stream access, and I think that's really something…[I] fervently hope we preserve. (*Stillwater County Recreationalist*)

The stream access law…ruffled a lot of peoples' feathers. I think it is still right. We should all be allowed to use the river. (*Carbon County Recreationalist*)

The other thing that's very important…is this Montana Stream Access….People that come here for the fishing experience, in particular, are used to much more restrictive fishing experiences. So I explain to them the fact that…Fish, Wildlife and Parks has great programs, and access sites that allow you to get to the river, [and]…that once you're there on the river, legally, then you have the right and freedom to maneuver around the river up to the high-water marks unabated. That's a lot different than a lot of states, and that's pretty significant, I think. (*Stillwater County Recreationalist*)

The average high water mark is where the determination has been made that private land stops and flood plains begin. They mapped this all out in the past five years. What is the flood plain? It changes annually,…so the high water mark is a negotiable item. It changes from year to year. So, they did map it out, and there was some clarity. It isn't the 100 year flood or 500 year flood: it is the average from all the years. Basically, you can see where the high water mark is when you are fishing because of the logs and debris that came down in high water have deposited in a place where you can see. (*Sweet Grass County Recreationalist*)

You can go up and down the stream, anywhere you want. And you do not own the water in the State of Montana….We took some folks fishing, and…the next day I got a phone call, 'I know [your clients] got some fish, and I'd like to know where they caught their fish.…I also want you guides to know that when you float through this water that doesn't mean they can stop and catch my fish.' Now, this was on an answering machine, thank heavens, because, …whew, you know. My guides knew where those fish were before [that caller] even knew where Big Timber, Montana was….[That caller] came here, and floated with us through everybody else's property, and caught fish on everybody else's property, but now….You have to, you know, gently work in some awareness. (*Sweet Grass County Recreationalist*)

The Yellowstone is important because it binds us as a community. It is public water. The biggest thing that binds people in this country are the public lands. None of the politicians talk about it, or if they do it is casually. It is not tops on the priority list, [but] I think…what makes our country and Montana, unique, is the fact that, so far, this is not the rich-boy club. Even the millionaires…have to drink the bitter beer if the guy walking through their place gained access legally. It gives access for the common people. (*Sweet Grass County Recreationalist*)

I can think of a situation where a guy across the river bought a place for fishing. He bought a couple miles of it. The guy on the other side of the river was letting whoever wanted to come and go fishing. [The new owner] didn't like that, so he got a buddy to come in and buy the land on the other side of the river. So now, you can't access the river from either side. A lot of that's happening. (*Sweet Grass County Recreationalist*)

You know there's the fine line. Say I'm an outfitter that has a hundred days in the National Forest.…I can sell [those days] as use in the National Forest. How do you do that when that's a National Forest?...You're making a living off of national [resources]. People who have a permit in the National Forest…can charge huge amounts of money. (*Sweet Grass County Recreationalist*)

The tributaries, the backwaters, the swamp, the sloughs. Nobody has rights to those, as far as I am concerned….Those are sensitive areas. Riparian areas shouldn't be treaded-up….[Those are] nesting habitat. (*Carbon County Recreationalist*)

C. Problems with Access

Every time you improve [a public access site], it invites more and more users, and, sometimes, it causes more problems than good. You get erosion, particularly when people start to slide their boats into the water, digging into the bank….You can see it is beaten up. I don't launch boats down there anymore. (*Sweet Grass County Recreationalist*)

Access is a big deal on the Yellowstone. There are sections of this river that you can't get on without camping overnight. Access can be 20-some or 30 miles between access points. With jet boats, it is not a problem; they can just zip, zip. Nothing against the jet boaters, but that upper area is so much more eroded due to jet boat traffic. (*Stillwater County Recreationalist*)

You can see huge, orange-painted signs, meaning 'Stay off. Private property.' And the thing is that is coming about. It is not the local people that are doing this. It is the people from out-of-state who are buying these parcels. [They] want that little island as their own, even though they can't access it, and they can't use it for agriculture. They just don't want anybody there. But, from an agriculture standpoint, when they show up to your house to go hunting, they expect you to allow them to do whatever they like. That is the problem with out-of-staters. They want it all for themselves and not let anybody use it. (*Carbon County Recreationalist*)

The Californian [said],'We got out of there because of all the politics, and all that.' And the first thing they do is they go to your river board meeting, and they say, 'This is how we did it in California.' That is the first thing out of their mouths. Well, that isn't the way we do it. And the thing is, now, they are getting into the public offices where they can actually change things to make it their way. The locals sit by and just….I mean, it is our own fault. We are just sitting by, letting them do it….The town of Red Lodge is an example. [Newcomers] don't want any new infrastructure, or new businesses, or anything like that in Red Lodge, because they moved there because of the 'little tourist town' that they have. Locals need the money to stay alive, [but the new people already] have their money. (*Carbon County Recreationalist*)

I think they've done a good job of developing access sites. We're always trying to get more, just trying to ease the pressure, and spread it out a little more. We're trying to get some more down in this area from Columbus to Park City, and we're working with Fish Wildlife and Parks to hopefully do that in the future. (*Stillwater County Recreationalist*)

D. Decorum: Respecting Others and the Resources

People are usually pretty congenial at the take out. I don't know…you just have to have some etiquette. You have to come from parents that taught you to give a shit. (*Sweet Grass County Recreationalist*)

There's some conflicts sometimes, but I think, as a general rule, they work fairly well together. I think, as a general rule, it's a pretty good group to have on the river. There's pretty good watch-dogs all the way around….[If someone is] dumping something in the river that shouldn't be there, we're probably the first ones to see it…. At the end of the day, you have to make everybody compatible, and everybody might have to give a little bit. It is a multi-use thing. (*Sweet Grass County Recreationalist*)

All in all, the garbage, the campgrounds, everything is pretty neat and tidy….When I was a kid, I saw tires burning along the shore, beer cans. Oh, yeah, it is a lot more clean than it was 30 years ago. (*Carbon County Recreationalist*)

An unspoken [rule is,] if we're out there floating, and somebody's fishing, we try to go on around them. We cut them slack, and not whoop and holler, and jump in the river. We wave at each other as we're going by….It's been that way here for a long time….We're usually all pretty courteous. (*Sweet Grass County Recreationalist*)

One of the things we do is we are strictly 'catch and release.' [And,]…in the summertime, when the water is hot, we are done fishing at noon. If the temperature is at a certain point,…you catch fish, and [even if] you put them back, they die. So we don't do that….That was something that took us probably two years to figure out….[Now] that we are 'catch and release' only…we do not impact the fishery. (*Sweet Grass County Recreationalist*)

I have given this overcrowding thing a lot of thought. Generally, on weekends, I don't do guiding. If I have to, I get out early, and get in early. Everyone goes out on the weekend to get away, and they take their dogs. When I first came here, the Yellowstone wasn't really used. Now there are people camping out. People need to take care of their waste. That is another issue. The one thing is, they have put potties in at access [sites], but how do you deal with it on an island? I don't know. There will be a lot more people camping out on that river. That is what I see in ten years. (*Sweet Grass County Recreationalist*)

E. Systems of Control

We don't have to be so greedy. Put some self-limits. We have to start thinking as stewards, not as businessmen. (*Stillwater County Recreationalist*)

You know how Montanans *love* regulation. My hope is [that] it will always self-level. It will get so crowded out there that people will take up golf, or take up something else because it is no longer enjoyable. (*Stillwater County Recreationalist*)

First of all, [think of the river] as a resource for a fishery, not just as a business. Unfortunately, in the past, the forest service has tied their businesses to the resources, and said, 'Without the business, the resource would be nothing.' I think the opposite—without the resource, your business would be nothing. That means protecting your resource. At times, they have shut down the river because it has been too warm for fishing. I think that is a good idea, and they maintain the fishery to some degree. (*Sweet Grass County Recreationalist*)

A lot of these people, potentially, will be building houses on the river. I teach them about the ecosystem, the economy, the effects that various things have on it, and the perspectives of the people that live here. I try to give them a lot of information in a gentle way….I use examples while we are going down, both pro and con. Like, 'See how nice that one blends in and is back away?' And, 'I can't believe someone would build right there in the flood plain. I would bet they get wiped out. I bet they can't even get insurance.' This one, down the bend here, it has two big picture windows, and as we go along I always comment, 'People with glass houses shouldn't build next to the river.' I think that gives them the subtle idea that maybe people would be throwing stones at those. (*Sweet Grass County Recreationalist*)

It would be really nice if people would regulate themselves, but they just don't do that….I'm really not big on government getting hugely involved in things….Well, I definitely go for regulation, but there'd have to be some forethought. (*Sweet Grass County Recreationalist*)

All I know [is] I want [to] get these stupid, big boats off the water….The way it used to be, the people you would see on the river were fishermen, not just people running up and down the river. Now we have the jet skis on there, which I am seeing more and more up in my little turf….Twenty-five years ago…you never heard the sound of the jet boat, and, now, everybody seems to have a jet boat.…Certain times of the year, there should be restrictions…[especially in] places where the [water] is real, real low. (*Carbon County Recreationalist*)

I've wrestled with how can you tell people you can go make a living on the river and fly fish, but you can't bring your motorboat….I don't want to…categorize people, but…there's just something [about] the quiet and the stillness, and just floating and seeing the birds….When you're floating in the drift boat, it's a completely different experience….But I don't know how you deal with that. (*Sweet Grass County Recreationalist*)

It needs to be protected from overuse by the boaters….Maybe they're getting it now, but an outfitter can come in from Gallatin, or anywhere, and float the river. And you're down there fishing along the stream, and you're not the boater, and it's kind of disturbing to see so many boats, one right after the other, coming down….The use of the river by boats gets a little out of control. (*Carbon County Recreationalist*)

I have a real struggle with the summertime overcrowding,…and it's sort of an outfitter issue. When you're an outfitter, and you have a certain area that you use, and the [water gets low in the] area that you're working out of,…then you, all of the sudden, pack up 40 boats and take them some place else, which has happened the last few years. That's been kind of hard for me to digest….Bozeman has become so overcrowded…[with] outfitters putting out 20 guides a day.…[Then] one guide decides to come down here and go fishing, and catches good fish, and goes and tells everybody….And there's really no control over that….I don't really like a lot of control, so how do you tell them they can't? (*Sweet Grass County Recreationalist*)

I think there has to be self-regulation, too. We have outfitters that are putting out 30 to 40 guides a day. That is a bit of an over-use by any one person. I would like to spread them all over the state. (*Stillwater County Recreationalist*)

I guess it would depend on who manages that river. If they're going to send somebody in from out-of-state, somebody from Washington, D.C., I don't look for the river to stay the same.…I don't want to see somebody from Washington, D.C., or someplace, coming and telling me what to do with our river. I think the government gets involved in too many things that they should stay out of, and our river is one of them. I think it should be left for people to use. I find anytime that they start getting into that kind of stuff, they start closing it off, just like our forest service. (*Sweet Grass County Recreationalist*)

We have our Montana Fish, Wildlife, and Parks that pretty much controls what is happening up and down the river recreation-wise. I imagine they will keep that control. (*Sweet Grass County Recreationalist*)

The hunting can be dramatically regulated for safety reasons. I would go with anything that the Fish and Game and safety people felt was important. As much as I like to be able to hunt, it takes a second seat because of the potential for injury. (*Sweet Grass County Recreationalist*)

You have to put in for a lottery to float down the Smith River. I am not convinced that is a great system. I think it is better to limit than to allow something to be so overused that no one gets the value out of it. A quota system is something I can accept, [but] I don't really like financially-based regulating….It is supposed to be for all the people, not just for those who can afford it. (*Sweet Grass County Recreationalist*)

I definitely like the 'no-motorized' [idea]. Nobody likes to see a jet boat go by when they're fishing. (*Sweet Grass County Recreationalist*)

We need a use-permit for the Yellowstone and the money should go to rehab [the problems that we create]. (*Carbon County Recreationalist*)

[What if] a bunch of 16 year-olds want to go inner tube the river? They have to have a five-dollar fee to inner tube the river? No. That is there for everybody to use. (*Carbon County Recreationalist*)

III. Shifting Scenery: Development Along the Riverbanks

A. Homes on the Riverbank

Everybody wants a little piece of land on the river, and then they build right on the river, which kind of sucks….You go up by Livingston, and you see the houses. I mean, house, after house, after house, after house, built right on the river. (*Sweet Grass County Recreationalist*)

What is unique about the Yellowstone is everything is undeveloped. When you float, you only see a handful of houses. That is the most unique thing. It flows through all this beautiful agricultural land, and the ranchers are satisfied with being ranchers. [But] the millionaires show up and want a house right on the river. It is a slap in the face to humanity. It is happening all over. You can't legislate aesthetics. Maybe that is true, but without aesthetics, you are fishing in someone's front yard. On the Stillwater, you are fishing in someone's front yard all the way down. It is a development dynamic that hasn't taken place [on the Yellowstone]. (*Sweet Grass County Recreationalist*)

I continue to see people moving in here, buying property….I think there will be some chunking up.…[This] is a subdivision that has a common lot on the Yellowstone, and then there's [a subdivision] right next to it that just started, and then there's [a subdivision] up from [the second]. It was a family ranch that sold, and now the guy's putting 85 houses in there….And one thing cool about it [is] there's a nice common ground on the river that they're not building on, so that's nice. They're building back from the river. (*Sweet Grass County Recreationalist*)

In ten years, I think [this area] will be fairly similar to the way it is today with a ten percent increase in the trophy homes….Where I live, they are building a trophy home. Not me personally. I think [the construction of trophy homes] has created a lot of jobs for the community, so a lot of people will say this is great. It is allowing us to stay here and make a living, but there are a lot of people that resent it. (*Sweet Grass County Recreationalist*)

Probably the biggest thing that has hurt the river is people wanting to build too close to it. You have to keep them out of the flood plain, that's for sure. The law kind of states that, but some will go anyway….You don't want to mark people too far back, [but] you have to have some rules to say, 'OK, there's a boundary that you need to respect.' (*Carbon County Recreationalist*)

We're seeing transition demographics….Between here and Big Timber,…what do you see? You see agricultural property along the river, hay meadows, and so forth. Those people that are the farmers and ranchers, as they get older, there's a shift, you know. Kids aren't staying on the farms and ranches, they're going to college, or they're moving to the cities to get jobs. The people on the farms and ranches are, at some point, going to retire or whatever. I guess, what I'm saying is, that I think it's just a matter of time before there [will] be some sort of significant development that's going to take place in terms of commercial development on the river. Now, that's not necessarily all bad, and it's going to have to be done properly, with an eye towards insuring that we don't have any adverse impact….But I think that we can reasonably expect within ten years that there's going to be some piece of agricultural property that's going to get sold off and developed,…whether it's tract homes, or subdivision, or whether it's a resort of some sort. I wouldn't be at all surprised. (*Stillwater County Recreationalist*)

Even in-state folks [are] buying along the river….It's a more prestigious piece of land. (*Sweet Grass County Recreationalist*)

Housing divisions along the river [are a problem]. Housing is too close,…[and], the thing is, it is going to multiply twice as fast as it is right now. [Where] there are ten houses, there will be 30. It is going to multiply….There are houses everywhere. (*Carbon County Recreationalist*)

[Housing along the banks] affects wildlife, it affects the river banks, it affects the beauty….There is a place up the Boulder, bought by two guys from New York, nicest guys in the world. Right on the bank of the river. You know, little stairs out…and, gosh, I suppose if I had enough money, I might want to do that, but I think I'd build back….I think, maybe, look ahead. (*Sweet Grass County Recreationalist*)

It's people with lots of money coming in,…and [some are] pushing this planning so that the guy down the road that has a ranch [can] break a chunk off [for himself] so that he can stay on his place for the rest of his life, and give [what's left] to his kids. (*Sweet Grass County Recreationalist*)

Recreationalists aren't really happy seeing a house right above them, or a row of houses, and looking on their back decks and patios as they are recreating. And people sitting on their back decks watching the river, or watching people recreate don't always appreciate…people who are having fun [and getting] loud….It is a great little view, but everyone is in view. And people that buy on rivers have to realize that…there are more people recreating. (*Stillwater County Recreationalist*)

Anglers [are bothered by the houses] a little bit. Floaters…are bothered the most. The anglers seem like they are here for fish and don't have time to look at the scenery. (*Sweet Grass County Recreationalist*)

I can't say that this is the prettiest stretch in the area. If you want beauty and pretty, go up to Yellowstone Park, Gardiner, stuff like that. Here,…you see 50 houses next to [the river]. As far as I'm concerned, it is not that pretty. (*Carbon County Recreationalist*)

B. Housing Developments Threaten Water Quality

They shouldn't build on the banks of the river. Their septic systems can contaminate the river. (*Sweet Grass County Recreationalist*)

You go down the Stillwater and they have sewer problems like crazy because the sanitarian let them build too close to the river. There is no way it can not violate the water table. It has happened several times with this community [because] the sanitarian, who got fired over there…came over here. They allow people to build right on the river, and they allow them to pump their sewage up the hill so they can pass a perk test. That is not in the interest of the community or the resource….I think it [comes down to], basically, how well you know the sanitarian. I know he is congenial with some, and not so much with others. As far as septic law is concerned,…I know you have to have your septic system 100 or 150 yards away from your well. Other than that, it is where [the sanitarian] determines you can get perked. It is really a gray area. It is violating the water table on the Stillwater. Every time we allow someone to build on the flood plain, it is a public liability, from a water quality standpoint, from an erosion standpoint, and a liability for FEMA when the sanitarian allowed that to happen. (*Sweet Grass County Recreationalist*)

The longevity of the Yellowstone and making sure of our water quality [are both important].…I honestly think we could make it better. We have irrigation upon irrigation, [and] that…water is coming out and going back in. You should have to send water from a field that is maybe not as clean, [and]…run it through a panel, or something, to clean it up. I don't know the solution. I am not a scientist, and I don't want to make it hard on the Ag community. Sometimes they put garbage water back in there after taking palatable water out. The wild fisheries in the states are evaporating. Colorado has had whirling disease so bad that a lot of their natural fisheries had to be helped by the state. I would say, when I am dead and gone, that river is going to be rolling like it is today. (*Sweet Grass County Recreationalist*)

C. Inadequate Weed Management

In Paradise Valley, there's a lot of out-of-state homes with a lot of weeds on them. Maybe people don't even know about, or aren't here enough to take care of [them]. And that keeps spreading the problem, especially on the river corridor. If somebody upstream has weeds, you're always going to have them. It is a problem. [The spraying program] is a ten-year program, so if somebody's willing to stick with it for eight to ten years, and in combination with some of the biological beetles, and everything else, you can stop it…. It takes everybody doing it, not just a few people. (*Sweet Grass County Recreationalist*)

If you don't have livestock, weeds tend to be a problem. People don't want livestock on their parcel of the river, but they won't spray it. See, it is a catch-22 situation. At least if you have livestock in there, they knock it down, and the seeds won't go everywhere. The Yellowstone has a tremendous area of leafy spurge, and it is just growing rampant, and we can't stop it….Education is the main thing. They don't know….[With] the smaller parcel [the weeds are] not getting them in the pocketbook like it would the rancher. They come into the state and say, 'Look at the pretty purple flowers.' (*Carbon County Recreationalist*)

It's the wrong kind of people that are buying the land around us….I mean, the guy comes out and says, 'Get off my land.' Well, [I said,] 'I'm on the stream access.' [He said,] 'It doesn't make a difference. I own this piece of property.' They are going to make you move, and I don't have the money to fight. I mean, I'm thinking of several different ranches the guy bought just…because he wanted that stretch of river. He isn't going to want anybody even on his high watermark. (*Carbon County Recreationalist*)

D. Setbacks: Benefits and Impediments

They are building now right in the high water areas….I even see it where they are letting people build on the flood plains. They are permitting them….There should be a map set up [to designate] where you can and cannot build. Or within so many yards. It affects us all as far as insurance, higher rates. I mean, the people that live here know what the river can do, but the people that can afford these places are building right next to the river because they want the pristine beauty of living on the river. (*Carbon County Recreationalist*)

A few years ago, they were doing a master plan. I recommended that they take half of the setback of a Wild and Scenic River, which is 300 feet. [I was] thinking we could find some compromise. In one weekend, the commissioners flushed half of what the community recommended down the toilet. I don't think you can find anything in the master plan that says anything about a setback. We had some…'Don't tell me what to do with my property' attitudes. I sympathize with that idea, but when your actions influence someone downstream….Look, if you were to punch a well in down here, and somebody uphill punches one, and all of the sudden your well is gone. He doesn't know it, but he is impacting what you had….Basically what the county commissioners represent are the agriculture people. Some of them do belong to NPRC, and are standup people as far as water quality and doing things right, others are, 'Do whatever you want.' (*Sweet Grass County Recreationalist*)

We have so much recreational use of the river now, and the floating, and what not. People from a big city, or populated area, they like to float down the river and see nothing but trees and wildlife….These big, fancy homes along the river, to them it is disturbing. To me, I just think they're crazy. A million-dollar home for three weeks of the year…,It's a changing world. So I think we have to protect the river from encroachment from housing. (*Carbon County Recreationalist*)

I worry about some of the houses and things right on the river….One of the things I hate is the big RV park in the middle of Paradise Valley right on the river. Supposedly, they have services, [but]…I'd like to make sure they're not polluting the river. There's been problems with places in California where rivers basically die because of the number of septic systems near the river. Pumping that many nutrients into the river [leads to] high, high algae growth, and it will kill all your bug life. So, it's definitely a concern. (*Sweet Grass County Recreationalist*)

The Wild and Scenic Act, where I was familiar with it was in Washington state, gives you a certain buffer zone where you can't build next to the river, no subdivisions, no new [buildings]….If you have an existing foundation, or existing cabin, you could use that, but no new stuff….I don't know the exact distances. (*Carbon County Recreationalist*)

I would rather see [setbacks of] 500 feet….There was a guy down-river that had his whole house go into the river….You shouldn't build that close to the river. That is where the setback comes in. If it is back far enough, and the river does change, it has room to change. Instead of saying, 'The river is going to take away my house,…[so] I am going to change the river.' (*Sweet Grass County Recreationalist*)

Along every river, there are people right there. So there has got to be an understanding that if you are going to live *on* the river, you have to live *with* the river. A setback is nice. They have done that on several waters. (*Stillwater County Recreationalist*)

I think that if you leave people alone, without rules, the corridor will change…because this is where they want to build. They want to change it, to cut the trees down [so they can] see the water, but the trees help armor the shore. It's just a multitude of things. (*Carbon County Recreationalist*)

IV. Ideas About Erosion and Rip-rap

A. Erosion is Not Necessarily a Problem

There's definitely erosion….I can't say if that's just the natural flow of things, [or] if there is certain things that people have done to the river that have caused those sort of things. There's been huge changes….Some people moved in from California, and they wanted the stream to run a certain way so they could build this little pond. They flat-out moved the county road—the county road. And then there was a huge flood up there, and people are going to…get sued because…[some think the flooding] happened because these people changed the flow of the river….I'm of the mind that natural things do natural things, and that's what happens when you get lots of water. If you're not intelligent enough to know that a river has a mind of its own, and you build too close to the river, those things can happen. (*Sweet Grass County Recreationalist*)

I've seen the devastation that took place south of Livingston on the Yellowstone because [the river] got behind the rip-rap, and then it took acres and acres away. And, to me, it took a lot of the beauty.…[The river] takes a long time to heal, but it will. A free-flowing stream is one thing, but…there's no more erosive practice than nature itself. And if you want to see [a free-flowing river], and you're not interfering with private property, that's okay, but I think we still need to help people protect their property from over-extension of the river. (*Carbon County Recreationalist*)

I don't see that the erosion itself is a huge problem, unless you are a farmer that is losing ground, which is big. I don't think there is much fighting [erosion]. I think rip-rap is a mistake. I think rip-rap is almost an arrogant way that man tries to control a force much bigger than himself. (*Sweet Grass County Recreationalist*)

It's a real fine balance, in my opinion. I have the utmost respect for other interests….I know we have to work together. So I think that's why it's important that we do strike a balance in terms of some of the things people are looking at. For example, putting the rip-rap on the banks…may prevent erosion of their property and their interests, but, if its not done properly, it could have some sort of adverse impact on the fishery, which concerns me. And then it takes away from that pristine environment….I like the fact that,…in this section [of the river, in] very few places do you see any man-made changes to the river. It meanders, it's pretty natural, and, as you can see [today], it's really roaring….When it starts to lower itself down, some new side channels will [form], there'll be new obstructions,…new fish habitat, and so on. (*Stillwater County Recreationalist*)

In '97 to '98, [flooding] changed the Yellowstone River in a lot of places….Pools I used to fish in are not there. The islands I used to mushroom, are not there….[One] man wanted to armor it, and they wouldn't let him, and then when this big flood hit…I don't know how many acres it devoured at that one man's place. (*Carbon County Recreationalist*)

To try and tame a big river to not erode is silly….[You might use] hay bales, straw bales, plants to catch the sediment….Straw bales are a temporary fix to keep the sediments. Replanting has the long term effect. (*Sweet Grass County Recreationalist*)

The Spring Creek's are part of a public thing. They're a private fishery, but their value to the Yellowstone is very big, too. I use them a lot, too. So, I have personal interests in there. I think they should be protected, but they were affected by old rip-rap and armoring of the bank in the past, so where do you draw the line?...They're all valuable to the local economy and valuable to the river system. Eighty percent of the rainbows are within ten miles of…Spring Creek….It's where all the fish go. They're very valuable and should be protected, but I don't know where to draw the line. (*Sweet Grass County Recreationalist*)

B. Rip-rap and Its Effects

I don't think rip-rap is a good thing. But it's not a bad thing either, most of the time. (*Sweet Grass County Recreationalist*)

I'm not going to say I'm against rip-rap, but it should be judged and approached carefully. There's one place in Paradise Valley where I thought they rip-rapped a fairly stable bank, and the bank immediately below there now is kind of in trouble, and I think you really have to be careful where you rip-rap, and why. Be careful.…[If] the next bank down starts eroding and you rip-rap that one, soon you have a big, armored channel. You can take a look right through Livingston—that's all armored, and the speed of the river right through Livingston is very fast, especially now at flood stage, but it's very fast compared to the other sections of the river. (*Sweet Grass County Recreationalist*)

I'm of the belief that proper rip-rapping is good; it armors it. You have to be careful whenever you work with the water that what you do here does not send it over…there. The river has its own means of equalizing….But if we wait for nature to take its other way, people lose too much land….One thing, you don't want to re-channel it. You just try to stop it from taking more land….With rip-rap, you have to place them, you have to work on it, you have to bed them down, then it becomes a reasonable armor. It can mess up [if not done properly]. We have a lot of scientific data on the rip-rap….Natural is great, but I don't see very many women looking natural….Just a little touch, here and there, sure does improve things. (*Carbon County Recreationalist*)

Rip-rap is what I am afraid of….It is just taking away the wetlands, side edges, the rearing ponds, the place where a lot of things happen in the ecosystem. And the rip-rap is like building a ditch. You don't have…the little wet spots, the things for the little fish to hide in and rest….The otters, and everything else, comes in through there. When you rip-rap like that, you increase the force of the river coming down, and it will move stuff and it will keep moving. It will force the guy down below to rip-rap if it changes the course the little bit….[Now] he's got to rip-rap, too, so we are losing all these side wetlands that is really important to the ecosystem. (*Stillwater County Recreationalist*)

It takes an arm and a leg and an act of God to do anything as far as rip-rapping in the stream. I know one lady,…after the last flood came through, she paid beau coups bucks to keep that river where it was. (*Sweet Grass County Recreationalist*)

People are moving down along the river, and they are putting houses, there, and they are trying to save their property. You can't blame them, but the river has changed course dramatically for years, through the rip-rap….I think a lot more people are moving down to the river and wanting the safety of rip-rap. They see it around, and everybody is safe behind the rip-rap. (*Stillwater County Recreationalist*)

Certainly, I understand the people that have property, and they want to try to preserve their property, and I respect that. But the fact is, the Yellowstone is a wild river, and,…to me, it sort of comes with the territory….[We should] try to achieve [a] balance, and not be overly regulatory with citizens [as far as]…what they can and can't do with their property, but, on the other hand, realize that, hey, you're not just doing something that's going to perhaps impact a little piece of property; you're doing something that could have potential impact on a resource that has significant economic impact, [and] social impact…on a whole bunch of people. So, people need to understand [it is] a lot broader than their little piece of property on the river. (*Stillwater County Recreationalist*)

[Rip-rap] can definitely have an effect downstream. It re-energizes the river. You definitely have to take a look at that….I'd be very concerned if I was a landowner downstream and somebody put in some rip-rap. They should definitely have a say, too, and there should be some remediation, if [those downstream] lose land as a result of rip-rap upstream. (*Sweet Grass County Recreationalist*)

I'm not in favor of rip-rapping to save somebody's house who built right on the flood plain. If you build there, you take the chance. But there are some spots where I think it's appropriate: where somebody's losing a lot of land, where the river is just spreading….Maybe that's an argument for fixing [a specific place] when it blew out in

’97. A lot of that may have been caused by the old rip-rap [upstream]. It just didn’t give that river anywhere to spread out. It backed up enough where it blew a new channel….It’s a toss up all the time; you have to weigh good and bad. (*Sweet Grass County Recreationalist*)

Down here…[are] a bunch of rocks that are two to three feet in diameter. They are just all piled in there. They are working for that guy, but they are pushing the river to his neighbor on the other side. The more you try to hold a river in, the more problems you are causing for your neighbors down- or across-stream. (*Sweet Grass County Recreationalist*)

It’s such a meandering, naturally flowing river; it seeks all these little braids and channels and so on….I’m not sure, but my suspicion is that when you start to mess around with it too much, then it’s going to perhaps eliminate or degrade some of that natural structure and…habitat. (*Stillwater County Recreationalist*)

I always figured rip-rap made habitat for the fish….They say it’s [only for] the big fish, but you can have two people with the same study, one for one group and one for the other, and you will never have the same answer. (*Carbon County Recreationalist*)

C. Please, No Junk as Rip-rap

To me, it’s the big boulders…I. don’t want to see junk in there.…I don’t want to go along and see somebody’s old wrecked car in the river to hold the banks. (*Sweet Grass County Recreationalist*)

I like [big rocks] better than using old concrete, and stuff like that. Keep it as natural looking as you can. And you know, barbs and everything, they end up not looking natural. If you can do some landscaping, in turn with the rip-rap, you can have a pretty nice looking bank….[Use] willows and trees to create a stable bank rather than creating an armored bank….The river’s a moving, living thing, so you’re always going to have an instability…someplace. (*Sweet Grass County Recreationalist*)

At least they don’t use old cars anymore. It doesn’t really bother me, [but] I’m glad they don’t do it now. It’s almost become part of history. There’s a ’56 Ford in the bank! I’m really glad they don’t do it now. If you had a chance, it’d be nice to remove some of them, but they’re part of the town….They call it the ‘Drive-in on the Big Horn,’ where there’s 50, 60, 70 cars, but I’m glad they don’t do it anymore. (*Sweet Grass County Recreationalist*)

Yeah, stone is fine. We don’t need the old cars anymore. And it worked. We are more advanced. As far as I am concerned, let’s make it look more natural. I don’t want to see pictures like down south where they cement everything around. I did see the cars for so long it almost looked natural. (*Carbon County Recreationalist*)

D. Alternatives to Rip-rap

If you want to redirect the water, rip-rapping is not the only way. You could create a [broader] situation….When the river gets big, it is best to have three channels. If the river splits up, that is when it does its best work, from a fishery standpoint. When it comes down in the summertime, and it splits up into two channels, then that is perfect, too, because you have lost your high-water channel. One big channel is not going to look good from a fishing standpoint. It creates a big lake, or big trench, and it isn't conducive to fishing. (*Sweet Grass County Recreationalist*)

The resources of the riparian zone…would be the flora and fauna on the flood plain. I think, you could follow…the cottonwoods. They are of ultimate importance to the river, but without a flooding situation, they don't regenerate. And so, the cottonwoods are very important. We have beaver problems, and some people don't want to kill the beavers; they want to save the beavers. A few beavers are good, not a lot. Once they take the cottonwood down, it is a short time before [the bank] gets eroded and…is gone. And junipers—let's not forget the juniper. It is the most amazing vegetation on the river. It can grab amongst the rock and start growing right out of the rocks. There isn't a lot on the Yellowstone but there is on the Boulder. You can't wash it out, even in high water. Those roots hang on so tight….The beavers don't bother them so much. So [cottonwoods and junipers] are my two friends. (*Sweet Grass County Recreationalist*)

We sloped, with a little bit of dirt, and put some grass clumps in there—some snake grass [and] Bermuda grass, and then we put willows in there. Last year, we had one of the biggest floods we had ever had, and it held up just fine. I have done some on my property, but I put small sandstone, small, and [I] mixed dirt in with it, and it held tremendously. (*Carbon County Recreationalist*)

With people moving in, a lot of people are fencing off the riparian area, [and it] is growing back. They're fencing it off, and…that's helped a lot as far as with the erosion to the banks. (*Sweet Grass County Recreationalist*)

We have a grant project…[for] the Yellowstone River and the Clarks Fork River for removing the salt cedar. But now, this is the last year on the project….For all the salt cedar we removed, we are reintroducing the native species, the willows, the cottonwoods, just so we don't get the erosion problems. (*Carbon County Recreationalist*)

E. The Value of Local Knowledge

I realize…there's certain things that, maybe at the local level, we don't necessarily have control of….But these rivers have been existing for a long time, and we've been co-existing with them, now, for quite a while, and we've seen a lot of change….So hopefully, we can come up with some sensible things, and I think it's always nice if it can be done through the groups and the citizens rather than it being something that gets generated from the top down….[If it comes from the citizens it] makes it a little more palatable to people. (*Stillwater County Recreationalist*)

It's got to be a commission that balances everybody. I don't think it should be totally up to the Army Corps of Engineers, or anybody else that permits it. I think you really have to show a need and [show] why this river needs to be armored at this point. There's some very good reasons,…but [no one should] have *carte blanche* to go ahead and place rocks. (*Sweet Grass County Recreationalist*)

Just so things go forward [on a] scientific basis,…not emotion because emotion is a very dangerous tool. I believe, whether it's the river, whether it's anything, you get emotion involved, and reality goes out the window. (*Carbon County Recreationalist*)

It's landowners, and sportsmen, and everybody. Basically,…everybody has to work together to make a decision. Most of the time, it's the Army Corps of Engineers that makes the decision….They have a big hand in it…[There] should be more [people involved] than them,…[and] it should be more than the landowner, in a lot of cases, too. That's a tough one, too, even in Montana. Look at some of the old ranchers, 'It's my land, and I'll do what the hell I want with it.' And they're right in a way. It is a tough one. The use and everything has grown so much on the Yellowstone. Montana has gone from agricultural to basically tourism, and the Yellowstone is a huge part of that….But you don't want agriculture to go away, because that's what made Montana attractive in the first place….[We've] got to keep some of the wide-open spaces. (*Sweet Grass County Recreationalist*)

It's a totally different river and environment five miles upstream of Livingston than it is five miles below Big Timber. It almost has to be a special case. I don't think you can adopt a policy for the whole river. It's a different fishery downstream. Below Forsyth and all that, it's an unbelievable warm water fishery…that probably isn't being utilized. Decisions being made down there shouldn't necessarily be the same decisions made up here. It has to be a case-by-case….For one thing, it's a lot bigger river down there. It's a lot flatter, less gradient. I don't think they have some of the rip-rap issues that we do, but, boy, I don't know. It's almost on a case-by-case basis. You really have to look at it. It's a tough one, especially since you're looking at the river all the way down. (*Sweet Grass County Recreationalist*)

Let's start with who would be on the board. Get knowledgeable people on board to make those decisions. There are some excellent stream reclamation people in this community. I would definitely get one of those guys.…They know a lot about fisheries, and they know a lot about reclamation….They need to account for county property or state property. Down there, where the bridge is, they spent millions of dollars on the bridge. If they don't do something about that they will have [another useless] old bridge. You saw that bridge…that goes nowhere. The policy would have to consider the roads, but, most of all, alternative ideas to rip-rapping are essential. (*Sweet Grass County Recreationalist*)

I've traveled around in the west quite a bit, and I've spent a lot of time in other states….By and large, Montana does it better than anybody else…in terms of the management of the resource….Montana, being historically an agriculture, mining, and timber state, a commodities resource state, you have a lot of long-standing interests that exert pressure….The State of Montana derives tremendous commercial economic impact from the use of the river, through tourism and tourism-related industry,…the fishing and outfitting, and guiding industry, and so on. So I think it's important that everybody gets a chance to weigh-in on the resources. I was just reading something in the paper this morning, and I thought it was a good comment....Something…[like], 'If you don't plan for the future, then the future's just going to dictate itself to you.' So I think it's wise that we try to look ahead. (*Stillwater County Recreationalist*)

I think you have to include more than just the government people. There are a lot of older ranchers that know a lot about the river. I think it is who you incorporate in the policy-making that would make the biggest difference. An outfitter, a reclamation specialist,…a white-water individual, and the experts that work for the government. (*Sweet Grass County Recreationalist*)

It seems like it is everybody's [experimental area]. The Conservation Districts, years ago, they were dumping cars for rip-rap. Now cars are not all right. Now cement is not all right. The Corps of Engineers stepped in, and started doing their little deals, and found out they didn't work. It is everybody's experimental place, to find out how to actually stabilize banks. Sometimes it is best to slope them off, add some willows [and] do it naturally, versus doing big huge projects. I am glad they quit using cars. I am glad they quit using cement with iron in it. Nobody wants to get stuck with rebar....If you want the prettiest, or the longest free-flowing river,…you need to keep some of that crap out of there. (*Carbon County Recreationalist*)

I think that it's reasonable to assume there probably could be, over time, more and more rivers having to [be regulated]. I think that most of us have a natural resistance to being overly regulated. I think that's why a lot of people live here, and want to live here, because they want to have less government regulation…over their lives. That's one important aspect. They don't want the government telling them how to recreate….With that said, I'm not sure how you get around that….I think if you just sit idly back, and just don't do anything…things will just deteriorate, and then you'll be just totally worse off….Nobody really wins on that deal. So, I'm not a big proponent of [regulation], but I see that it's probably an inevitable thing…when you have a lot of competing interests. (*Stillwater County Recreationalist*)

V. Sympathies and Concerns

A. Agriculture, Economies and Land Prices

You can't just…tell a guy who's been farming and ranching for, oh, 50 or sixty years that the water to irrigate his grass, to feed his cows is—[that] it's more important that I have [water] for the fish and the river….I mean, how do you?…This has been such an agricultural place for so long. (*Sweet Grass County Recreationalist*)

Most of them are very wealthy that purchase property. They come to visit, and then they'll come back, and they'll buy a ranch for two million dollars. And that farm family who's struggled their whole life, moves to town and builds a house—you know, easy street. But I don't know how cool that is. It'd be nice to have the property in the family forever. (*Sweet Grass County Recreationalist*)

I know he's losing more and more hayfields all the time….I'd rather have him stabilize the bank, and keep a bunch of silt from going into the river, than trying to protect the houses built right along that thing. (*Sweet Grass County Recreationalist*)

I've lived here my whole life,…[and,] as for agriculture,…I grew up on a little ranch on the north of town on Big Timber Creek….Water is huge here. (*Sweet Grass County Recreationalist*)

Land prices are going up. Farmers can't afford not to sell. You can't buy a piece of ground that will support the farmers. (*Carbon County Recreationalist*)

Agriculture is on its way out, especially with fuel prices and everything the way it is. Which is a sad thing, because who is going to raise the food for the country? (*Carbon County Recreationalist*)

Will agriculture still exist at the level it does? I suppose it will to a certain extent. We'll still have recreation, whether it's boating and fishing….I think we'll still continue to enjoy it. I kind of think people are pretty mindful of that, I really do. Realizing that we got a good thing, and it's important that we try to keep it in reasonable shape so we continue to use it, and those who follow on can continue to enjoy it and use it. (*Stillwater County Recreationalist*)

To a degree, if I was a farmer, and [my land] was being washed out, I would want to rip-rap. *(Sweet Grass County Recreationalist*)

Another plan is to try to fence the rivers off….You can't have it all one way or all the other way. We need to learn how to use it properly. (*Carbon County Recreationalist)*

B. Local Values

Being able to heat people's homes [by building a power plant near the river]…is probably a higher value use of the resource than fishing and boating, and, conceivably, even [higher than] using it for irrigating hay meadows….I guess, if push came to shove, then probably…it would be looked at in terms of that old thing, 'the greater good.' (*Stillwater County Recreationalist*)

Big Timber had about ten or 12 guys.…They were called the 'Red Neck Express,'…and they would go to Helena, and they would fight [various issues].…It's a western way of thinking: I own the land and everything that's on it, and every good thing that goes through it, [including] the elk [and] the deer. (*Sweet Grass County Recreationalist*)

There are some good things [that the newcomers bring]….One guy employs…college kids coming home for the summertime. He keeps them busy, pays them well. I have a friend whose daughter is…making $12 an hour, where the standard rate in Big Timber for babysitting is two bucks an hour….One guy [asks me,] 'Can you make me a chicken dinner?' And he knows it's expensive….it's like $150. I mean, I have to stop everything, and go shopping, and cook dinner….It's absolutely ridiculous. But he's more than happy to pay. (*Sweet Grass County Recreationalist*)

C. Concern: Agricultural Runoff

It is a delicate area—the whole ecosystem along the river. The government, and the laws, and the regulation, can stretch their arms so far….[According to the law,] you can't spray certain chemicals on [fields] because that will end up in the water ways. Well, they are doing that....Fertilizers are really bad for our waterways, but we're still doing that. (*Carbon County Recreationalist*)

Most of us are very conservation-minded….Most fly fisherman are…more protective of the resources than farmers and ranchers, as far as the stuff they put on their fields to irrigate….I always take a big bag, and we just fill the bag [with trash]. (*Sweet Grass County Recreationalist*)

Limiting the building along the shores is my big worry, and the amount of livestock [runoff from] feedlots. [Feedlots] need to be back a little bit. But, you know, I fished below a feedlot…[and] I got that huge catfish. (*Carbon County Recreationalist*)

D. Concern: Water Rights

Water rights are huge, huge. It's huge….There's a guy,…he's owned that place for several years….He had some of the oldest water rights…and he sold them, or gave them, or deeded them, or I'm not sure how it worked, to the Fish and Game….So some people up above don't have enough water to water their fields, [but] his water gets down, and he's using it for the fish. (*Sweet Grass County Recreationalist*)

Irrigation has a long history of legal rights to water. That is fairly important, as it is historical, but some of those days are past. If we are going to allow a few people to have rights because they have had rights for so long at the expense of the masses, we are into a feudal situation. Just because they have been there for so long, and have those rights, doesn't mean they should have them forever….I think it is fair to compensate people if you have to take away some of those water rights, within reason. (*Sweet Grass County Recreationalist*)

E. Concern: Ice Jams and Floods

Ice jams can be a real issue. If they are big enough, they can probably cause as much damage as anything there is. They gouge the river, kill everything in the path. (*Sweet Grass County Recreationalist*)

During the flood years of ’96 and ’97...lots of people lost lots of ground as the river changed courses. It just took, and gave, one side to the other….The ice jams in the winter will move holes around…and cut up [islands]. Ice jams do a lot of things as far as carving the river. (*Stillwater County Recreationalist*)

I think in certain spots you can prepare a little bit for [floods], but nobody knows what’s going to come and how big it’s going to get. When it hits 37, or 38, or 40,000 [cubic feet per second], there’s only so much you can do. At that point, you’re not stopping it. You might try to do something to fix it or stop it from the next time, but it will do what it wants to. (*Sweet Grass County Recreationalist*)

F. Concern: Coalbed Methane

The coalbed methane situation is…one of the big deals going on in Montana, and a lot of people…downriver are really concerned about that because they are not sure [what the effects might be]. (*Stillwater County Recreationalist*)

Laurel to Springdale: Residential Interest Group Overview

Fifteen interviews were conducted with property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank. Names were obtained through a GIS search of public land ownership records. These names were randomized within counties. Other people living very near the river and whose primary incomes are not generated by agriculture were also recruited.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Laurel to Springdale: Residential Interest Group Analysis

I. Living Near the River

A. Appreciating Scenery, Wildlife, and Serenity

Paradise. It's just great, great living. Private and beautiful. We are so lucky and privileged to live here; it's just wonderful. We have about two and a half miles of riverfront, so we don't have any neighbors close, and it is just great….The river is the reason we are here. It's the whole thing. There is constant action going on at the river, whether it's birds, or fishing, or deer, or whatever. There is always wildlife around which is our great love. We cultivate our land for wildlife. (*Sweet Grass County Residentialist*)

Everyday I walk down my hall, and I have a new picture window. And you know, it's just awesome. The colors in the fall are beautiful, [and] most of the time the sun's shining on the mountains. We can see Granite Peak, we can see all kinds of activity in the river with geese, and we just love it, it's just awesome….My heart just feels so good. This is our place. (*Stillwater County Residentialist*)

You can look at the river, and you can walk along it. It's so peaceful, you know, it gives you such a sense of peace and serenity that you can't match anyplace else….We can just go and have a nice afternoon walking along the river….I used to sit here, and just get tears,…and I still do, you know, because it's wonderful. It's wonderful to be able to enjoy it. (*Stillwater County Residentialist*)

The beauty of our surroundings. You have all the wildlife, the birds. It's just fun to see all of that down at the river. The different birds,…the pelicans,…eagles nesting.…It's kind of a sanctuary.…It's a habitat.…The blue heron's nest, and the rookery. And it's unbelievable…the number of blue herons….There's a lot of bald eagles on the Yellowstone. I think that's a wonderful quality. (*Sweet Grass County Residentialist*)

Well, I've been here all my life,…and when you're around something all the time, you learn to appreciate [it]. You know the beauty, and what it offers, and what it gives….You get to enjoy being here, and…it makes you want to stay around. (*Sweet Grass County Residentialist*)

I will say that if we have ever talked about leaving, or moving, it is the river in my backyard that keeps me here. I love my backyard,…and being able to see water is important to me. (*Sweet Grass County Residentialist*)

There is a lot of wildlife out here….We see deer, turkeys, pheasants….bears, cougars…mountain lions, elk. There was a moose here….A big bull came across the river….The river is like a corridor for animals to travel, and they will move great distances along it….They actually use it like a highway, so you see a lot of different animals come through….Geese, ducks, sandhill cranes, two pair of bald eagles, and a couple pair of osprey….We have feeders up, [and we've seen]….,probably, 30 species that we identified in a book. We are not bird watchers, per se, but we just write down what we see, and we kind of expect them when they come. (*Stillwater County Residentialist*)

When we started floating on a raft, I gained a much greater appreciation of the Yellowstone River because you just see it from a different angle. You're part of it; you're in the midst of it. You're seeing all the birds; you're seeing all the people fishing. You're picnicking on an island and finding petrified wood and agates, just enjoying the beauty of how it is out here. No phones. There's mountains, and there's blue sky, and there's all this beautiful scenery along the way….I developed a new appreciation. (*Sweet Grass County Residentialist*)

We enjoy walking along it. We enjoy fishing in it. We enjoy walking along and picking rocks. We enjoy watching the deer. I mean, they cross from there to over here. It's wonderful seeing them and the beaver splashing….We've seen eagle,…with the spotting scope, and we're watching them tear the meat off fish, and it's just wonderful. I don't know how many different things we've seen. We've seen unusual birds that are not probably common to this area. (*Stillwater County Residentialist*)

[The geese] come up here in the yard even. Yeah, and walk around out here. [We] have them on the pictures…out in the yard, here, just walking around in. And we learned something that we haven't found in the bird books. They grow a feather, during mating season,…like a little ponytail right back, here. And…after they've hatched the young ones, that feather is gone. (*Stillwater County Residentialist*)

B. The River as Taken for Granted

I just take it for granted.…It is just there. It is a part of everyday life. We don't play on it a lot. Occasionally, but not very often. I am not a fisherman. We float it once in a great while. Go down and picnic once in awhile. I can't say it is important to me….It is not something I have to deal with on a day-to-day basis. I view it more as recreation than anything. (*Sweet Grass County Residentialist*)

I don't fish. I'll probably take my two little ones fishing when they get older, so they get to learn. I don't know how to swim, so I don't get in the water too much….[When] you're born and raised with it, you kind of take a lot of stuff for granted. A lot of people from here, for us, it's an everyday thing. (*Stillwater County Residentialist*)

You can live here all your life, but maybe never have that appreciation for the river because you never spend any time on it. You take it for granted. If you never take advantage of it, you never have that appreciation. (*Sweet Grass County Residentialist*)

C. Keep the Yellowstone Natural

Personally, I like knowing that the Yellowstone has no dams, and I am all for keeping it that way….Part of me says the river was there, first, and if you are going to live in a place like that, you should know before you do it….Probably, if I was buying a house lot, I wouldn't buy there. I wouldn't build a house there or in the flood plain, if there was a potential for more damage. The river will eventually go a different way. (*Sweet Grass County Residentialist*)

As long as it stays natural, that's the best. No dams, no changes. Just leave it…like it is today. I mean, I wouldn't like to see anybody going out there and building something in the islands, or anything else….I like to watch the river come up in the spring and go back to normal. And just, you know, wait for [William] Clark to come down.(*Stillwater County Residentialist*)

I think it is important to keep it a dam-free river. I think that is important. I think it is important that they protect the species of fish that are living there, and their habitat, and do what they can to keep it a great recreational river. Plus, it is used for agriculture. That is real big around here, too. Continue to serve those purposes that it has [served in the past,] and keep it clean. (*Sweet Grass County Residentialist*)

I think it is a pretty neat part of Montana history. And where it originates in Yellowstone Park, and is still free-flowing, I think it is important to protect that. I think it makes our part of Montana special. It is a huge piece of who we are as a state. (*Sweet Grass County Residentialist*)

Don't put a dam on it. Don't mess with the river. Keep it for recreation. (*Stillwater County Residentialist*)

D. The River as Shared Element of Life

Everybody thinks we're all entitled to the river. It belongs to all of us, so that's what's hard. It doesn't belong to me, or to you. We all feel that we should have easy access to it, [but] I don't know how you get everyone to play together well. (*Sweet Grass County Residentialist*)

I will live here while I am still able to maintain the property.…I like the freedom. I like the wildlife. I am trying to maintain the watershed. We like trees….We like to sit outside. We like the fresh air and the quietness. We lived in Billings for 30 years….We like the elbow room. We like the birds. We will stay here for as long as we can. I am concerned about the future, and people that live along the river. Make sure that the river is protected when people build along the river.…I am not a tree hugger, but I think there is a happy medium. You have to use natural resources, and you have to protect them. (*Stillwater County Residentialist*)

Being an agricultural state, the river is very important all the way down….They've used it to irrigate croplands for years and years. I know…[because] I did a lot of crop insurance….We're such a great food source, for ourselves and other countries. I really think agriculture should have as much [water] as any. (*Stillwater County Residentialist*)

Every July they have the annual boat float, which is a celebration of Lewis and Clark, but it is typically a big drunk. It used to be really wild, and it has tamed down. Not as many [participate] as…[did] 25 years ago. They leave the fairgrounds in the morning, and for a couple of hours you can hear them whooping and hollering. It is kind of fun. (*Sweet Grass County Residentialist*)

The kayakers come and knock on the door and ask for access to the river….There are some teenagers in town that have discovered where we have a campfire down by the river, and they made it their party zone. It is not a huge problem. (*Sweet Grass County Residentialist*)

Maybe a canoe will pull over when the water is lower. They will stop, or a fishing boat will come over, or they will go on the other side of the river in the sand bars. It's okay….I have gone down and talked to people, and we wave at them when they go by. If they are having trouble, we want to help. And you always check. If we hear yelling,…we will go down and check that they are not in trouble. It is not like they can't be on there, we don't care. It's their river too. (*Stillwater County Residentialist*)

We realize that if someone is on the river they can get off and get out as long, as they stay within the high water mark….They can come along, and stop and fish along the bank, as long as it is at, or below, the high water mark. That is the law….[But,] as I understand it, there are some rich people that are trying to take it away. (*Sweet Grass County Residentialist*)

Fish and Game suggested that, due to the conflict…he would patrol the area.…This worked well until he was no longer working for the Fish and Game….Then people began camping and leaving their trash everywhere, and encroaching on us….[They] were not considerate of private property. (*Sweet Grass County Residentialist*)

Well, there's always going to be a conflict between the fisherman and the recreationalists….There's a lot of people that boat upstream with inboard motors. They zip around, and it bothers the people that are fishing. There's people here who make a living guiding fisherman, [and they say,] 'Hey, we're trying to fish over here.' And [sometimes] you've got a family out floating the river, having fun, making noise, splashing around, and somebody's over here trying to fish. (*Sweet Grass County Residentialist*)

I can see both sides: the people wanting on the river, and the private landowners next to [the river] that don't want people going through their land to get on the river. I like to use the river, but I also understand that people don't want you driving through their bull pasture, and leaving the gates open, and driving all over their pasture, and killing the grass and stuff. The best I can see is public access in spots along the river, so you can get down there, and then you can use it. You can use it next to a private land, as long as you get on it legally, which I agree with. Some people think that you shouldn't be able to use that river next to their land, but I don't agree with that. I think it's a public river. But, as far as any change, I don't know what could be done to make it better. I know there are problems. (*Sweet Grass County Residentialist*)

Boy, if there is any water around here, there are people using it. (*Sweet Grass County Residentialist*)

E. Ruralness of Subdivisions

A lot of [living in the subdivision] is to have space, clean air, clean water. A lot of people like to have their five or ten acres so they can have a horse, or a couple animals, or a little bit of space to move….Everyone wants their five or ten acres, especially the people who come in from out-of-state. They live in a city, and they come out here, and they think it's beautiful—we've got clean air and clean water, which a lot of the United States doesn't have. And they think that is an asset. (*Stillwater County Residentialist*)

At first, I guess, I was a little hesitant, because it was five miles from town, and [I wondered] what was it going to be like? But it was the best thing that ever happened. It was great when our son was home.…He had great times down at the river. They would build forts, and go fishing, go swimming. I mean, they would spend hours down there. It was the perfect playground. It was great….I don't know if when we purchased the lot we realized how important it would be. (*Sweet Grass County Residentialist*)

I don't really have a lot of desire to live in a great big place. [This is] a great place to raise a family….The clean air, clean water, that's a big plus, anywhere. (*Stillwater County Residentialist*)

I grew up here. I like it. I like the river, and I like the mountains. It is a good place to live. It is a good place to raise our kids….It is home to me….We live here for the lifestyle, I guess. That is really the bottom line. (*Sweet Grass County Residentialist*)

The biggest problem is deer. They are everywhere, river or no river….They eat everything in our yard, and strip the bark off the trees with their antlers….I love to look out and see them, but they will come up and eat flowers on the deck. (*Sweet Grass County Residentialist*)

Actually, the fact that [our home] is out of town is what we really like, and we wanted to get [our children] somewhere where they could not be running around town [and] we wouldn't know where they were. And this is really a beautiful area. (*Sweet Grass County Residentialist*)

The previous owners planted 120 trees, and I added another 20. Most of them were fruit and nut trees. So, we have got quite a few trees on the place. It was a hayfield before it was subdivided, so there was nothing here, it was just barren ground. (*Stillwater County Residentialist*)

II. Affordable Privilege

A. A Private Commons

Well, our place right here, our subdivision owns about an acre and a half of common property right along the Yellowstone. So we have the opportunity to go down there anytime we want, and go down to the river….We have access to the river, and often we float from upriver to our common area and get out….It is just really nice having that access. (*Sweet Grass County Residentialist*)

This subdivision is unique in that there is a bridle path that follows the river for use by the owners in the subdivision. Anytime you have an easement like that, it is somewhat troublesome because there is no incorporated town out here. But if the towns grew enough, they could make a permanent easement, and everyone could use it. That is what bothers me….That bridle path was meant as a bridle path, and they shouldn't use it as access to the river. It may sound selfish, but I am paying taxes on it, and they don't. My liability covers only me, and if they got hurt, they could sue me. They wouldn't win, but they could still take me to court. That bothers me.…A guy bought a bunch of the land, and is going to put in 100 houses [behind me, away from the river]. That is a huge impact. If those people think they are going to use the bridle path, I will have a problem with that. It was designed for this portion [of the subdivision], not the whole. So, the enforcement problem may be a real problem. (*Stillwater County Residentialist*)

Between us and the river is common area. And nobody can build, and nobody can live there, and it is available to everyone in the subdivision. (*Sweet Grass County Residentialist*)

We did get a great deal on the lot,…[and now] property prices have multiplied four or five times.…Yes. Now we kick ourselves that we didn't buy two lots! (*Sweet Grass County Residentialist*)

We don't make a lot of money, but we aren't hurting. (*Sweet Grass County Residentialist*)

B. Interrupting Ruralness and Diminishing Privileges

We didn't want to start trouble [with the boat floaters], but we don't want them to destroy things. We had the illusion that the local law enforcement would help enforce the rules, and that was wrong. If you questioned 90 percent of the people in this state, they are not aware of it. Anybody we talked to, the title company, the realtor, they won't tell you those things. In town, it is different. (*Stillwater County Residentialist*)

Another thing, when boats go by, and they've got a pretty big-sized wake,…there is nothing to slow down any wakes,…and [the wake] can wash away the shore more than…it should….But that is just a normal thing. You can't get away from that. The other thing, we have been very fortunate [because] there is no personal watercraft used on this river to speak of. They are obnoxious. There [were] a few last year, and the last couple years. They just go round-and-round, in circles, and make so much damn noise, but fortunately there is not a whole lot to do….[When] fishing boats go up and down the river, people sight-seeing, whatever,…no big deal. (*Stillwater County Residentialist*)

[With] so many houses and congestion, I'd like to see them away from the river, and back so that when you are here, you don't see all that. I say that as I sit here 50 feet from the river in our house! (*Sweet Grass County Residentialist*)

C. Public Access Verses Private Property

The thing we do see right now is that the common property is supposed to be limited access, limited to the people who live here in the subdivision. Well, more and more people are coming from town,…or you will see them driving down here with their kayaks and rafts, thinking there is access to get down to the river. I think that is going to be more of an issue for us….How do we deal with that?...More and more people are going to be trying to use our space down here along the river….I think [it] is a class three rapids….It is on the map now, and these kayakers can see it from the interstate….I mean, I don't think I would deny them access if they would just do what they came to do, and not impact the area….If they are responsible and pick up their trash…[but] we are going to be putting up some more signs, because people don't necessarily [do what they came to do].…It is a great place….We have a camp area with a campfire ring, [and] a lot of people want to enjoy that, and you cannot blame them. But I think we will probably see more of a demand like that, people who want access to the river. (*Sweet Grass County Residentialist*)

Mainly what I get is people asking if they can put their boats in down there, and I always say, yes. I mean, why not, it's not my river. I think some people that live in some of these [subdivisions] think that's their river,…[I] tell them, 'Park your car, here, because our neighbor down there does not like it. So just park your car here.' I think he thinks he's in the middle of nowhere. That's where the problem lies. (*Stillwater County Residentialist*)

There is nothing easy about [public access]. It will get more and more complex as time goes on. You will have a greater influx of people from metropolitan areas in here. (*Sweet Grass County Residentialist*)

The people that don't live along the river don't respect it. (*Stillwater County Residentialist*)

This is private subdivision property down on the river, but it got put on a website that it was a public access to the river….There were a lot of kayakers from Minnesota coming out and kept wanting access to the rive there, which is not exactly what we wanted.…They put up signs saying that it is private property, and not a public access, and for a while they put up a gate, and closed the gate. I think they had a chain there, but I don't think it was padlocked….I don't think it is a problem anymore. I think it has been noted that it is not a public access. (*Sweet Grass County Residentialist*)

We let people fish….We have a sign that says, 'You can walk in and fish the hole….Access is for fishing only'.…[But,] sometimes you catch some clown in there trying to hunt, or…picking mushrooms…And you know the sign says, 'For walk-in fishing only,'…but some people don't seem to take a hint….I had one guy from out-of-state, he pulled his camper in here, and set up camp right over here….He said, 'It's public.' I said, 'No, not here.' He got off in a huff, 'Montanan's ain't very friendly. Everybody says Montanan's are friendly, but you sure the hell ain't.' (*Sweet Grass County Residentialist*)

I really do believe that river is for everybody to enjoy. It's not my personal [property]…It's not my river. And I hate to see where other people are not allowed down there. I know we [the subdivision] have 'No Trespassing' signs all over, but I would not put those signs up, and I would take them down because I don't feel that way. I think if people want to go down there and fish, or put their boat in, or get their boat out, I don't see a problem. (*Stillwater County Residentialist*)

A lot of guides [are] on the river now, just this last year. Five years ago, we might have occasionally seen one, but this last year, we have had 15 to 20 guide boats a day come by. We see them every day. They all come by about the same time, every day. There gets to be a lot of them, and then they get feeling real possessive of the river. They can be real rude to land owners, and the general public, too, because they don't want anybody bothering them and their clients, fishing their water. I would hope Fish and Game would put some control on those….My son guided; I have nothing against guides, …but you've got to realize it is not your river, and you need to be courteous to the general public. (*Sweet Grass County Residentialist*)

HUSBAND: Another thing that is grinding people bad: rich people buying up this land along the river, and shutting it off to hunting and fishing. That is a big issue. WIFE: As a subdivision, we don't allow access to the river. HUSBAND: If somebody asks, we would let them down there. WIFE: Not just someone off the street. HUSBAND: No, [but we would] if we know them. It isn't a public access; it is private land. We wouldn't deny access. WIFE: We do to outsiders. If someone comes from Billings, and wants to fish, we would tell them no. HUSBAND: That is our policy to keep it kind of private. The Fish and Game need to have all the accesses they can get. They need to maintain them, and clean them. There are a lot of rich people buying land and shutting it off. Public access is important. (*Sweet Grass County Residentialist*)

D. Covenants as Protections and the Complexities of Management

Subdivisions are governed by a set of covenants….Have the people who own the subdivision, who own that property, make some good sensible decisions on…this is what you have to put in, or this is how far from the river you have to build. (*Sweet Grass County Residentialist*)

We were having problems next door. They decided to be hateful, and they put a gate on the bridle path, and locked it, and put a ‘No Trespassing’ sign. Other people brought it to the homeowner’s attention that they didn’t want the gate,….[but] they will have to file a civil lawsuit…to get them to take it down. Or the association has to go against them, and nobody would do anything. It was a civil thing. Unless there is criminal activity, it is a civil lawsuit. Each line on the covenant stands on its own. Those people next door have turkeys and chickens. They aren’t supposed to have them. Manure is not good for the river. It goes into the groundwater. They shouldn’t have those….It is against the covenants,…[and] it is a federal fly-way for birds. It is a wild river. There is a reason you can’t have poultry. (*Stillwater County Residentialist*)

The [subdivision] covenants are to protect the environment, the land...They put a bridle path in as an easement so they can subdivide it and everybody can enjoy the river, the water, the land….Those people did not read [the covenants]. Other people did not.…It started with motorcycles. They were racing down by the river…and we wanted it stopped because they were destroying property. We have a real erosion problem where they were riding on the banks of the ditches….We were going to take them to court….I took a petition around because nobody else wanted to do it. We didn’t have to take them to court….The dust was unbelievable. When the wind would blow, all you could see was a white cloud. And the noise carries. We are 30 acres away from them, and our windows rattled. Let them go do it somewhere where there aren’t homes. (*Stillwater County Residentialist*)

I think it has to be compromise….If we want to protect the river, there…[are] measures we have to take, but, at the same time, we want people to be able to enjoy it….I’d hate to see the river become something controlled to where we’re just letting outfitters down to fish, and nobody else can go on the river. I would be sad if it came to that….[I would rather have] people taking the initiative, and saying, ‘Okay, we’ll run this.’…People have to assume some responsibility, and they have to be educated on what we’re doing and how it impacts the land, and how we can work together so we can enjoy it…. It’s going to have to be a give and take thing, especially as we become more populated. It’s got to be a give and take thing….I don’t know if that’s what the Conservation District Council is, I don’t know what their goals and objectives are, but if that’s what they’re wishing to promote, that would be wonderful. (*Sweet Grass County Residentialist*)

When you have more people, you need more water. How do you share that with the agriculture? That’s going to be one of the big questions.…What happens to agriculture? I know in Billings a lot of that Ag land is being bought up and is being subdivided. Is the amount [of water] they use less or more in those subdivisions versus what farming would use? What is the trade off there?…I think that would be as big a concern as any. (*Stillwater County Residentialist*)

All through Montana history, you could do what you wanted. But now you have to have a permit for everything. So that's changed. (*Stillwater County Residentialist*)

That's one of those things where the local or state know as much [about regulating subdivisions], or more so, as the federal government. (*Stillwater County Residentialist*)

Life isn't fair. You've got to do the best you can with the situation. It doesn't matter what we do, or where we're at, we can't choose our neighbors. I think you have to try to make the best of the situation…best for all. You're never going to please everybody, no matter how you do it. (*Stillwater County Residentialist*)

III. The River as a Physical Element

A. Living with the River

While we are here and living along it, we want to try and control it because we want to protect our property. If no one lived along it, we wouldn't have a problem, nobody would care. (*Sweet Grass County Residentialist*)

The river splits into two channels right there, and the one makes a big bend, and it comes, BAM, right into the bank. (*Sweet Grass County Residentialist*)

Whenever that happens, and we do have floods here, there are always those houses, and homes, and land, that are threatened along the way. You know, maybe, for those homeowners, in particular, there are things that could be done, because, you know, that periodically, there is going to be flooding; it is just the nature of the beast. It shouldn't be a surprise to those people. There are things you can be doing in the off-years to protect your property. You shouldn't have to worry about losing your home into the river. (*Sweet Grass County Residentialist*)

There is no way to manage the river, [except for] a dam at the high water point. (*Sweet Grass County Residentialist*)

I don't really see there being change. I wouldn't think that there would be that much change right along here [on the river]. See, there's a highway right along the other side of that river that takes you to Absarokee. Yeah, they're rebuilding that, so I'm sure they're going make sure [the river] stays where it's at. The railroad is not going to let it go, and the highway's not going let it go….I don't see very much change. (*Stillwater County Residentialist*)

B. Stories of Destruction

We saw damage down here with ice. The ice just all of the sudden broke, and spread and knocked down trees….We had an ice jam, and it backed the river up, and it floated ice out all over this area. There were ice chunks, clear over to the bank, the size of

Volkswagens. It happened while we were sleeping, and we didn't hear it, but we got up the next morning and were like, 'Holy crap.' (*Sweet Grass County Residentialist*)

The river took that island out in about a week and a half. It had 50 to 60 feet cottonwoods. It was just covered in trees. It just took it right out, you know. That is what the river does. We just expect it is going to happen. (*Stillwater County Residentialist*)

If you own property along the river, you expect erosion, you expect change….I wouldn't want property along the river, and if I did, I would have to look at it really carefully. It is horribly expensive to try and protect it. To me, it is a detriment to own land along the river. (*Sweet Grass County Residentialist*)

We certainly have. There is a lot [of erosion] right down on the corner of the subdivision….I suppose [our neighbor] has lost about a quarter of the lot. The river makes a turn in there and just digs. A lot of that bank is leaving, and below there, too, because the owner had to have them rip-rap it along there….And certainly with the flood we have notice….And, that was major. That was major. (*Sweet Grass County Residentialist*)

You can attempt to control it, but when you have a flood, like in '96 and '97.…We hauled rocks that were huge, and [now] they are sitting out in the middle of the river, and the ground that they protected is gone. You can control it somewhat. (*Sweet Grass County Residentialist*)

C. NIMLYs: "Not In My Lifetime/Years" (Folks convinced the river can change, but…)

As far as flooding and such? No, we don't [worry]. The town's going to flood before we would. We're higher than that, so we don't have a problem with that. I think if we're going to flood, I'd better call Noah in because, you know, it's going to get pretty high. (*Stillwater County Residentialist*)

I don't know if during our time down here we will [see change]….But there again, it depends on the number of floods. That is going to have the biggest impact on it every time. If that happens there is something different every time….But I don't think we will see a major change. I don't expect a new channel to be going across the hills or something. If it does that, we will be out of here! We will be building a big boat with a lot of animals on it. And one thing down here where the river runs, there is that big hillside there, so if it is going to change, it isn't going to impact this way….It was a big flood we had in 1996, 1997, and we weren't living here prior to that, but we floated it a lot, and it didn't make huge changes. That was a good-sized flood. (*Sweet Grass County Residentialist*)

Tremendous amounts [of erosion]. Acres and acres of land—gone. Gone…in various areas, all up and down the river. I would say hundreds of acres lost. And some gained….This area, right through here, isn't a problem for erosion, except for right down-country where the river takes a turn to the left and that land was damaged….I don't think the river has ever changed course right here. When Clark came through here 200 years ago, it was going through right here. Elsewhere it goes all over the place. (*Sweet Grass County Residentialist*)

I might not be around, then, so I don't care. (*Stillwater County Residentialist*)

I know we had some flood-type waters a few years ago,…but that's probably about the only erosion that's been discussed in the 18 years I've been here. (*Stillwater County Residentialist*)

D. Flood Plain Maps are Restricting but Potentially Credible

The last time they did a survey for the flood plain was probably over 20 years ago, and it is something that needs to be done and upgraded….If you look at the flood plain maps they have got, they show us in the flood plain, and that is wrong. We are not in the flood plain. We are too high for a flood plain, but that is the federal government. What are you going to do about it? As far as people building low, I don't think they should be allowed to build in the flood plain. All it does is cause problems for everybody concerned. And for people not in the flood plain, we are being penalized….If there are not enough regulations, or if they have not been reviewed, when the river changes over the years [the maps are not accurate]….Anybody along this side of the river is required, if you refinance, to have flood insurance, and you can't fight it. If you pay cash, you don't have to have it, but if you finance, [it is required]….I mean, there need to be regulations, and people need the proper insurance, but it needs to be looked at closer and more often. (*Stillwater County Residentialist*)

[Flood plain mapping] needs to be done because it hasn't been done for a long time. The river has changed channels because it is a wild river, and the flood danger in some areas is no longer existent, whereas in other areas it might have come up. And the bad part is, people may not be aware they are in a flood channel….I must have called 50 people, and what I found out was, 'Yeah, it needed to be redone, but we don't know when we are going to redo it. You are still in a flood plain.' That is about the end of it. I say, I am not. I am 20 feet above the river. Well, you know it has to be remapped. When are you going do it, I don't know. (*Stillwater County Residentialist*)

E. Private Commons as (Consciously?) Functioning Flood Plains

That area down there is 22 or 23 acres of common ground. It is in the flood plain, so you wouldn't want to build there anyway….In '96 and '97 we had a 500-year flood, and I don't know who the hell knows what that means, but it was the worst flooding that had been seen in human history. Most of that flat was covered with water. It was pretty destructive. It didn't affect us right here. (*Sweet Grass County Residentialist*)

And then 1996 and 1997, back-to-back. Our whole common property was under water, so it was pretty major. (*Sweet Grass County Residentialist*)

F. Rip-rap is a Known Solution, but Expensive and Difficult to Get Permits

That guy spent tens of thousands of dollars rip-rapping it to protect it. Since the flood, he has done more rip-rapping. (*Sweet Grass County Residentialist*)

I think [rip-rap] is the common method you see around here. I don't know what other things they would do. I don't know what the other options really are. That is what you see around here, especially if there is potential flood stage; you see a lot of rip-rap being spread around. (*Sweet Grass County Residentialist*)

When we're talking about the Yellowstone, we're not talking your normal Montana river. I mean…there's a lot of power in this bad boy….It will do what it wants. So…to keep it from eating stuff up, you've got to get pretty tough with it. (*Sweet Grass County Residentialist*)

People don't want to have their lives regulated to hell. (*Stillwater County Residentialist*)

Rip-rapping is the cheapest form of erosion control….Some people will use steel plates, and pound in bridge pilings, and make a wall if they are trying to protect a house. Concrete walls are very expensive. (*Sweet Grass County Residentialist*)

There are places along the river, if you float the river, where you can still see car bodies. They haven't been made to take them out, which is sad….They don't allow it anymore, but there are places where you will see the whole rear end of a car sticking out, or a hood, or a top. It's definitely a car. (*Sweet Grass County Residentialist*)

We've got a bunch of rip-rap that we got put in before all of the environmental regulations….I don't know…if we can even rip-rap now or not. It's a touchy situation….A lot of these…environmentalist seem to have a problem with it….They said it can create sediment problems….I think it all boils down to they think that if the stream wants to move, it should be able to,…even [if] some guy's paying the taxes on the land….If the river wants to take it all out, they don't care. I think that's the way they look at it. (*Sweet Grass County Residentialist*)

We did a little rip-rap on Bridger Creek last fall, and there were six or seven agencies involved in that permitting process. The county was involved in it. We were working for the county. They were trying to protect county roads. It took months. (*Sweet Grass County Residentialist*)

They said…we couldn't put rock on the bank….We could put a trench behind the bank, and fill it with rock. So, that is what we did to it. You can get away with doing that. You can fill a trench with rock, and let the river eat its way to it. It is stupid. (*Sweet Grass County Residentialist*)

And [rich people] don't want to lose [land], either. There is a guy down-country who is rich beyond rich, and he is having a hell of a time getting permission to rip-rap. (*Sweet Grass County Residentialist*)

If someone sits down with a true environmentalist, and actually hear what they believe, and why they think this way,…[that person finds out] they don't have a specific plan….They [just] seem to be against anything that nature doesn't do itself. I don't understand their thinking. It is so bizarre. (*Sweet Grass County Residentialist*)

G. Rip-rap and the Potential for Unexpected Consequences

I heard that when people rip-rap…they are causing more damage to somebody down river, or on the other side. (*Sweet Grass County Residentialist*)

The river is the river, and you are not going to control it. If you are doing something here, it is going to affect something, or someone, down there. High school geology taught me that. (*Sweet Grass County Residentialist*)

If you start changing things, and start changing water routes,…those are all unknown….If we start messing with the water supply, are we going to have groundwater? Are we going to have the other things that we [want]? (*Stillwater County Residentialist*)

When the river is flooding and eroding land it is trying to relieve itself. If you tighten up down here, someone downstream is going to get it. It is almost impossible to get permission to rip-rap. (*Sweet Grass County Residentialist*)

People that work in those types of positions in government are so far removed from the reality. They think that if you drive a bulldozer in that river, and you change something it completely upsets the ecosystem. That is bull. You can't begin to hurt it because it changes itself. In a day that river can move more gravel from one side to the other than you could in a lifetime with ten bulldozers….Experience and working around the river, and doing that sort of thing—I don't have a degree—but, it is just common sense. I have watched that river for years, and I have seen what it can do, and what it does do….I don't see how you can really hurt anything in that river with those machines. You don't want to bulldoze it out like a bowl, all the way down,…but I know dang good and well the fish are going to be swimming, and you aren't going to kill them. They will tell you it is harmful. I don't believe that….I have seen them do it, and the fish are fine. (*Sweet Grass County Residentialist*)

WIFE: Common sense tells me that if you are running big machinery in the river, there is a possibility of damage. HUSBAND: What? WIFE: Well, if you are running diesel and gasoline…HUSBAND: Yeah, there is a risk of contamination, but if you dumped 100 gallons of diesel fuel in that river it wouldn't affect nothing. WIFE: It would affect something. The fish that live right where you dumped it. HUSBAND: Maybe. (*Sweet Grass County Residentialist*)

Yellowstone River is the longest, free-flowing river in the United States, un-dammed. That is pretty neat, and to do too much to it, [such as rip-rapping], would be sad, too. To do too much, would take away from it….I don't know, just a thought there. (*Sweet Grass County Residentialist*)

They say rip-rap is bad for the fish and all that crap, and [then] you watch the guides take people where the rip-rap is. The fish love it in there. It is habitat for them. They can get under the rocks and hide. I don't understand [the objection]. (*Sweet Grass County Residentialist)*

IV. Other Problems

A. Subdivision Life, Septic Systems and Water Quality

Homeowners [should] know the impact that their septic system has on the river—this is what it can do, over time. (*Sweet Grass County Residentialist*)

You get people [in the subdivision] that think they are farmers and ranchers, and they are going to flood irrigate. Many things happen when you flood….[I was worried they would] flood my septic system, and I would have to go in and put an above ground septic system. I went to the lawyer and did some research and found out…that if you don't use [a ditch easement] for so many years [they can't use it]….Water hasn't been through here for 30 years. They are done….Who in the hell wants their septic flooded? That is the stupid thing about leaving water rights with the subdivision. Wells are a different situation. Water rights for flood irrigation should not be left with a subdivision. I think they should go back and get rid of them….People come in, and put in a septic system, and Joe Blow wants to start flood irrigating, and he is above [us]. It won't affect him, but he will get everyone downstream, and he doesn't give a damn. That is human nature. (*Stillwater County Residentialist*)

I think a lot of steps are being taken in the building area with new types of septic systems. I know this new subdivision, over here, is requiring a new pressure-hose septic system which isn't as hard on the land….[With] the old septic systems, the stuff comes out and your drain field is basically level. You don't get a rapid flow, so it just kind of goes. I would think there is a possibility of stuff getting into ground water. The new ones are pressure-hosed, that shoots it all at one time and you get quick evaporation, or something. I'm not sure….Any new system that is better is something that ought to be required. (*Sweet Grass County Residentialist*)

I think they have to be real careful with septic, and things like that polluting the river. I think they are already doing that. I don't think we could build here today, and have a septic system. I don't think we could ever get away with it, or ever get approval. (*Sweet Grass County Residentialist*)

Keep the water…clean, and useable for the needs of the people. Where it is needed by agriculture, [use it] without waste. (*Stillwater County Residentialist*)

B. Out-of-Staters Change the Local Context

I know some people sell their places in California, live on the interest, and come here and have just as nice a house for a fraction of the cost. (*Stillwater County Residentialist*)

It used to be people that lived along the river were farmers and ranchers. Now it is rich people that live there….The rich people…are taking a lot of Ag land out of production. You have extremely wealthy people buying these ranches more for toys. They are not interested in cattle production, hay production. It is just a toy, ‘I have a ranch along the Yellowstone. I am cool.’ (*Sweet Grass County Residentialist*)

Rich guys that bought these places and who don’t care about production of hay are just giving the rights away…to the Fish and Game, which scares me. I don’t like that,…because I think we are going to lose our water rights to the Fish and Game. (*Sweet Grass County Residentialist*)

You don’t come into Montana and tell Montanans how to do things….There is a bar in a small town north of here that has a sign that says ‘Welcome to Montana. We don’t give a shit how you did it back home. Have a nice day.’…If I was going to buy a place in Arkansas, and farm [the place], I am damn sure not going to go down there and tell them how to do that. I am going to ask them how to do that. There was a guy that came up here from Georgia, and he was going to show everybody how you could raise six crops of hay in Montana….He is back in Georgia [now]. (*Sweet Grass County Residentialist*)

C. Safety: Debris and Undercurrents

The biggest problem on the Yellowstone are the undercurrents. There’s a lot of undercurrents, so you don’t see a lot of kids swimming in it….I don’t think it’s used recreationally as much as all the little rivers and tributaries that come into the Yellowstone. (*Stillwater County Residentialist*)

Lot of times when people drown in the river, this is one of the first spots they’ll look….There’s a hole, there, and a body will come down and sit right on the bottom…..I don’t know why they mess around. It’s the same story every year.…They jump off bridges and swim through the river, but there’s under-tow like crazy in there.…Boy, you wouldn’t catch me swimming. (*Sweet Grass County Residentialist*)

D. Un-informed Buyers

Some rivers overflow their boundaries. That is a natural process….Getting people to understand that [is the problem]….Maybe part of that is [lack of] education. (*Sweet Grass County Residentialist*)

Maybe there needs to be a type of educational thing….It is like building in New Orleans, and building below sea level, and then not expecting water to get in….But, you know, maybe that is something that needs to be done in addition to like building codes, etc. Yes, it would be lovely to have your home here, but a recommendation says 30 feet back, or whatever, because at some point in time, over a period of time, there is going to be some gradual wasting away of the property here. I don't know, maybe that is done. (*Sweet Grass County Residentialist*)

Well you know, I think that it is a Montana law that the public has access to the river. It is not a federal law. Well, we are from Montana, so we know that….I have no idea what other states have for access laws….I think education would probably be the best thing because out-of-state landowners don't understand that the people do have access to the river….So if they were better informed, before they bought….[It should be] something that real estate people would tell them when they are looking at land. Just let them know that this river going through your property *is* a public river, and it has public users. (*Sweet Grass County Residentialist*)

E. Outfitting and Regulations Seem Unfair

You have a guy making a good living on public water. I am not sure I like that. They aren't paying anything for it. Taxpayers are providing the fish. (*Sweet Grass County Residentialist*)

I have been told you can't operate a motorized boat above Springdale to the bridge above. That is what I have been told….[But] they can down here. Why? See what I mean, there is no explanation for it. It is just control. That is all I can see. (*Sweet Grass County Residentialist*)

F. Exotic and Invasive Plants

[The weeds] are very hard to control. The spotted knapweed, you can spray down there, and it will control it some. But the leafy spurge,…you cannot spray [for] near a water table, so we have put some beetles there—you know, the biological control. But it doesn't seem to be doing a lot….It is one of those things that, until they control it up river, you are not going to get rid of it down river….The water will bring more seeds down, and it spreads….It probably doesn't affect [our recreation]. We just know that it is there, and it is nasty, and it shouldn't be there, so it kind of bugs you. But, as far as actual use of the river, it doesn't affect it all. Now, if you were a cattleman, the cows won't eat it, and it will compete with the grass. (*Sweet Grass County Residentialist*)

It just got to be such a mess of weeds with really no food value for wildlife. They would walk through it, but they wouldn't stay in it; there wasn't much to eat. That is why we took it out. Sprayed it, burned it, and replanted it with non-alfalfa grass. (*Sweet Grass County Residentialist*)

Spotted knapweed, leafy spurge, Russian knapweed. You name it, if it's got a seed, it's been brought down the river….Seems to be getting worse every year….You got guys up river that they don't take care of it. (*Sweet Grass County Residentialist*)

I don't know if it's affecting parts of Yellowstone, but I know the salt cedar we're reading about consumes so much of the water it affected the water flow in Utah. And then the Russian Olives…are just taking over….I don't know if they can ever do anything to overcome that. (*Stillwater County Residentialist*)

G. Property Values and Economic Dynamics

There has to be a clause for people like ourselves who have been here and never have any intention of selling it. This land has appreciated so much since we got it. I just got a new tax notice today, and they have about doubled the value of this home out here. You can only afford that for so long, especially the people that have grown up here and farm along the river. They have to be protected some way on taxes. And sure, when these big guys come in, and spend all that money, they should set new bases,…but to keep jacking taxes up on a farm that has been here forever because now the people next door have millions is not fair. It will drive the small farmers away. [They] can't afford to stay here or to pass the land on to their kids. My opinion. (*Sweet Grass County Residentialist*)

You get greedy people….[They] buy a piece of property, put about 15 home sites on it, [and sell] them for a lot of money. It is pretty tempting. I was talking to a realtor in Big Timber last week….She had a guy from Hawaii call and said he wanted ten or 15 acres on the Yellowstone River….Buy it for me, and my budget is up to one million dollars for ten or 15 acres. So how does a local, say someone from Billings, try to come up here and find a little place to have a home on the river? You can't anymore. (*Sweet Grass County Residentialist*)

So when you start putting these huge subdivisions in,…the sky's the limit on how much this stuff's going to be worth here in ten years….I don't really want to see a bunch of houses, you know. (*Sweet Grass County Residentialist*)

I think…as more and more people want to live along the river, and develop along the river, and how much do you really want to develop along the river. It's up against the people in agriculture who have places along the river….One thing that is hard, it's change. Gosh, these ranchers have always lived along the river, and all the sudden they can't refuse the prices they get for property….It's not like it used to be, it's change, and that's something that's difficult, that "C" word. (*Sweet Grass County Residentialist*)

Yellowstone River Cultural Inventory—2006

Part V: Springdale to Gardiner

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The research team acknowledges the people of the Yellowstone River. The participants in this study were friendly, hospitable, open and generous. We shared coffee, cake and sometimes breakfast or lunch with our participants. More often than not, we were invited onto their properties and into their homes. The tours were enlightening and each of us felt privileged that we were allowed to share in the lives of so many. There can be no doubt, "Western Hospitality" is alive and well in Montana.

The team also acknowledges the members and administrators of the local Conservation Districts for their assistance in identifying and recruiting participants. Additionally, members of the Resource Advisory Committee of the Yellowstone River Conservation District Council provided invaluable support. Finally, the team wishes to acknowledge the support given by the Yellowstone River Conservation District Council, the Technical Advisory Committee of the Yellowstone River Conservation District Council, Dr. Tarla Peterson from Texas A&M University, the Montana Department of Natural Resources and Conservation, the Montana Office of Natural Resources Conservation Service, and the US Army Corps of Engineers.

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Preface

The Significance of the Yellowstone River

The Yellowstone River has a long history of serving human needs. Native Americans named it the Elk River because of its importance as a hunting environment. William Clark explored much of the river in the spring of 1806 and found it teaming with beavers. By 1906, the US Bureau of Reclamation was sponsoring diversion projects that tapped the river as a source of irrigation waters. The river then enabled "twentieth-century progress" and today it supports many nearby agricultural, recreational and industrial activities, as well as many activities on the Missouri River.

Management of the shared resources of the Yellowstone River is complicated work. Federal and state interests compete with one another, and they compete with local and private endeavors. Legal rights to the water are sometimes in conflict with newly defined needs, and, by Montana law, the public is guaranteed access to the river even though 84 percent of the riverbank is privately owned.

Interestingly, in spite of the many services it provides, the Yellowstone River in 2006 remains relatively free-flowing. This fact captures the imaginations of many people who consider its free-flowing character an important link between contemporary life and the unspoiled landscapes of the Great American West. As a provider, as a symbol of progress, as a shared resource, as a management challenge, and as a symbol of our American heritage, the Yellowstone River is important.

Purpose

The Yellowstone River Cultural Inventory—2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.

There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants' views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river's resources. Special attention is given to the ways

in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

Identification of Geographic Segments

The Yellowstone River is over 670 miles in length. It flows northerly from Yellowstone Lake near the center of Yellowstone National Park in Wyoming. After exiting the park, the river enters Montana and flows through Paradise Valley toward Livingston, Montana, where it turns eastward. It then follows a northeasterly path across Montana to its confluence with the Missouri River in the northwestern corner of North Dakota.

Five geographic segments along the river are delineated for purposes of organizing the inventory. These five segments capture the length of the river after it exits Yellowstone National Park and as it flows through eleven counties in Montana and one county in North Dakota. The geographic delineations are reflective of collaborations with members of the Yellowstone River Conservation District Council and members of the Technical Advisory Committee and the Resources Advisory Committee.

Working from the confluence with the Missouri River towards the west, the first geographic segment is defined as Missouri River to Powder River. This geographic segment includes some of the least populated regions of the entire United States. This segment is dominated by a broad, relatively slow-moving river that serves an expansive farming community whose interests blend with those folks living along the seventeen miles of the Yellowstone River that traverse North Dakota. Here the Yellowstone River is also important as a habitat for paddlefish and Pallid sturgeon. At the confluence with the Missouri River, the size of the channel, significant flow and substantial sediment carried by the Yellowstone River makes its importance obvious to even the most casual of observers. Prairie, Dawson and Richland Counties of Montana are included in this segment, as well as McKenzie County, North Dakota.

The second geographic segment, Powder River to Big Horn River, is delineated to include the inflows of the Big Horn and Tongue Rivers as major tributaries to the Yellowstone River and to include the characteristics of the warm-water fisheries. This segment is delineated to recognize the significant agricultural activities of the area and the historical significance of the high plains cowboy culture. This segment includes Treasure, Rosebud and Custer Counties.

The third geographic segment, Big Horn River to Laurel, essentially includes only Yellowstone County, but it is a complex area. To begin, important out-takes near Laurel divert water to irrigations projects further east. Additionally, it is the one county along the length of the river with a sizable urban population. Billings is known as a regional center for agriculture, business, healthcare and tourism. This area is notable for its loss of agricultural bottomlands to urban development. Irrigation projects are important east of Billings, especially in the communities of Shepherd, Huntley and Worden. These

communities and Laurel also serve as bedroom communities to Montana's largest city, Billings. It is in Yellowstone County that the river begins its transition to a warm-water fishery.

The fourth segment, Laurel to Springdale, ends at the northeastern edge of Park County, Montana. The river in this area is fast-moving and it supports coldwater fisheries. While there is little urban development in this segment, there are some rather obvious transformations occurring as agricultural lands near the river are being converted to home sites for retirees and vacationers. The geographic segment includes Sweet Grass, Stillwater, and Carbon Counties.

The last geographic segment is defined as Springdale to the boundary with Yellowstone National Park at Gardiner, Montana and is within the boundaries of Park County. The river leaves Yellowstone National Park and enters Montana at Gardiner. It flows in a northerly direction through Paradise Valley and is fast-moving. It supports a cold-water fishery that is well-known for its fly fishing potential. Near Livingston, Montana, the river turns easterly and broadens somewhat thus losing some of its energy. However, severe floods occurred in 1996 and 1997, and local groups have since spent many hours in public debates concerning river management.

Recruitment of Native Americans

Native Americans also have interests in the Yellowstone River. They are active in maintaining the cultural linkages between their histories and the local landscapes. For the purposes of this study a number of Native Americans from the Crow tribe and the Northern Cheyenne tribe were included. Native Americans were recruited by means of professional and personal contacts, either as referrals from state agency personnel, from Resource Advisory Committee members of the Yellowstone River Conservation District Council, or from other project participants.

Recruitment of Geographic Specific Interest Group Participants

The participants represent a volunteer sample of full-time residents of the towns and areas between the confluence of the Yellowstone and Missouri Rivers in North Dakota and the town of Gardiner, Montana at the north entrance to Yellowstone National Park. Participants were recruited from four major interest groups: agriculturalists, local civic leaders, recreationalists, and residentialists living near the river. A database of names, addresses and contact information was constructed for recruitment purposes. Nearly 800 entries were listed in the database, representing a relatively even contribution across the four major interest groups.

Individuals representing agriculture interests, including farmers and ranchers, were identified and recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of the Natural Resources Conservation Service.

Individuals holding civic leadership positions, including city mayors, city council members, county commissioners, flood plain managers, city/county planners, and public works managers, were identified and recruited through public records.

Individuals who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, and others who use the river for relaxation and serenity, were identified and recruited from referrals provided by members of the Resource Advisory Committee. Participants were also identified and recruited by contacting various non-governmental organizations such as Ducks Unlimited, Trout Unlimited, the Audubon Society and by contacting local outfitting businesses.

The names of property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank, were obtained through a GIS search of public land ownership records. Twenty acres was used as a screening threshold to separate people who lived along the river corridor but whose incomes were from something other than agricultural practices (residentialists) from those who were predominantly farmers or ranchers (agriculturalists). The names were sorted by county and randomized. Recruitment proceeded from the county lists. Other people living very near the river and whose primary incomes were not generated by agriculture were also recruited. These additional participants may not have had property that technically bordered the river and/or they may have owned more than 20 acres. In all cases, the recruits did not consider agricultural as their main source of income.

Participants were recruited by telephone and individual appointments were scheduled at times and meeting places convenient for them. Many interviews were conducted in the early morning hours and the late evening hours as a means of accommodating the participants' work schedules.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

A total of 313 people participated in the project, including 86 representatives from agriculture, 68 representatives in local civic roles, 76 representatives of recreational interests, 76 residentialists and seven Native Americans. A relatively equal representation was achieved in each geographic segment for each interest group.

Description of Interviews and Collection of Participant Comments

A master protocol was designed from questions provided by the US Army Corps of Engineers and approved by the Office of Management and Budget (OMB approval # 0710-0001; see example in the appendix to this volume). Questions were selected that would encourage participants to describe the local environs, their personal observations of changes in the river, their uses of the river and any concerns they may have had about the future of the river as a shared resource. Open-ended questions were used as a means of encouraging participants to speak conversationally.

The questions were adapted to the participants' interest groups. For instance, interviews with agriculturalists began with the question, "How many years have you been in operation here?" while local civic leaders where asked, "How many years have you lived in this community?" Similarly, agriculturalists were asked, "Are there any problems associated with having property this close to the river?" and local civic leaders were asked, "Are there any problems associated with having private or public properties close to the river?" The overriding objective of the approach was to engage the participants in conversations about the river, its importance and their specific concerns.

Participants were promised confidentiality, and open-ended questions were asked as a means of encouraging the residents to talk about the river, the local environs and their personal observations and concerns in their own words. All respondents were interested in talking about their perspectives, and they represented a variety of views of the river, including: farming, ranching, agricultural science, commercial development, recreation, civic infrastructure, environmental activism, historical views and entrepreneurial interests.

With only three exceptions, the interviews were audio-recorded and verbatim transcripts were produced as records of the interviews. In the other three cases, hand-written notes were taken and later typed into an electronic format. The total resulting interview data totaled approximately 2,700 pages of interview text.

Steps of Data Analysis

The content of the interview texts was distilled by way of analytical steps that would retain geographical and interest group integrity.

Segment-Specific Interest Group Analyses: Taking all audio-recordings, transcripts, and field notes as the complete data set, the research group first set out to determine the primary values and concerns for each geographic segment-specific interest group. The team began with the four interest groups from the segment Springdale to Laurel. Team

members read individual interview transcripts and determined a core set of values and concerns for the individuals represented. As a team, notes were compared and a combined outline of values and concerns was constructed for each interest group in the geographic segment. Quotes were then taken from each transcript in the set to illustrate the particular values and concerns.

Outlines of the interest group analyses for the Springdale to Laurel segment were then used as aids in constructing the interest group analyses in all other geographic segments. Care was taken to adapt the interest group analyses to highlight if, and when, the core values and concerns were different in each geographic segment. The Native American perspective was addressed as an individual analysis with attention to the specifics of those perspectives. Each of the 21 segment-specific interest group analyses was then illustrated with quotes from interviews.

21 Segment-Specific Interest Group Analyses

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
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Segment-Specific Geographic Summaries: A summary of the values and concerns for each geographic segment was constructed using the sets of four geographic-specific interest group analyses. Geographic summaries were written to reflect the concerns that crossed all interests groups of the segment, either as points of agreement or disagreement, and were illustrated with quotes from the four relevant interest group analyses.

5 Segment-Specific Geographic Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

River-Length Interest Group Summaries: River-length interest group summaries were constructed for each of the four primary interest groups. For example, agricultural concerns from the five geographic segments were compared and quotes were taken from the segment-specific interest group reports to illustrate commonalities and differences. Similar reports were constructed for local civic leaders, recreationalists and residentialists.

4 River-Length Interest Group Summaries						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Organization of the Reports

Overall Summary of the Yellowstone River Cultural Inventory—2006: An overall summary of the inventory was written as a means of highlighting the values and concerns that cross interest groups and geographic segments. The segment-specific geographic summaries and the river-length interest group summaries were used as the bases for the overall summary. This report is by no means comprehensive. Rather, it is written to encourage further reading in the reports of each geographic segment and in the interest group reports.

Part I: Missouri River to Powder River: This volume includes the geographic summary for Missouri River to Powder River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part II: Powder River to Big Horn River: This volume includes the geographic summary for Powder River to Big Horn River and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part III: Big Horn River to Laurel: This volume includes the geographic summary for Big Horn River to Laurel and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part IV: Laurel to Springdale: This volume includes the geographic summary for Laurel to Springdale and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Part V: Springdale to Gardiner**:** This volume includes the geographic summary for Springdale to the boundary with Yellowstone National Park and the four relevant interest group reports: agricultural, civic leader, recreational, and residential.

Research Team and Support Staff

The project was directed by Dr. Susan J. Gilbertz, Montana State University—Billings. She was aided in data collection and data analyses by Cristi Horton, Tarleton State University and Damon Hall, Texas A&M University. Support staff included: Amanda Skinner, Amber Gamsby, Beth Oswald, Nancy Heald, Beth Quiroz, Jolene Burdge, and John Weikel, all of Billings, Montana.

Springdale to Gardiner: Geographic Segment Overview

Interviews in the geographic segment Springdale to Gardiner were conducted October 1-6, 2006. A total of 57 interviews were conducted, including individuals with agricultural, civic, recreational, or residential interests as their primary concern.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
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NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Springdale to Gardiner: Geographic Segment Summary

> *The most important thing is to be proactive and not assume that problems will solve themselves. The only thing that happens with that passage of time is the two sides of the issues become more concrete in their positions and less willing to look at the common elements of interest.* (*Park County Local Civic Leader)*

Introduction

This segment, defined as Springdale to Gardiner, essentially takes in the river as it flows through Park County. A review of the interview data for Park County suggests that people in this area engage in five primary discussions when asked about the Yellowstone River. First, they seldom speak only of the river, as they are likely to broaden the conversation to a discussion of the changes that are occurring in Paradise Valley. They see their valley as changing rapidly. Second, the floods of 1996 and 1997 left lasting impressions on the people of Park County. Even newcomers are aware of those events and of the devastations visited upon locals. Third, many people in Park County are vocal participants in public deliberations concerning the management of the river. The 1997-2003 Task Force created a legacy that continues to define discussions of the river and its resources. Fourth, then, are the particular topics that continue to generate discussions in the wake of the Task Force. These include debates about rip-rap, setbacks and Mill Creek. Finally, a set of observations emerge as the Park County residents both reflect on the Task Force and move forward. These observations are shaping community members' concerns about the river, the role of governing agencies and local commitments to future public processes.

Paradise in Flux

Virtually everyone who lives in Park County appreciates the beauty of their surroundings. They all agree that the area south of Livingston, Paradise Valley, is aptly named and that perceptions linking the area with Yellowstone National Park are important in establishing broad recognitions of the special beauty in which they live:

> I feel real fortunate to live here. I mean, they call it Paradise Valley and it is. (*Park County Residentialist*)

> The word Yellowstone is a very magical word. But …when [the] Yellowstone is threatened there is an incredible rally worldwide. When you talk to people from elsewhere it means the last free-flowing [river], the last preserved river. (*Park County Recreationalist)*

> It is a place of unbelievable beauty….Tremendous beauty….[This area] is very pristine and clean, and wonderful air and light, and very clean compared to other parts of the country. Fantastic wildlife. The weather changes all the time. It is entertaining just to watch the weather. It is really beautiful. I don't tell other people that. I just tell them I enjoy it and leave it at that. No sense advertising too much. (*Park County Local Civic Leader)*

> Whenever you mention the Yellowstone River to anybody, anywhere in the country, their eyes kind of light up and they kind of perk up. Because anybody who's an outdoorsman knows about the Yellowstone River. This is one of the wildest rivers in the world, and the fishing is unbelievable. It came from the Park and it kind of reminds you of the Park, and to say that we're along the Yellowstone River that's kind of a feather in our cap. (*Park County Agriculturalist*)

Many people of Park County articulate strong senses of personal connection to the land and the river:

> There is a relationship that forms working with the land. You learn to love it, and it becomes part of you. It becomes part of your character. It has some very formative influences on who you are. It becomes part of your soul. I think of the legacy and the heritage. Our kids understand that formative influence on their character. This place defines who they are. (*Park County Agriculturalist*)

> The Yellowstone [River] is my cathedral, that's my church, that's my spirituality, …it's where I charge my batteries. It's my connection to the natural world. (*Park County Recreationalist)*

> The mountains have a…type of impact on the individual, even if that individual doesn't acknowledge it….The river has an impact as well. Without the river, the mountains have too much power and actually impact your ego. The river provides a balance,…a healing,…a strengthening of your ego. (*Park County Residentialist*)

> [People are drawn to the river for]…the surrounding beauty and the river itself. People like to be on it and look at it. They like to fish it. They like to sit and contemplate life. (*Park County Local Civic Leader)*

However, the valley is undergoing obvious change as many agricultural areas are converted to residential areas. The shift both reflects and reifies a shifting economic base in which agricultural activities are much less lucrative than real estate development. An obvious dynamic is that farm and ranch families sell their marginally profitable agricultural lands to residential developers who invent landscapes that are attractive to wealthy outsiders:

> It looks to me like the agricultural lifestyle is going by the wayside. This community was an agricultural community at one time, and I think it's migrating

> the river, to a more recreational community. I think and feel there is some miscommunication between what the ranchers have to offer in this field of recreation. There are a lot of ranchers involved in recreation as well, and it just seems to me like there needs to be some education as to what everyone can offer. So it can work for everyone. (*Park County Agriculturalist*)
>
> We're sitting on a gold mine and starving to death. (*Park County Agriculturalist*)
>
> We have CEO's from big companies…that fly in with their jets and helicopters. They will spend a day, or a few days, and then they are out of here. The rest of the year we are taking care of it. We worry about weeds and roads…[while] they have one little ranch manager whose authority is limited to keeping people out….We don't want to be a rich man's Disneyland. They come, they go….We are trying to maintain something and still be progressive. (*Park County Local Civic Leader)*
>
> I'm expecting to see more recreational ranches more houses on the river, more houses in the mountains….more of the high income, non-resident, second home people that don't rely on this county to provide their income….The people that can afford to have a second home can afford more recreational activities. They tend to use the recreation harder than what was done 20 years ago when the majority of the land was owned by Ag people. (*Park County Local Civic Leader)*
>
> Montana [has] always been an agricultural state. In the Paradise Valley…there's still a lot of agriculture there, but a lot of that Ag land is [where] houses [are] built now…with part-time residents that are here for a few months out of the summer. (*Park County Recreationalist)*
>
> Most of the ranchers are looking down the road and thinking, if they get in trouble, they can subdivide. From what I am hearing, the price of the lots on subdivisions is going down. They aren't selling like they were. (*Park County Residentialist*)

This new dynamic is regarded by most as a simple reality, but it does not occur without a sense of loss among the residents who have lived in Park County for many years. Some residents even anticipate that the attractiveness of the valley will be ruined by those seeking to share it:

> When I was a kid, agriculture, and particularly livestock, was far and away what everybody was engaged in. They were all working farms and ranches. Recreation was interesting, but it was way down there [in terms of economic importance]. Now everybody that has any land out there has either sold it or is waiting to sell it. [There is] hardly any livestock….A lot of ranches exist in name, and maybe in area, but they are purchased by absentee owners or part-timers, and they don't have any interest in livestock. It has been a whole different slant on the vegetative

and ecological part….The farm ground is worth so much…they can't afford to not sell. (*Park County Local Civic Leader)*

That's like the population growth that's going on all over the world, there's just no way to stop it. I mean we can try to slow it down, maybe control it to a certain extent. Sure it would be great if there was no more houses ever allowed, here…draw the line. But we can't do that. There's too many individual rights that you're violating when you try and do something like that. (*Park County Agriculturalist*)

You know, that's progress, and I can understand that, [but] I don't like that. I would prefer that people held onto it and kept it in a big block of land, and used it for agriculture. But I can understand why that doesn't happen. I mean money seems to be what drives everything. (*Park County Agriculturalist*)

Say someone is 18 [years-old], when they turn 30 they would love to have a summer place in Montana. Fine. They have to wait until one comes up for sale. It [should be] like wanting a real Class-A apartment in New York City. Nobody is going to build you one, you have to wait until the next one comes available, [and] there might be a two-year waiting list….Let's take the 100 homes that are [within] a ten or twenty mile distance along the river and make them really prime property because nobody else is going to build right next door….You're going to have to wait until one comes up for sale. (*Park County Agriculturalist*)

Ag lands contribute to the beauty of the area, the open space of the area….I like the conservation easements....The conservation easements are controversial, but I see them as protecting us from developers. Do we want open space or do we want houses? And the other side of that is, …if you see the beauty of the Paradise Valley, a lot of the beauty is [in] the open space the ranchers are protecting….Which people don't even see, especially environmental groups, which really aggravate me. That's why you have wildlife on those fields and birds. If you had houses there, you're going to have a groomed lawn and too many horses. (*Park County Local Civic Leader)*

The real-estate developers…know it's wide open…there's no constraints on developers and I think that's holding a knife to the heart of the Yellowstone…there's no plan. The county planning commission is populated by real estate developers… I see a very deep connection to the river of all of the people here, but nothing that says, 'Wait a minute this is a real gem and let's keep this at least like it is, without further degradation.' (*Park County Recreationalist)*

The real estate developers have a huge amount of power both in the property and the way they market them and how they are organized….We have this huge issue between these people that can't see the change and are unwilling to accept the adverse change and the people who say it is going on other places and we need to

> stop it right now. Both sides have these real knee jerk reactions. (*Park County Recreationalist)*
>
> The development is just unreal….At night…I used to drive around and see a dozen lights in the old days, and now there are just hundreds of them, thousands of them, literally. So a lot of the ranches have been chopped up. But it's dollars….They can make more selling it for a house site than they could making hay. (*Park County Residentialist*)
>
> Developers...go and dangle two million dollars in front of somebody's little ranch….[The ranchers] are going to take it. And that's happened a lot. So you're actually losing some of the rural people….[This began in the] late '70s. (*Park County Residentialist*)

Thus "local development" is a primary topic of discussion in Park County, and many people express regrets concerning the ways it changes their landscapes. However, at least a few openly recognize that the community also benefits from having influxes of new people and new money:

> It's kind of a good/bad thing because…the tax dollars still roll into those places, but yet the people are only here for a small part of a year. So the population, in a sense, is down, but it's still the tax dollars….it's a good/bad thing. (*Park County Residentialist*)

The Floods of 1996 and 1997

The communities of Park County were greatly impacted by floods in 1996 and 1997. Those events were devastating to more than a few families with homes near the river. As well, some productive lands were also, at least temporarily, put out of commission. At least one local official is convinced that flooding will, inevitably, happen again:

> The flood of '96 changed my property….The island broke in half and…when it broke the force of that came over and hit that island and doubled back. My neighbor had very poor rip-rap and [the water] found the weak link and just kept coming to my house….I lost 100 feet [of property]…and part of the house. (*Park County Residentialist*)
>
> In 1996 we lost quite a little bit [of land]….We lost quite a bit this year….We recently…got it re-surveyed and found out that there isn't, and never has been since we've owned it, as much land as we've been paying taxes on. We've been trying to obtain two titles on this property….Once we get that done we will take it to the county treasurer and see what we can do about that. (*Park County Residentialist*)

> If it does come out of the banks, it goes onto us. It floods some of our hay meadows. So be it. We can clean up after the water goes back down. It's just…basically nature taking its course. (*Park County Agriculturalist*)
>
> We've had what you call sheet flooding, but we were never in any trouble. That's where it comes—it doesn't cut, and it's not fast—but it spreads out. Once it gets to a certain height in the flood plain it just flows through the flood plain. And actually it gave us about two inches of new sediment, [which] cut the grass for two years from production, and then after that we really benefited from that amount of sediment. So, in a way, that's the way the system works. (*Park County Agriculturalist*)
>
> [The] flood issue is always a problem….We have an affidavit that shows, back to 1865, that this property has never been under water. But in 1996 and 1997 it came [and we had] one or two inches of breeching back here. We sand-bagged portions of it. Of course, when a river is that big, you can't stop much….We didn't flood but a lot of people did. (*Park County Recreationalist*)
>
> The Armstrong and DePuy and Nelson spring creeks….are a valuable asset…[that] brings a lot of money into the economy and they are a unique fishing experience….[At the] campground fishing access, the river eats directly into the gravel. This fills up the river bottom with gravel and it spreads out. It elevates the flood plain. It damages the spring creeks on the east side of the river in that area….These last two high water years really devastated the spring creeks. Nothing has been done as far as I know. No one wants to acknowledge that it is a problem, but it is.…They don't know how to deal with it….When you get these large floods and especially if the river is pushed out of its channel, it tends to go down those channels and the spring creeks are located along the western edge of the low lands. (*Park County Residentialist*)
>
> With respect to the river, I am not panicked about the river in the next ten years. I feel pretty good about where we are going with the Corps of Engineer's works and that they will come up with some measures that will prevent big floods. I have also lived around rivers enough to know that sometimes a river will just jump. Unless you have 14-foot flood retaining walls, there may come a time…despite the best efforts…[when the river] will jump. That is somewhat incumbent on living by a river. I certainly realize it is something that we may have to go through. (*Park County Local Civic Leader)*

In the aftermath of the floods, the number of applications for bank stabilization permits soared. Conservation and environmental groups began to pressure river officials to consider the cumulative effects of such projects, and many Park County residents became vocal participants in arguing for, or against, stricter controls.

As management authorities shifted away from automatic approvals of permit applications, the community entered a difficult period. In addition, complications regarding flood plain designations surfaced as exasperating problems for local officials:

> 1996 and 1997 were historical record flood years and…conversations have really been stark because of those two major floods….I think people got scared about protecting their properties and some properties were lost. And so with the protection of property and living on the river, there's controversy. And I think, before the [floods, the] controversy probably wasn't as strong….I think we can be good stewards to the water and the river ways but also [we can] protect our homes….Somehow we have to come up with a balance instead of just saying, 'Oh, you can't do this, and you can't do that.' Somehow we have to work together to come up with what is the best thing for the river and [the people]. (*Park County Residentialist*)
>
> [After the flood was over] I said, 'Couldn't we move some of the rocks so the river would go back where it was?' [The Commissioner] said, 'The fishermen wouldn't like that.' I said, 'What is more important?' and he said, 'Around here, the fish.' Can you believe that? (*Park County Residentialist*)
>
> The flood of 1996 took out Armstrong's Spring Creek. I was the one that said they couldn't do what they wanted to do. It was bad…Then it hit the press and they finally brought in experts. The landowner spent $800,000 [on rip-rap] and it washed down the river in four days. I lost a lot of business because I stepped on the fishermen toes. They wanted it back at any cost. My family has been involved in stuff a long time and people hurt, because it was $100 a day to fish the spring creeks. (*Park County Recreationalist)*
>
> We have flood plain issues that are dealt with on a continuing basis….They are actually completing a study in the valley trying to re-establish the actual flood plain. It has been fairly controversial….[One set of designations affected] a lot more land area than what they had anticipated….The elevations weren't right and so it kicked a lot [of property]…into the flood plain and….nobody really wants to be in the flood plain very bad because you can't do any building or anything….On the flip-side, [an area] above Emigrant was in the flood plain [before] and when they redid [the designation] it was out of the flood plain….So, which one do you go by…..Trying to get flood insurance is a problem….They used the wrong formula…[but] they haven't really come back yet with anything new….The DEQ is involved, and the Corps, and FEMA as an insurance part….The interesting thing is the Corps of Engineers and the Montana State definitions of the flood plain are different….The boundaries…aren't the same….We don't really know [when they will make the final determinations]. It is still pending. I would guess within the next two to four years….Not having a flood plain [defined]…we have no idea what to expect from year to year, especially since we have been in a seven- to nine-year drought in this area. Water flows are much lower than normal and we don't have the flows like we used to

> have in the ’70’s and ’80’s. In ’96 and ’97 there were back-to-back flood years. That was a 100-year and a 500-year flood….The biggest issue is the flood issue not being resolved. (*Park County Local Civic Leader)*

In the fall of 1997, then-Governor Marc Racicot, appointed a Task Force for the purpose of providing an official local forum for the deliberation of issues concerning the management of the river:

> The Governor’s Task Force…came together [because] we had seen a lot of bank stabilization projects without a lot of planning in my view. (*Park County Recreationalist)*

The Task Force worked for six years and submitted its final recommendations in the fall of 2003. The Task Force and its legacy continue to evoke much discussion in the local community.

An Involved Community—The Task Force and Its Legacy

Membership in the 1997-2003 Task Force varied somewhat over the years in terms of the particular people who served; however, local landowners and people with interests in the recreational resources of the river were involved throughout the years. Agency representatives also worked with the group. Opinions now vary as to the degree to which membership was representative of local interests and the degree to which the efforts of the Task Force were productive:

> The Yellowstone River Task Force was formed because the local people here…are pretty recreational-minded. Fishing’s a pretty big deal here in Livingston. They were trying to figure out, after the flood, what was the cause of the loss of the fish… That’s how it all started, and then of course there was a lot of sentiment about building next to the bank, and there was a house that was too tall here, and they wanted to change the channels and stuff like that. And they were just trying to get a hold on the thing. They were just trying to prevent some of the things that have happened, which is not all bad. (*Park County Agriculturalist*)

> It seemed like there were a lot of different interests [on the Task Force]. Maybe [they needed] a tighter agenda. They had people coming from all different walks and concerns. You have people that make money from it and guides and developers and you get the people that actually live there and have lived here for years. It got quite dicey at times and it got hard to stay focused on what the job was….Everybody had a different perspective. Very strong opinions and all different opinions. You can’t put a label on anybody. There were ranchers, sportsmen, developers, environmentalists. They all had very different ideas. Their meetings would go until 2:00 in the morning. Everybody had to say what they had to say and they would go on and on and on. (*Park County Local Civic Leader)*

We've become a minority anymore it seems, and it's pretty tough. We don't have near the money that these other organizations can put together, and some of these battles get kind of tough. I know that when that Task Force deal was going, there were things said….They said, 'Well, the ranchers are on the way out, deal with it.'… I guess we're not ready to hear that. (*Park County Agriculturalist*)

The governor ordered a river study. One of our former commissioners was a member of that task group….They spent six years on it….They came out with a stack of stuff that deep….They talk about protecting this resource….They didn't want to armor banks and stuff like that. They want the Yellowstone to be free-flowing and let it meander where it wants. (*Park County Local Civic Leader)*

The time I spent on the Task Force, I enjoyed. Some [of the information] was way over my head and my education level. I have a whole stack of material, and I don't think there is a human being alive that could take that stack and make sense of it….They were all experts in their field, but we didn't have a person that took that information and put it into any kind of program…. It just wasn't gathered up…I don't know if there was anybody that could do it… When I listened to all the experts…nobody put the thing together, and they still haven't. (*Park County Agriculturalist*)

[The task force] was a waste of money. They told us where the ripples are, and…told us where the river floods. Anybody who's lived here for more than two years could figure that out without a PhD…..I guess what bothers me about the task force is it comes back to the ranches should be the buffer zone….just let it flood over the ranch….Ag should not be the whipping boy….The sacrifices should not be borne by just the agricultural properties on the river, it should be borne by all, including the highways….Do we need to build a highway right along the river?...Or should we move the highway over a little bit [so we don't have to rip-rap it]. (*Park County Local Civic Leader*)

The Governor's Task Force…did focus a lot of attention on the riparian zones…[They brought attention to questions such as]…What are the alternatives of grazing management? And, what are the implications for riparian zones? What are the effects that riparian zones have on avian productivity?...[On] diversity and preservation of fish habitat?....There is more public awareness…than there was say ten years ago. There's an awareness that a lot of what we've done to the river is to diminish the productivity of the riparian zones. (*Park County Local Civic Leader)*

[The Task Force] was helpful because it opened people's eyes….Any publicity [showing] that we need to protect the river is useful. (*Park County Local Civic Leader)*

I did go to some of the meetings. I just thought they weren't really getting anywhere in the meetings….They weren't allowing the professionals to be a

> participant and a voting party, so basically they had task force members, but a lot of the scientists and people that have the expertise, I felt, were not part of the equation. I mean, they came and they presented things, but [the professionals] weren't a voting mass….The scientists and the professionals…need to be participants in the Task Force, not just presenters. Because they are the people that know, and they should be the people that are helping this balance that needs to be met here. (*Park County Residentialist*)

> There were tons of recommendations [from the Governor's Task Force] but I don't see where any of their recommendations were followed at all….The people…on there…did a good job….It's a sad thing because there's a lot of good-meaning people put a lot of time into that and really cared about what they were doing. Then to see nothing happen out of it is kind of discouraging. (*Park County Residentialist*)

> You know, [the Task Force] didn't hurt….I know several of the people that were on it and some of them came away with a better feeling, some of them came away with a worse feeling….[The one's that thought it helped] felt they did some good and that the government was honest with them. The other group…[says] it's the old conspiracy theory, 'They used us.' (*Park County Residentialist*)

> [Regarding the Task Force] I think…[they made good decision about] the flood plain and how the rip-rap was done to prevent erosion. Overall, there was a lot of good, sound thinking and they reached compromises. The health of the river came first and will be maintained. (*Park County Residentialist*)

Complications Near the River: Rip-rap, Setbacks, Mill Creek

In the wake of the engaged and prolonged conversations of the Task Force, residents of Park County offer a great diversity of opinions regarding the use of rip-rap as a method of bank stabilization. The diversity appears across and within interest groups. For instance, consider the differences of opinions offered by agriculturalists:

> You need to use big rocks. You don't want to put in small stuff or it will wash away. It has to be done according to soil conservation specifications and all that. Big rocks on a bank are the best way. (*Park County Agriculturalist*)

> Something that will work is hard rip-rap and barbs…None of that [soft rip-rap] has ever worked on the Yellowstone. I can see where it might work on a river or stream that is not as violent. (*Park County Agriculturalist*)

> I think every time man decides he's going to manage nature, he normally screws it up royally. (*Park County Agriculturalist*)

> Erosion [happens] on the banks…which is too bad….You hate to lose areas of the ranch, but [if you] put structures in the river, and try to push the river over, you effect somebody else. So it's a no-win deal, really. (*Park County Agriculturalist*)
>
> I just think that there needs to be some careful planning….when stream bank stabilization is done to make sure that you are protecting your property but not jeopardizing someone else's. (*Park County Agriculturalist*)
>
> They have almost shut down any bank stabilization….I should do some bank stabilization but I don't know if I have it in me to take the guff that it is going to take to get it done. It is tough to have to do battle....I just dread it. (*Park County Agriculturalist*)
>
> All my father-in-law used to do is talk to the [Conservation District] and the Army Corps. They used to design the project for you, but they don't anymore. (*Park County Agriculturalist*)
>
> Well, it's going to take some time and you have to kind of get ahead of the curve. If you've got a certain time schedule….you have to get started, [but] like I said, we found them very reasonable. (*Park County Agriculturalist*)
>
> The banks have to be stabilized, and we have had to do quite a little of that since we've been here—thirty-seven years. But we've always had good cooperation from the Bureau of Army Engineers and the…Fish and Game and those [in the] conservation services. I think they've treated us fairly….We've always left some riparian area there along the river. We never graze that real hard. There's always a lot of grass and brush and things like that, and I think that's probably one reason we've always been able to get along with the Fish and Game and the Bureau of the Army of Engineers because we've always tried to leave the riparian area there next to the river. (*Park County Agriculturalist*)
>
> We had to haul rock in, probably 85 percent [of what we used]….Maybe even more than that, maybe 90 percent. (*Park County Agriculturalist*)
>
> We counted them. There were thirty-one different representatives from different agencies [involved in our project]….We had an engineer that should have known we had to re-apply, and he didn't even know. (*Park County Agriculturalist*)

Local civic officials and residentialists also offer a variety of opinions regarding rip-rap:

> You do have to be careful when you rip-rap because you may protect yourself but you are pushing it to someone else….[and] pretty soon you would have a big channel if everybody rip-raps. Once you let one person do it, you start the problem. (*Park County Local Civic Leader)*

I don't know that there is a whole lot you can do [about erosion]. The river starts to move and…you can plant trees. That is probably what is holding the dike together right now. Tree roots are a great thing. (*Park County Local Civic Leader)*

There is only a certain amount of [stabilization trees will] do. You try and get willows started in a sand bar…sometimes that works and sometimes it doesn't. (*Park County Local Civic Leader)*

If one person rip-raps, the next one does, all the way down. It speeds up [the river]. They don't want that constriction….On the flip-side you have the landowners…that are subject to the whims of the river and that is their property that is being washed into the river when it creates a meander. It was kind of ironic during the course of that study that there was a house that was on a 100-feet high bluff, about 500 feet back, and during the major floods it undercut the bank so much they torched that house before it went in [the river]. It was pretty dramatic. It was even more dramatic the way the banks fell off….[The house] was on a big gravel slope….The river was so high it kept washing away that bench. It just gradually eroded that thing back hundreds of feet. (*Park County Local Civic Leader)*

I would like to see some better science on the effects of hard armoring and rip-rap on the…fish production…[and] habitat areas [such as those created in] flood stage….We've lost a lot of that. (*Park County Local Civic Leader*)

I don't know, at this point, what you can do other than encourage responsible planning…and really being careful if you allow somebody to rip-rap. You have to think about the consequences…Some of the biggest problems here are these old bridges that constrict the river. They need to redesign those bridges, of course it would be millions and millions of dollars. (*Park County Local Civic Leader*)

After the flood, they built concrete all across the front of the house up to this floor. Then they put the huge rocks in….It is [a] concrete wall…[and] there is the barb. I am pretty safe. It was nothing like this before….They are saying you shouldn't rip-rap, but this is my home. The engineers will allow me to repair this….If anything happens, they will let me fix it. I am grandfathered-in. They will let me do that. (*Park County Residentialist*)

[Rip-rap] can divert water. It can shift the problems up or down….The reason that I probably might not do the rip-rap is I'd lose ten years of vegetation that's out there since the last flood and the vegetation is as good or better than hard rip-rap…[and] once I talked to some people who explained that to me, I don't really want to tear it up to put some rock in…but [the information] didn't come from any of the [government agencies.] (*Park County Residentialist*)

I was interested in one technique [to prevent erosion.] I saw on a ranch that used root balls along the river to start collecting rocks to start building the bank up

> again....It is a natural form of rip-rap. I saw some of that and was interested in that although when you call somebody that does that natural stuff it costs a lot of money. I don't know if I have that much to put on the bank of the river. (*Park County Residentialist*)

The recreationalists are the most uniform in their concerns regarding rip-rap. They typically view erosion as a natural process, and they regard the free-flowing character of the river, along with flooding, as serving important riparian functions:

> We have a little erosion every year…There always will be some erosion inevitably. (*Park County Recreationalist)*

> The '96 and '97 [floods] were so refreshing, in many respects, because the river was just huge and nobody had ever seen it like that. And it was rampaging all over the place and doing wholesale channel changes down there in Livingston. (*Park County Recreationalist)*

> There was a time when a property owner was at a loss but to just accept the influence of the river and they just accepted it….I guess there is a certain communion with owning the land and understanding how it works and knowing you take the good with the bad. The river changed course and I lost that bottomland but at some point I will regain it. It might not be my generation; it might be through my kids. (*Park County Recreationalist)*

> Do you rip-rap the south bank and leave the north bank natural? It is a slippery slope. Once you go there it exacerbates itself and it changes the ecosystem and there is no going back. (*Park County Recreationalist)*

> One of the saddest things about the Yellowstone is you go down between Hysham and Forsyth and there are some of the most incredible cottonwood forests you have ever seen. I would assume it was here too. That is the problem with rip-rap: you get the floods coming over the top and they don't get re-seeded. (*Park County Recreationalist)*

> It's not great for riparian areas when you have a rip-rap bank. That wrecks it. (*Park County Recreationalist)*

> When you channelize the river, it takes away its wild characteristics….but every time you stabilize that bank, you tame the river more…. the Yellowstone isn't allowed to spread out…it stays in one channel and it just digs a big deep trench over the years.…a lot of people think [rip-rap] provides great habitats for fish [but]…the fish studies that have been done have documented that surprisingly the [smaller] fish aren't there like they thought they would be. (*Park County Recreationalist)*

> The Yellowstone left to its own devices would take care of itself because it is a wild river, but if you continue to rip-rap it…it can't handle that amount of rip-rap. The river goes where it needs to go, and when you change it, it doesn't just affect the flow, it affects many, many things …It reaches a saturation point. (*Park County Recreationalist)*

The topic of setbacks also comes up regularly amongst the people of Park County. Again, opinions vary:

> About four or five years ago [some people] wanted to have a 500-foot setback. That got everybody's attention in a hurry. So we soon shot that one down. [With that setback] you couldn't have done any rip-rap, and you couldn't have done any stream stabilization, and you couldn't do any capital improvements unless you [had] the approval of the group. (*Park County Agriculturalist*)

> People have wanted to put setbacks in place on the Yellowstone to keep development away from the Yellowstone River. I think they talked [about setback of] up to 300 feet, maybe, from the Yellowstone River. I think the setback now might be 100 feet. But that's one issue that has come up that people bristled-up a little bit over. I think the landowners themselves would probably be most content with no regulations, but people who float the river, maybe they want some regulation. (*Park County Agriculturalist*)

> I feel strongly, if I'm in harm's way, it's my fault and I'll have to deal with it. If they want to pull my insurance that's fine. I have the means to survive somehow. But I think if you do live in harm's way, regardless of wherever you are, you have to be smart. (*Park County Agriculturalist*)

> [Set-backs can function as] a public safety component, and there's also a river health component. You don't want to be in situation where you see…concrete sides and sedimentation runoffs in the river? So far, this river system has been fairly resilient….there is a fair amount of seasonal rehabilitation that the river does for itself, but that's limited in terms of capability, and it's hard to know what the limits are without bumping up against them. (*Park County Local Civic Leader)*

> We will listen…and advise….We look at hydrology, [to see] if it is…in a hazard area. We have regulations about altering the flood flow or armoring the banks or putting fill in. We look at all these things. The best thing we can tell them is, 'If you get near the river, you will get your feet wet.' (*Park County Local Civic Leader)*

> From a recreational stand point, how many houses do you really want to see sitting on the river bank as you go floating by?...That is a resource quality that we take for granted, but it's not necessarily going to be here 20 years from now. We're seeing an awful lot of development right along the river and…I think that

effects property values long term, it degrades property values. And it certainly degrades the marketability of the fishing experience for a lot of the river guides. (*Park County Local Civic Leader)*

If we're not careful it's going to look like a bunch of squatters all the way down [Highway] 89. All the way along the river, it's going to be ugly. (*Park County Recreationalist)*

These people have built beautiful homes. They're not junky. They're beautiful but there are too many, too close to the river. (*Park County Recreationalist)*

We have a cabin here that we rent to people. And every once in a while my husband will say we should build a couple more and I say, 'I will not….that's more sewage on this small plot.' That's not being a good steward of the land that we've been given. (*Park County Recreationalist)*

Have those homes set back from the river…this was the last best place in Montana and it's been discovered, so you've got to have rules. (*Park County Recreationalist)*

This county is going to be subdivided. There's not any way of stopping that, but I think we should have 200 foot setbacks on the river both for the houses and for the septic tanks and drain fields. (*Park County Recreationalist)*

How do you set an arbitrary 300 or 500 feet? It has no bearing on the river. We have a 300 now….These arbitrary lines don't make sense…They have a 500 foot in Madison Valley but they seem to give exceptions all the time…If you think of how different rivers are, you need to do it by reach tide. (*Park County Recreationalist)*

[Setbacks,]…That should be an easy answer but it isn't….we are concerned with the function before the aesthetic wants….Knowing that in some areas there may not need to be a setback at all. In other areas there may need to be 500 feet or half a mile depending on what you want to maintain. As you come to the lower end it meanders a lot more. At the upper it is naturally armored and doesn't meander as much. Since we are heavily dependent on tourism the aesthetic qualities are very important for the floater and the fisher people. (*Park County Recreationalist)*

We need to be looking pretty seriously at why we're still allowing homes to be built on the river. And…I'm kind of speaking out of two ends here because I do live on the river, but I do think that since the floods we need to look more seriously at what we are allowing….Each place wants to protect their property….Are we all going to be able to do that and still allow the river to be healthy? (*Park County Residentialist*)

> It will put more people on the river. It will impact the visual aspects of the river. I think there should be setbacks from the river, for aesthetic problems and pollution from septic tanks. (*Park County Residentialist*)

> The latest the efforts have been a lot about growth….They've been trying to work on the growth policy and the subdivision regulations….So that there are setbacks from the river. And Park County Environmental Council is definitely behind setbacks, and I agree. I agree that new building needs to be different than the old….It shouldn't be that we say, 'Well, you live like that so why not [the next?]'….You know, things change. We need to be better stewards because there are a lot of us. (*Park County Residentialist*)

> We're going to get more regulations….And, of course, you have all sides….You get the guys that say, 'They are taking our property rights.' I try to tell people that what you do [on one side of] the road sometimes does affect the other side of the road. They don't like to hear that, of course, but we have to be honest….It's the conspiracy theory, the government's-got-too-much-control theory. I get a lot of that here. (*Park County Residentialist*)

Another concern involves water rights and the seasonal conflict in late summer between irrigation needs and recreational resource needs. Some of the participants from Park County wanted to discuss concerns about Mill Creek:

> Mill Creek…has a significant drainage area. Through the Conservation District, they've developed a lot of pivots and irrigation systems…[and the farmers] have taken quite a bit of water. The fisherman and the recreationalists are upset because generally that creek will run dry in the lower end, below where the big head gate is, [in] mid-summer….Fish and Game want to restore the cutthroat fishery, and they don't know quite how to do it. They can buy the water, [but] at what cost? I don't know what they arrive at, but there's a conflict [between] recreationalists—the new second-home people that moved up there—and some of the older, traditional agricultural water users—primarily ranchers, and alfalfa [growers who]…use the water for their livelihood. I understand the need for maintaining some water flow…[and] there is another approach….That lower section is just going to run dry at certain times of the year….When…the small fish get to a certain size [upstream], they'll flush [the creek] for three or four days….Open that up and blow all those little fish into the river. But that's expensive, they have to pay for that water, and there's some concern about fire [in late summer]….Having that water is pretty nice…when you're worried about fires. (*Park County Agriculturalist*)

> We're going to have a leasing meeting over on Mill Creek with the watershed group next week, and a lot of people are feeling that they're coming up short because [one guy is] leasing his water rights [to provide for the fish in the creek]. It is going to effect me, but we have a law that says, if it's beneficial use, you can do that…..Fish and Wildlife is beneficial according to our legislature,

> now….And, let's face it, I'll be the first to say, that sometimes the fish in that creek are worth more than the hay I'm raising….[Most people] got their irrigation systems put in by the government—not totally free, but with lots of grant money—that was ten years ago….[Now, with this guy leasing his water, another] says, 'It's not fair.' Well, it may not be fair, but you did get a new pivot…for half-cost….So, I don't know. It's tough. I mean, that's going to be a real contentious meeting….We have water rights, but we dry up Emigrant Creek every year. So I can see both sides. But sometimes I [ask about the] outfitters and how much money they make on the Yellowstone River—it's tremendous. (*Park County Residentialist*)

Observations from the Veteran Community

Because they have gone through prolonged discussions of how best to manage the river's resources, many of the participants from Park County see themselves as veterans. The local deliberations have not necessarily resulted in consensus decisions about what should be done, yet many of the Park County participants offered advice concerning how communities should approach complex issues. For instance, even though particular individuals may feel threatened by change, taken as a whole the community understands that traditional activities will have to be balanced against new demands. A new type of stewardship is emerging:

> I think you're always going to have your contrast between people whose interest is progress, and those that want to save [the valley as it is]. It's an on-going thing. (*Park County Agriculturalist*)

> Part of our stewardship is to make sure….I mean, let them come, let them see, but [don't ruin the valley]…..There's a rancher-gentleman in the valley…that made the statement, 'In twenty years, US Highway 89 [will] be solid strip malls.'….That's his fear. He's lived here [and] he's managed the same ranch for twenty-some years. His father managed it for thirty years prior to that. They have been in this valley for a long, long time, and that's their fear. That is their tremendous fear. (*Park County Agriculturalist*)

> What resonates from both sides…is water quality….[But what is] water quality? Is it simply the chemical analysis?....Or is water quality [connected to] the system?…If you started from water quality, and worked gently outward…describing the mountains that create water quality, then there may be an incremental way to bring people into consensus. They [need to]…fundamentally understand why this water is good and why it is bad. Start from why is water so important to us. It may sound elementary. (*Park County Recreationalist)*

> I think there are some people that want to see the agriculture survive just for the benefits for wildlife. They could see the handwriting on the wall, that there are

> going to be more and more homes built, and habitat for wildlife would become a premium. (*Park County Agriculturalist*)
>
> I think in the long run it would be better to support Ag, even from [the newcomer's] standpoint. Ag is what the people like about the valley now. (*Park County Agriculturalist*)
>
> My big thing is the public access and the public's right to use the resources and enjoy the wildlife….Most of us live here because of what the outdoors has to offer.…We just really need to safeguard that. (*Park County Residentialist*)
>
> I think the river is threatened. We have rules, but we are only [a few] eyes up and down the valley. If it weren't for a lot of caring people, and a lot of snitches…[we couldn't do our job]….We need to update our regulations. We need to look at them and revisit them, and make more people mad at us. (*Park County Local Civic Leader)*

As is true with many Montanans, Park County participants are certain they do not want too much governmental oversight, especially if it comes in the form of arbitrary rules:

> I don't like legislation because it seems to be arbitrary. I don't see any flexibility, either you do or you don't. It's like this house. We were grandfathered in, and we're living where they lived for almost a hundred years, and yet there are a lot of people who object to our living over here. (*Park County Agriculturalist*)
>
> It isn't that we have to change it or protect it to death. We need to maintain it and respect it. I hate to say it, but the usage is going to have to be limited. You can't just send 200 boats a day down that river. There has to come a point, like with the Smith River, it will have to be limited or on a permit basis….You will have to be a resident, and they will give out so many non-resident permits….I don't know what the answer is, but we have to do something to change or we can forget it. (*Park County Local Civic Leader)*
>
> The public, and myself included, we need to have some available information….We [weren't] really good stewards when we moved here. We've done some rock work along our bank, and there wasn't anyone there [to advise us]…unless we could have paid for professionals….But at the time we couldn't afford it….If there's some kind of grants that may be available so you can hire a professional—if those professionals really have the answer—that's a question…I have. (*Park County Residentialist*)
>
> Don't be too hard on the people that live on the river. I don't have the money to make big changes….I had a bunch of cottonwoods growing and the beavers came and ate every one of them. There went my stabilizing….[The beavers] are really destructive. I am trying to keep this place,…[even though] the moose come and

> they eat everything they see and…I am not going anywhere. I am going to stay here. (*Park County Residentialist*)

Private property rights are considered very important, even when this means letting people make mistakes:

> I think that people have to understand that private property needs to be protected. Without any property rights protection, agriculture as we know it is going to fail, big time….There are areas on the river where the river has a solid bank and no amount of high water is ever going to erode it…[In other places] I think that…people have to be first. (*Park County Agriculturalist*)

> You do the best you can. People have the right to live where they want to live. I think there is a growing awareness that [rules sometimes] change. It is tough to deal with, but just making the people…more aware of the problems that we all face, and having them taking some responsibility…[will] help make that change positive instead of negative. (*Park County Local Civic Leader*)

> It's difficult to save people from themselves, so I think that one of the most important things a governmental entity has to do is persuade rather than demand. And I think that's where the involvement in the decision making process is critical….You have to be open and receptive to public comment—you have to be empathetic without necessarily having to agree. And I think in the instances when we don't agree, you have to convey [that you are] understanding without necessarily being in agreement….The Corps, in the past, has not been as sensitive as they might have been in terms of conveying to the public that they are listening, not necessarily agreeing….[With] set-backs, you're trying to save people from themselves—it's a very hard sell. (*Park County Local Civic Leader)*

> Private property rights are always an issue along the river. They often are trampled on by regulation and then those regulations cost the private property owners along the river money….There is always a balance and to find that balance and for everyone to be responsible along the river.…I think that's done through education not through regulation. (*Park County Residentialist*)

It is certainly true in Park County that a call for public participation is not ignored. Those who participate in and who organize such efforts find themselves involved in intense conversations. The outcomes are seen as potentially negative and positive:

> [In this] culture…nobody sweetens their tea. It's the attitudes. It is a very self-reliant culture….[an] everybody-takes-care-of-their-own type of culture. The view of government out here is not just suspicious. It is flat out distrust. If government is involved, something is wrong….In other communities they at least give you a chance to screw up. Here they assume you already have and they haven't found out about it. (*Park County Local Civic Leader)*

You can't impose your ideas. You need to involve everybody and all sides. The difficulty is…all sides feel threatened.…A good process has to be inclusive and usually that is tedious and difficult to do….The hard part is paring away the rhetoric and getting down to what it is you actually value, and what threatens that. Not your fears, but the reality. It's really hard to…trust people enough so you can actually talk about the real issue. (*Park County Recreationalist*)

The squeaky wheel gets the grease. If you want to have something done you've got to make some noise. It's good to think about doing it the right way. It's good to understand the process. I just think your average person doesn't understand the process. They don't know how to go through it. (*Park County Residentialist*)

Some of these people don't take no for an answer. Now, developers come and bring a staff of lawyers, hydrologists, engineers….They will come to the planning board meetings with their attorneys. They will set up their own sound systems so they can record everything. This is a kind of intimidation where they will sue you if you don't do something they want, 'We are recording every word that you are saying.' They have a whole entourage of people working for them, and you are one person, trying to do the best for the county, and you have to face their staff. That is how they are now….They will hire their own stenographers for meetings. They will go to the commissioners meetings when it is their turn to decide something. They intimidate….First they will try and schmooze you. They will put on a luncheon. If that doesn't work, they will get tighter and angry. Then come the lawyers. (*Park County Local Civic Leader)*

All too frequently we are ready to find the differences…I think in my mind there is a bond between the ranchers and the environmentalists but socially they can't find it. (*Park County Recreationalist)*

Montana is interesting to me in that it goes beyond public information and public comment to public decision making. Folks don't just expect to know what is going on or have access, or be able to make comments, they expect to be seated at the table with the ability to put their hand in the air and cast a vote. I appreciate the interest that people have. It can present challenges if a lot of people feel like there has to be a consensus before a decision can be made. That can be difficult. (*Park County Local Civic Leader)*

The largest input should be from the local people and what they want…because each county here has different circumstances….Even though you have a lot of similarities, each one has their own uniqueness. (*Park County Residentialist*)

I would like to feel like somebody's listening to me because I live here.…I care about it and…I want to see it still be here for my grandchildren and generations to come….God gave me this [to me] and he made me the caretaker and this is my job. I don't do it for money. I do it because this is my job. (*Park County Residentialist*)

One consequence of lengthy deliberations is that the role of government is both appreciated and decried:

> Everybody's a little leery about some [governmental] program that's going to leave an agency being married to them. So that's one fear that certainly a lot of us have. (*Park County Agriculturalist*)
>
> The ranching community has had an aversion to any zoning or control and I think that mindset has prevented a lot of these things from happening. I think that is changing but they just don't want any more regulation. (*Park County Residentialist*)
>
> I wouldn't have found out [about the new flood plain maps] if a landowner hadn't contacted me about what they had come up with. You know they didn't send those flood plain revision maps out to us. (*Park County Agriculturalist*)
>
> It is amazing [that] only one-half the county is zoned. You might buy a piece of property and create a nice place…but your neighbor could create a gravel pit. You get a lot of conflicting land use because there is no zoning. People fight [zoning] because they want freedom to do what they want with their property. (*Park County Local Civic Leader)*
>
> When something happens out there and they come and say, 'Can't you do something about it?' And we say, 'We have no regulations.' We just need to balance regulations and rights….Right now [the community is] so anti-regulation….[but] we need more effective regulation. We need rules…that have some teeth. The things that are in place…we need help enforcing. You are talking 2700 square miles, 14,000 people, and [a very few people to watch] the rivers, subdivisions, and drainages….If we didn't know people as well as we do, we would have a hard time. (*Park County Local Civic Leader)*
>
> People complain about their neighbors, and we referee….Sometimes they can get a lawyer and sue. There are not a lot of regulations, and we can't go out and wing it….We refer to the County Attorney to see if it is something we can pursue. We can't make up our own rules. We try and do the best with the rules we have…[We try to] not appear to be heavy handed, but not appear to do nothing. (*Park County Local Civic Leader)*
>
> Our old maps are terrible to use and the new maps with elevations and overlays on aerial photos are so wonderful to use. What little we have been able to use them has been very helpful….[The maps] have to be accepted by the commissioners, and then they go to DNRC…then to FEMA, and then they have to review and put them on a rate map to drive the flood insurance. Some of the meetings that are scheduled for approval are [scheduled] for 2008….It has gotten political. They have talked about moving the flood plain and it is a big financial burden on those people. (*Park County Local Civic Leader)*

> I think at some point the government is going to have to be willing to step in and help the landowners along the river. That land has value, but it has value for many different possibilities, not the least of which is wetlands. The flood plain is what lets the river spread out during these floods. I think that there is going to have to be some programs where the landowners get some compensation [if they] allow the river to go where it wants to….And it has to be in the same context as if they are raising a crop. It has to be a long term agreement [with] the landowner, be it a rancher or a farmer or someone who bought in for aesthetic purposes. They need to be compensated. I don't know any other way to do it. The local landowners…don't have the means or the money to just donate that. That is what they are being asked to do now. That isn't right. (*Park County Local Civic Leader)*

> [Our former] planner….noticed the local people don't like the local people telling them what the regulations are, but if it comes from the state or the federal government they are fine with that. They don't want a local official bossing them. They feel [the local official] could be more biased than a state or federal agency….We get it constantly….If I can say, 'I have to administer [this way]…it's from FEMA and I don't have a choice'…then they say, 'Oh, okay.' (*Park County Local Civic Leader)*

Yet, in spite of not always generating consensus and in spite of the many complications and disagreements that public forums generate, many people from Park County accept and engage public deliberation as an important right. Of late, some people are involved in the watershed groups sponsored by the Park County Conservation District, others are more generally committed:

> I'm involved in the Upper Valley Watershed, and they're trying to do some stuff with ranchers. They have education for the people that are involved in it, and yet everybody that's in that watershed are all in the same group. So everybody is welcome to come to those. They get to hear from both sides a lot of times. I think there has been a lot of good that comes out of those watershed groups. (*Park County Agriculturalist*)

> Not everybody sees things the way I do. But…it's good to have different opinions too, because that's how you get problems solved. You can't have everybody agree on everything. You need to be able to have good healthy arguments about things and hash out the details. (*Park County Residentialist*)

> The most important thing is to be proactive and not assume that problems will solve themselves. The only thing that happens with that passage of time is the two sides of the issues become more concrete in their positions and less willing to look at the common elements of interest. So if I were to talk to someone in a county that's maybe twenty years behind where we are in terms of growth…[I'd say] start from the perspective of trying to determine what values are generally

> held in common by the whole community. Work with those commonalities and keep the focus on the commonalities…It won't [necessarily] prevent the polarization, but it will certainly keep people focused on avenues to solutions that recognize commonalities. (*Park County Local Civic Leader)*
>
> [We need] some common ground where people could realize that the river is the most important....Hopefully it doesn't take something really bad to make people realize, 'Hey we need to help this river.' Usually by the time things are bad, they're really, really bad…[and] can't be helped, so hopefully it doesn't ever get to that point. (*Park County Recreationalist)*

In sum, conversations from Park County suggest that in a few short years a community can learn a lot about how the river works and about what is at stake when authorities impose rules and regulations that impede the actions of private citizens beyond the customary limits. It is obvious that such community engagements do not necessarily engender consensus opinions about the rules. Nor is the work of the community ever truly completed. New problems and evolving situations will constantly require the development of new information, new management strategies and new commitments from the people of Park County.

Springdale to Gardiner: Agricultural Interest Group Overview

Interviews were conducted with fourteen individuals representing agricultural interests, including farmers and ranchers. Participants were recruited from referrals provided by the local Conservation Districts, the Yellowstone River Conservation District Council and the Montana Office of Natural Resources Conservation Service.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Springdale to Gardiner: Agricultural Interest Group Analysis

I. Specifics of An Agricultural Perspective

A. Lifestyle and Way-of-Life

Our family likes this lifestyle. And I can keep my kids out of trouble by providing wholesome activities and a lot of good hard work for them. It's what I do. I've always farmed and ranched, and this is what I like to do. (*Park County Agriculturalist*)

The lifestyle—the view and the freedom—is what keeps me here. I've been self-employed my entire life, and I hope to always be that way. I couldn't be any other way. (*Park County Agriculturalist*)

There is a relationship that forms working with the land. You learn to love it, and it becomes part of you. It becomes part of your character. It has some very formative influences on who you are. It becomes part of your soul. I think of the legacy and the heritage. Our kids understand that formative influence on their character. This place defines who they are. (*Park County Agriculturalist*)

Part of the reason for locating here was the river. I like rural areas. I like the outdoors. And I like this area of Montana and have the means to live here. (*Park County Agriculturalist*)

Some of the people have told me, 'You are never going to win against the river,' and I think that is probably true. As an agriculturalist, I don't deny that that is going to happen. Mother Nature is cruel, tough, and hard. If I didn't do anything because I was afraid my crop would freeze or flood then nothing would get done. You gather up and do the best you can, and you might fail. She might cut you down. (*Park County Agriculturalist*)

I value the people who live here. I value the natural beauty of this area. I love the river and the recreational opportunities, less so then when I was younger. It's a nice place to raise kids. (*Park County Agriculturalist*)

B. Rural Ideals

If it weren't for the farmers and ranchers, this valley wouldn't be so beautiful. It's the river that keeps the valley beautiful because it subsidizes the farmers and ranchers by supplying the water. (*Park County Agriculturalist*)

Agriculture keeps the land out of development. For one thing, Ag is a big contributor to our economy in the state and the country. I'm real pro-Ag because I think this country is founded on natural resource based productivity: mining, timber and agriculture. (*Park County Agriculturalist*)

I think it's important to be able to continue to use the water from the Yellowstone. Our livelihood depends on our water rights from the Yellowstone River. That's a pretty important issue to me. Then I think keeping the wide open spaces is important. Because without cropland, we'd be out of business here….Instead of mowing hay, we'd be mowing lawns. (*Park County Agriculturalist*)

The river is a beautiful resource and I really value nature. I value the animals. I value the birds—we love to see the birds. But they are all impacted by people. You know, we tend to love things to death. And there's just a hell of a lot of people that have moved here and enjoy those things, but it changes—you don't find solitude on the river anymore. And that's an important word I should put in there. I value the ability to go down and be in the woods and sort of get away from the maddening crowds. (*Park County Agriculturalist*)

I don't think we should say, 'Ok, Joe, Sally, and Alice own four miles of the river so we have to let them do what they want.' No we don't. (*Park County Agriculturalist*)

On this place, I love it here. And I would never do anything to hurt it. It is my job to be a good steward. And I don't need some conservation easement to encourage that. (*Park County Agriculturalist*)

I do have an obligation, there's stewardship in ownership. You never really own anything on the river. I do believe strongly in private property rights, but in terms of ownership it's a fleeting thing, it just changes hands. (*Park County Agriculturalist*)

My sister and brother-in-law, it seems with impunity, sold that place next door. They never worked it. They always hired help. That relationship with the land can't happen unless you become physically involved in it. It is not just ownership, it is actually working it. When they sold it, it broke my father-in-law's heart. We brought him up here and he looked at those buildings and you could see the tears rolling down his face. It broke his heart. He had worked so hard all his life to give a precious gift to his children. What an insult that was. They have no soul. (*Park County Agriculturalist*)

Agriculture is such an important fundamental industry in the world for us today. There are people who talk about production agriculture as a thing of the past. What a crazy notion. I can't see how we would become more vulnerable. That weakens our security. The safety of our food supply is in jeopardy if we depend on foreign agriculture. Listen to people squawk now about foreign fuel. This is an industry that is so vital to our security that I think there needs to be public responsibility to keep it healthy rather than challenging it and making it more and more difficult for us to make money. I don't take a dime off this ranch. I am living on my retirement because I am trying to see this ranch survive. (*Park County Agriculturalist*)

C. Individual Rights are Important

I don't really feel like being told what to do by a bunch of fishing guides. The reason we're here is because we like the independence, the open space, and the freedom. (*Park County Agriculturalist*)

I think that people have to understand that private property needs to be protected. Without any property rights protection, agriculture as we know it is going to fail, big time….There are areas on the river where the river has a solid bank and no amount of high water is ever going to erode it…[In other places] I think that…people have to be first. (*Park County Agriculturalist*)

D. Water Conservation—Water Quantity

I think there are some things that could be done, not particularly to the Yellowstone, but to the tributaries of the Yellowstone to conserve water so less water would need to be taken out of the Yellowstone. We have several streams on us, [and] if we were allowed to dam up the stream to build up a reservoir…there would be less water drawn from the Yellowstone….Most of [our] water would be [drawn from] the reservoirs [that] would fill up during run-off time. (*Park County Agriculturalist*)

We need some off-stream storage. We need to preserve some of this water. There's times when this river runs [very high]. And the climate is changing, we know that. And the run-off is coming a lot quicker than it used to. It used to be the river held up until August, as it is [now] it starts to go way down in the first of May, June and July. (*Park County Agriculturalist*)

I think that we're going to…use water more intelligently. Pivots are very effective, and they don't use the amount of water that we used to use with ditches. But when we flooded these valleys with flood irrigation, that charged the aquifer and the system. There were some advantages to that and we're loosing out. (*Park County Agriculturalist*)

People don't realize how important it is to [flood irrigate]. I mean, you can figure that as water storage, too. Of course, [whatever] help [was gained is gone now] because they wanted us to…economize the uses of water [by using] sprinklers. (*Park County Agriculturalist*)

They [might] need this water for a municipality, or to put a coal-fire generator plant down here at Roundup….Every gallon of ethanol…takes two gallons of water. So the usage of water is going to change. That's going to have a big bearing on who sells out and who is forced to sell out. (*Park County Agriculturalist*)

The only thing I really want to stress is that somewhere along the line they're going to have to take steps to increase our supply of water.…When we had that oil embargo back in 1973, and you know how panicky everyone got when we didn't have a supply of oil, what would it be like if we had a lack of water to grow our own foodstuff and we have to depend on some third-world country for our foodstuff. (*Park County Agriculturalist*)

II. Agriculture's Viability in a Developing Area

A. Threats to the Viability of Agriculture and the Choice to Sell

It's becoming harder for agriculture because land is worth so much, [and] the tax values are so high, and yet the production doesn't go up. (*Park County Agriculturalist*)

Property along the Yellowstone River, in dollars and cents, is worth ten- to thirty-thousand dollars an acre. That is not an agricultural value. I have three miles of Yellowstone River frontage. It is covered with cottonwood trees and brush. The value that I put on it is that I use it in winter for cover for stock. In spring, it gives the calves some protection from spring storms. (*Park County Agriculturalist*)

The agricultural value is anywhere from $150 to maybe worth $500 to $1500 an acre [for] irrigated ground. It is amazing. We just went through an appraisal for IRS. In going through an IRS appraisal you look at a highest and best use. It isn't agriculture. (*Park County Agriculturalist*)

We've looked at our inputs, such as fertilizer and fuel going up a third or more in one year. That's a pretty big hit for a small business. We don't have anyone to pass that along to. Our prices are pretty much set. We sell at what the market offers us. And in a business where the margins are pretty slim, it makes a big impact. I don't know how long Ag will be viable. (*Park County Agriculturalist*)

We're sitting on a gold mine and starving to death. (*Park County Agriculturalist*)

There is no financial reason to ever not sell. Working seven days a week…that isn't what makes somebody's day. (*Park County Agriculturalist*)

You got grassland here that takes forty acres for one cow. It doesn't take long to realize that there's not very much money in it. Some people struggle as long as they can and then sell their property….It's just economics. (*Park County Agriculturalist*)

This land won't sustain. You can't buy land and raise cattle on it—nothing on the river bottom, unless you're grandfathered. So viable agriculture will not be what it is. There are areas further east toward, Glendive and Miles City, those are still viable areas. (*Park County Agriculturalist*)

Real estate agents, greedy real estate agents, people looking for money, are responsible [for subdividing the land]. You usually don't see the farmers selling directly for a subdivision. They will sell to someone else and [the new owner] will subdivide it. It winds up being sold to a developer. Most of the local farmers and ranchers won't subdivide. Someone else is doing that. (*Park County Agriculturalist*)

B. The Changes Associated with Development

There used to be sixty-five or more different ranches in this valley. Now there are probably fifteen, and the population along the river here has increased dramatically. (*Park County Agriculturalist*)

What is happening here, along the river, and the influx of people that are here, is what happened in Colorado one hundred years ago. And it happened in Texas two hundred years ago. That's what I think is the most precious thing about the river, there's not much of this part of the world left. Very little of it. (*Park County Agriculturalist*)

We've done some projects where people objected to what we were doing. They didn't like to see our equipment parked in their view. They didn't like the dust or the noise created by farm operations. (*Park County Agriculturalist*)

It's getting harder and harder just to move your equipment up and down the road. We've got a 70 miles-per-hour highway out here that we [use to] move a lot of equipment from one farm to another, and it's getting hard to transport equipment. It's getting harder to move cattle. It's getting to be a busy area. (*Park County Agriculturalist*)

Moving cattle on the highway…we don't do too much of that, but we help neighbors and that has noticeably become more of a problem. It used to be that people that came up would visit and slow down….[Now] we get people that get mad, and we have had some close calls. That has noticeably changed in fourteen years. Now we have a flagger in front and behind, and flashers. It has kind of become dangerous. There is more traffic than there used to be. (*Park County Agriculturalist*)

There are some silly, thoughtless things. I see little ponds and things impacting the areas. I've seen people put ponds where there's no reason to put them. It's their rights to do it, but I don't have to like it. (*Park County Agriculturalist*)

When they start subdividing, all this land that was…flood irrigated at one time, you're taking the storage capacity out of that aquifer. (*Park County Agriculturalist*)

We've become a minority anymore it seems, and it's pretty tough. We don't have near the money that these other organizations can put together, and some of these battles get kind of tough. I know that when that Task Force deal was going, there were things said….They said, 'Well, the ranchers are on the way out, deal with it.'… I guess we're not ready to hear that. (*Park County Agriculturalist*)

C. Outsiders Have Obvious Wealth and Different Values

There is a very wealthy man who lives up the valley....He called us and said anytime we are ready to sell the ranch, he had a blank check in his desk drawer. It was an insult. It was just money. They knew nothing of the heritage. Nothing of the lifestyle…You can't sell who you are. (*Park County Agriculturalist*)

Absentee owners litter the land with houses, and then they don't use them. I don't have a problem with [a new house] if it's being used, they're not using it. (*Park County Agriculturalist*)

I think with the number of outsiders moving in and buying property does change the political culture here. They have more money…[and] more time….They seem to be able to organize more readily than ranchers do. A lot of the newcomers bring their ideas with them. (*Park County Agriculturalist*)

A lot of those homes, I'd say quite a few of them, are second homes. I think that the people that live in them don't have the ties to the community and so there is, to some degree, a little resentment. I don't think it's class, it's a wealth issue. (*Park County Agriculturalist*)

As more homes spring up, we have to be careful with high powered rifles—that's a liability. We want to thin out the deer….[There are] too many [new owners that] don't allow hunting, and I've got irrigated alfalfa, so we'll have fifty, sixty deer out there. And so that is a problem. As people move onto smaller plots, how do you get control of the habitat, [the] deer and game? Some of the people…don't approve of hunting. That's a conflict. Locals, they tend to want to go everywhere and be able to hunt. (*Park County Agriculturalist*)

We're in the process of selling a little chunk of ground in Sweet Grass County….It was a good piece of grass—pasture, and all that….And the fellow that's buying it…all he's interested is how many fish are in the creek on that property. He didn't care how many cattle it would run or anything like that. (*Park County Agriculturalist*)

If you've been in a ranching family, like people who've been here a long time, you've got a different attitude about the land than [incoming people] do. A lot of them have made a lot of money someplace else. They don't want to speculate on stock anymore so they put it in the land. They're not as uptight about what's going to happen as we are….They don't have to pin-point their rights to make a living. (*Park County Agriculturalist*)

Development brings a lot of people in. [We get] more taxes, and more people on the roads, versus you used to be able to drive the roads and there was no one. (*Park County Agriculturalist*)

Agriculture is getting wiped out with more people. More people that probably like the land, but they want the city. They want everything they had in the city. (*Park County Agriculturalist*)

It's changing….even in these environments. Park High [school] and the smaller towns…[have problems with] drugs, and there's all kinds of opportunities for a kid to get lost or pulled astray. So it's changing. It's common everywhere. It's no longer sort of a small, isolated, little community. That's for sure. (*Park County Agriculturalist*)

D. Ideas About Managing Development

That's like the population growth that's going on all over the world, there's just no way to stop it. I mean we can try to slow it down, maybe control it to a certain extent. Sure it would be great if there was no more houses ever allowed, here…draw the line. But we can't do that. There's too many individual rights that you're violating when you try and do something like that. (*Park County Agriculturalist*)

Take [the] new gallery up the valley—what a beautiful addition to the valley. It's gorgeous. It's another commercial place where people can stop and bring money into the valley, but how beautifully well done. That, most certainly, is not a strip-mall. It's gorgeous. Then there's another place they just built that says commercial spaces will be for lease. It's intrusive, it looks like a big shop. It just looks like a metal building right on the highway. It doesn't blend in real well. Most places will build log home or a log cabin so it really blends in well. (*Park County Agriculturalist*)

Part of our stewardship is to make sure….I mean, let them come, let them see, but [don't ruin the valley]…..There's a rancher-gentleman in the valley…that made the statement, 'In twenty years, US Highway 89 [will] be solid strip malls.'….That's his fear. He's lived here [and] he's managed the same ranch for twenty-some years. His father managed it for thirty years prior to that. They have been in this valley for a long, long time, and that's their fear. That is their tremendous fear. (*Park County Agriculturalist*)

Stop developing the valley. You're not going to keep people out because there's plenty of homes and plenty of places here already. I'm sorry, yes, the rich are going to get it over the poor, but your poor can stay in the RV parks. Stop developing it. Leave it for everybody. (*Park County Agriculturalist*)

I think Paradise Valley, in general, is going to continue to develop. It seems to be pulling people from all over that want to own a home in a rural setting. There are a lot of subdivisions that…[are] starting to fill up. I hope that this place stays the same. In ten years [I hope] it's still growing hay and grain and cattle. I like the wide open spaces here. I'd like to see some planning done, and some thought put into the development of the area. (*Park County Agriculturalist*)

You know, that's progress, and I can understand that, [but] I don't like that. I would prefer that people held onto it and kept it in a big block of land, and used it for agriculture. But I can understand why that doesn't happen. I mean money seems to be what drives everything. (*Park County Agriculturalist*)

I think you're always going to have your contrast between people whose interest is progress, and those that want to save [the valley as it is]. It's an on-going thing. (*Park County Agriculturalist*)

Some [locals] bought [a large ranch] and do not want to develop it. They don't want to sell it. It is a group of wealthy locals, [from] within a 150-mile radius….[They] don't want to see it developed, no matter what. They came together in a conglomerate and bought it for $4.2 million just to make sure it wasn't developed. I know of two other very wealthy people in the area that were approached and [who] said, 'If you guys can't get it together and buy it, then, yes, we'll go in with you. We have to stop this development.' (*Park County Agriculturalist*)

My preference would be that there was a campground somewhere….Down there at the river bend, they can really crowd a lot of people in there…[but they keep it] so neat and clean—and when the season's over, they're gone. (*Park County Agriculturalist*)

Say someone is 18 [years-old], when they turn 30 they would love to have a summer place in Montana. Fine. They have to wait until one comes up for sale. It [should be] like wanting a real Class-A apartment in New York City. Nobody is going to build you one, you have to wait until the next one comes available, [and] there might be a two-year waiting list….Let's take the 100 homes that are [within] a ten or twenty mile distance along the river and make them really prime property because nobody else is going to build right next door….You're going to have to wait until one comes up for sale. (*Park County Agriculturalist*)

I think [we should be] educating these new people….They should do all they can to support Ag. (*Park County Agriculturalist*)

I think the Yellowstone has been improved because of the awareness of the flood plain. (*Park County Agriculturalist*)

E. Setbacks

About four or five years ago [some people] wanted to have a 500-foot setback. That got everybody's attention in a hurry. So we soon shot that one down. [With that setback] you couldn't have done any rip-rap, and you couldn't have done any stream stabilization, and you couldn't do any capital improvements unless you [had] the approval of the group. (*Park County Agriculturalist*)

People have wanted to put setbacks in place on the Yellowstone to keep development away from the Yellowstone River. I think they talked [about setback of] up to 300 feet, maybe, from the Yellowstone River. I think the setback now might be 100 feet. But that's one issue that has come up that people bristled-up a little bit over. I think the landowners themselves would probably be most content with no regulations, but people who float the river, maybe they want some regulation. (*Park County Agriculturalist*)

I feel strongly, if I'm in harm's way, it's my fault and I'll have to deal with it. If they want to pull my insurance that's fine. I have the means to survive somehow. But I think if you do live in harm's way, regardless of wherever you are, you have to be smart. (*Park County Agriculturalist*)

F. Water Rights

Your water right isn't as secure as you think it is. They're saying now a water right isn't a water right, it's a privilege. (*Park County Agriculturalist*)

We are getting a lot of new people moving in from California and New York, and they want water in the creek and don't understand at all…when you explain the water rights. (*Park County Agriculturalist*)

Down the road a ways, I think our water rights are going to be jeopardized. (*Park County Agriculturalist*)

Now they're trying to pass this bill [concerning] the government…and the 'takings.' ….What do you have if they take your water away from you? (*Park County Agriculturalist*)

G. Tourism and Its Effects

Yes, of course the summer traffic is annoying. But those people are getting to see something that they'll take back to their other world, and it will make them stronger and richer—not monetarily but in more important ways. (*Park County Agriculturalist*)

I think we should shoot our buffalo coming out of the Park with licensed hunters. People say that we [would] lose our tourism because of that. I think, 'Yeah, cool. It will make it easier to for me to haul my equipment back and forth on the highway.' (*Park County Agriculturalist*)

This is still a rural, Ag, community. But there is a group of people that think that tourism and development would be a better use for this area than agriculture. (*Park County Agriculturalist*)

H. Increased Recreation Pressures the River and Agriculturalists

I don't object to [recreation]. People enjoy the river, and I think they should. It's just [that] we love things to death….There are a lot of guides, a lot of people that want to float the river. *A River Runs Through It* made it very, very popular. It's a beautiful book, and he's a nice guy that wrote it—great guy. But I think we've seen a growth in that industry. (*Park County Agriculturalist*)

We are almost a bedroom community to Bozeman. And as fishing becomes more popular, we'll see twenty, thirty boats go past here in a day, at least. That's a lot. And fishing is [meant to help people] get away from crowds….[They] don't want to play bumper boats. (*Park County Agriculturalist*)

There are some conflicts….If [the recreationalists] respect the people who live along the river, and they don't sneak in with a rifle and shoot deer when they're not invited, we allow hunting, but we want to know who's in here. (*Park County Agriculturalist*)

III. Living with the Yellowstone River

A. The Famous Yellowstone River—A Feather in our Cap

Whenever you mention the Yellowstone River to anybody, anywhere in the country, their eyes kind of light up and they kind of perk up. Because anybody who's an outdoorsman knows about the Yellowstone River. This is one of the wildest rivers in the world, and the fishing is unbelievable. It came from the Park and it kind of reminds you of the Park, and to say that we're along the Yellowstone River that's kind of a feather in our cap. (*Park County Agriculturalist*)

It's the heart, it's the heart of the valley. To me, it's the heart of Yellowstone National Park. (*Park County Agriculturalist*)

The river is a fishermen's paradise. A lot of people fish the river. That is the main reason why it is a tourist country. (*Park County Agriculturalist*)

B. Yellowstone River is Big, Powerful, and Abundant

That river can do hell. The culvert there could blow tomorrow, and then we'd really be in trouble. (*Park County Agriculturalist*)

Well, it's what creates all life. (*Park County Agriculturalist*)

I don't encourage a good description. We don't want people to be on the Yellowstone. I don't understand why people want to own property on the banks of the Yellowstone because it is not the best place to live. It is nice to access it, but not to live on it…I went through the floods as part of the Conservation District. (*Park County Agriculturalist*)

We had a fairly decent run-off this spring, and it did eat the bank away, and it actually washed out one of our fences. We had to move our fence and put a new fence in there. It happens. (*Park County Agriculturalist*)

I'd say we've lost…about a half a section….I'll bet we've lost seven acres, at least, from that little pretty bottom area down there….probably six acres. It was only aesthetically valuable, agriculturally it didn't cost anything. (*Park County Agriculturalist*)

If it does come out of the banks, it goes onto us. It floods some of our hay meadows. So be it. We can clean up after the water goes back down. It's just…basically nature taking its course. (*Park County Agriculturalist*)

We've had what you call sheet flooding, but we were never in any trouble. That's where it comes—it doesn't cut, and it's not fast—but it spreads out. Once it gets to a certain height in the flood plain it just flows through the flood plain. And actually it gave us about two inches of new sediment, [which] cut the grass for two years from production, and then after that we really benefited from that amount of sediment. So, in a way, that's the way the system works. (*Park County Agriculturalist*)

IV. Life-forms of the River

A. Wildlife

It's a great wildlife habitat. We have a lot of fox, and just a real diverse wildlife population. There has been elk in there, [but] that's kind of rare. We'll see a moose every once in a while. There's rock-chucks, lots of birds, owls, we have a few ospreys, it's a place where bald eagles winter. They come in from the high lands, and winter along the Yellowstone. They have a nest down in there. I guess it's our little piece of paradise here. (*Park County Agriculturalist*)

Last night was hard to sleep because the elk were so vocal. We had the wolf people out the other day because we had a wolf that was down in the pastures….[The wolf] kept trying to get to road-kill…a beautiful, big, grey wolf. I mean, you can't ask for anything more. I mean, you really can't. (*Park County Agriculturalist*)

We had a gentleman drive up here one day [and it] turns out he was from Calgary, Canada. He and his partner were fishing down on the Yellowstone. They were here on vacation—he did not have his cell phone with him. They walked out to one of the islands on the river and they were fishing on that, and they happened to see an eagle on the side in the water, very distressed. Long story short, he came over here to ask us to help. We called the game warden, the game warden came down, and we finally caught the eagle. The eagle went to the Montana Raptors Center…they think [it was suffering from] lead poisoning. [The eagle] has completely recovered, and out of the kindness of their hearts they called us when they were ready to release it so we were able to be there and they released it at the same spot. That is the heart of the Yellowstone—it is. That is what it brings out in people. For that gentleman to quit his holiday enjoyment and just care….He didn't even know [what type of eagle it was]. (*Park County Agriculturalist*)

We have [about] 250 mama-cows. They spend their summers elsewhere so that we can [put up] hay. We do not run them on the mountain. There's 7,000 acres up there we could run them on, but [the ranch owner] likes to save that for the wildlife. (*Park County Agriculturalist*)

We do have wolves on this quite a bit. That's fine until they go from their wild state and get into the cattle. We've, so far, not had any problems. (*Park County Agriculturalist*)

One guy saw a couple of wolves….They didn't cause any problems. We haven't had any losses. (*Park County Agriculturalist*)

We work with a neighbor who is a hay producer and two years ago he had to fence off his haystacks….In the last four or five years we have had elk problems. Last year, over here, we had 300 head of elk in there. Once they learn where the alfalfa fields are, they come back every year. (*Park County Agriculturalist*)

B. Fishery Conservation: Mill Creek and the Cutthroat Trout

Mill Creek…has a significant drainage area. Through the Conservation District, they've developed a lot of pivots and irrigation systems…[and the farmers] have taken quite a bit of water. The fisherman and the recreationalists are upset because generally that creek will run dry in the lower end, below where the big head gate is, [in] mid-summer….Fish and Game want to restore the cutthroat fishery, and they don't know quite how to do it. They can buy the water, [but] at what cost? I don't know what they arrive at, but there's a conflict [between] recreationalists—the new second-home people that moved up there—and some of the older, traditional agricultural water users—primarily ranchers, and alfalfa [growers who]…use the water for their livelihood. I understand the need for maintaining some water flow…[and] there is another approach….That lower section is just going to run dry at certain times of the year….When…the small fish get to a certain size [upstream], they'll flush [the creek] for three or four days….Open that up and blow all those little fish into the river. But that's expensive, they have to pay for that water, and there's some concern about fire [in late summer]….Having that water is pretty nice…when you're worried about fires. (*Park County Agriculturalist*)

C. Cottonwoods

You could see all this downed cottonwood as you drove in here. Cottonwood is a sloppy tree, and we're always chopping it, and cleaning it out, and using it for firewood. Its marginal firewood, but this generation of cottonwood is starting to die and they are always self-pruning. They blow down, they snap off, they're sort of a weedy, big old tree. I love them, but they make a mess and so we have undergrowth building up right here, near us, that concerns me. Fire is always a concern in certain areas where you've got an accumulation. (*Park County Agriculturalist*)

D. Noxious Weed Management

Weed control becomes an issue…because when the floods come, we get the weed seeds [coming from the National Park]. Even fishermen who use the river on a regular basis are bringing weeds along with them from wherever they have been. I would like to see the fishermen that park on the islands for lunch go pull weeds and share in the responsibility. (*Park County Agriculturalist*)

The task force didn't want to use chemicals along the river so we end up with a weed patch. Big time. They have come out with a new chemical called Milestone, and you are supposed to be able to use it around…waterways, and it is not supposed to be harmful. It is quite expensive but it does show some promise. (*Park County Agriculturalist*)

V. Controlling the River with Rip-rap

A. Rip-rap Seems to Work in Some Places

You need to use big rocks. You don't want to put in small stuff or it will wash away. It has to be done according to soil conservation specifications and all that. Big rocks on a bank are the best way. (*Park County Agriculturalist*)

Something that will work is hard rip-rap and barbs…None of that [soft rip-rap] has ever worked on the Yellowstone. I can see where it might work on a river or stream that is not as violent. (*Park County Agriculturalist*)

I think every time man decides he's going to manage nature, he normally screws it up royally. (*Park County Agriculturalist*)

B. Rip-rap and the Potential for Shifting the Problem Elsewhere

Erosion [happens] on the banks…which is too bad….You hate to lose areas of the ranch, but [if you] put structures in the river, and try to push the river over, you effect somebody else. So it's a no-win deal, really. (*Park County Agriculturalist*)

I just think that there needs to be some careful planning….when stream bank stabilization is done to make sure that you are protecting your property but not jeopardizing someone else's. (*Park County Agriculturalist*)

Some of it was rip-rapped before we came. I know it is a controversial thing. You rip-rap here, and the water hits it and sends it across the river, and it does more damage to the guy that lives next door. You are sending the problem further down the river. I am slowly learning that…[but when] you see your own land disappearing, it is hard. (*Park County Agriculturalist*)

C. Rip-rap and Difficulties Getting Permits

They have almost shut down any bank stabilization….I should do some bank stabilization but I don't know if I have it in me to take the guff that it is going to take to get it done. It is tough to have to do battle....I just dread it. (*Park County Agriculturalist*)

All my father-in-law used to do is talk to the [Conservation District] and the Army Corps. They used to design the project for you, but they don't anymore. (*Park County Agriculturalist*)

Well, it's going to take some time and you have to kind of get ahead of the curve. If you've got a certain time schedule….you have to get started, [but] like I said, we found them very reasonable. (*Park County Agriculturalist*)

The banks have to be stabilized, and we have had to do quite a little of that since we've been here—thirty-seven years. But we've always had good cooperation from the Bureau of Army Engineers and the…Fish and Game and those [in the] conservation services. I think they've treated us fairly….We've always left some riparian area there along the river. We never graze that real hard. There's always a lot of grass and brush and things like that, and I think that's probably one reason we've always been able to get along with the Fish and Game and the Bureau of the Army of Engineers because we've always tried to leave the riparian area there next to the river. (*Park County Agriculturalist*)

We had to haul rock in, probably 85 percent [of what we used]….Maybe even more than that, maybe 90 percent. (*Park County Agriculturalist*)

We counted them. There were thirty-one different representatives from different agencies [involved in our project]….We had an engineer that should have known we had to re-apply, and he didn't even know. (*Park County Agriculturalist*)

D. Natural Techniques of Bank Stabilization

I think good riparian management is probably the major way that we keep erosion down. There is a lot of shrubs and grass. (*Park County Agriculturalist*)

They have some new things they are trying. It's a blanket thing, and they plant willow trees in it. [It is] working on small streams, but it won't work on the Yellowstone. The beavers come along and eat the willows off that. (*Park County Agriculturalist*)

People would say that in order to be environmentally sound I need to let that river come rip-roaring through my property and it will be fine in 500 years. I don't have 500 years. There is benefit to man being here. We do good things here. Man does need to manage, but he needs to manage softly. (*Park County Agriculturalist*)

Our attitude is that we'd be more than willing to move the fence ten feet than screw with the river. (*Park County Agriculturalist*)

When I was in grade school they talked about you shouldn't do things that cause erosion. Yet, here is the river running rampant and many are opposed to trying to prevent it. And for the life of me, I can't understand how allowing the banks to erode and cut away adds anything valuable to the river. All it does is add sediment. I am a little confused about that direction. (*Park County Agriculturalist*)

If there are some artificial ways that we can replicate the positive impacts of flooding, but still be able to mitigate the damage, then I'll try to implement them. (*Park County Agriculturalist*)

VI. Visions of the Future and Collective Management

A. Visions of Change

There will be more development in rural sites, homes….We're becoming a bedroom community for Bozeman almost. (*Park County Agriculturalist*)

I don't think this valley will be near as attractive if it's completely full of houses as it is now. (*Park County Agriculturalist*)

I don't think my sons will go into agriculture. This place wouldn't support them anyway. Potentially they'll sell it. I'd like to see it stay as it is, but realistically, being near the interstate…[they may sell]. The flood plain probably won't be developed because of regulations, but the upper bench land will probably have a bunch of homes sitting up there. (*Park County Agriculturalist*)

One of the reasons tourism is good here is because of the way the land is. People want to see the wild, wide open spaces. I don't know that they'll want to come here to see the river flowing through a big development. (*Park County Agriculturalist*)

I think there's a movement toward eliminating any kind of activity on those flood plain areas. (*Park County Agriculturalist*)

It probably never will get balanced. It will be majority rules. The property along the river is eventually going to lose. (*Park County Agriculturalist*)

B. Management Priorities

There needs to be a way to keep agriculture viable and keep the ranchers paying fair taxes. You can't pay taxes based on subdivision values on farmland for very long – you'll go broke. (*Park County Agriculturalist*)

There's a subdivision right next to us, and I guess if the money is important to you, then you know [what] to do….But there's wide open space, which is kind of what makes Montana as far as I'm concerned. I think that has some value to it, too. There's a lot of this open space, that's still open, that ought to be kept open. (*Park County Agriculturalist*)

The watershed group has a purpose….As we try to encompass the entire valley maybe some of this can be controlled…You have to look at the whole. When you start breaking it into pieces, you are like these tunnel-vision groups that don't want to look at the big picture and how an area can survive. (*Park County Agriculturalist*)

I think the most important thing to me is to protect the river from pollutants, from fouling it in any way. I think a magnificent job has been done about the fishing [with the] catch and release [rules]….The only problem that I'm aware of is the lead with the eagles. (*Park County Agriculturalist*)

Somebody has to come to the forefront and…we have to start providing ourselves with some water….Climatic changes, population growth, and industry are coming, and we will need more water. (*Park County Agriculturalist*)

So there's a lot of concern about fires. I worry about it. (*Park County Agriculturalist*)

We actually have a water right to 750 inches off the Yellowstone, [but] rather than withdraw the water directly from the Yellowstone, we actually take it out of the sumps [that draw] from the groundwater. Hopefully, [by not taking water from the river directly,] it sustains the fish in the Yellowstone. I would like to see other ranchers do that, especially during spawning seasons. It would save a lot of work of having to maintain that ditch every year. (*Park County Agriculturalist*)

In the cattle business today, a good year is a break-even year. With those narrow margins, you are probably going to be buying food and clothes for the family rather than putting money into environmental projects. There is not a rancher I know that wouldn't do it if he had the money to do it. If environmental sensitivity is important to the public, then maybe the public needs to help to support those programs financially….I don't know how you show people that the margins aren't there. (*Park County Agriculturalist*)

We [were recognized because] we preserve [acreage in the mountains] for cattle, [and] also it's preserved for wildlife. The award system is called Undaunted Stewardship. It is an exciting program that began in 2002. There have been over eighty ranchers that have been awarded for environmentally sensitive practices. (*Park County Agriculturalist*)

C. Government and their Management Techniques are Questioned

I don't like legislation because it seems to be arbitrary. I don't see any flexibility, either you do or you don't. It's like this house. We were grandfathered in, and we're living where they lived for almost a hundred years, and yet there are a lot of people who object to our living over here. (*Park County Agriculturalist*)

Everybody's a little leery about some [governmental] program that's going to leave an agency being married to them. So that's one fear that certainly a lot of us have. (*Park County Agriculturalist*)

When [my project was] washed [away], I was pretty upset because I put in a lot of work and it cost a terrible amount of money. Along in June one of the agency personnel showed up and said, 'How did that project work out?' I came apart. He said, 'I could have told you that wouldn't work.' I said, 'Why didn't you?' He said [the Army Corps of Engineers] wouldn't let him talk. There was an, 'agency difference of opinion.' (*Park County Agriculturalist*)

[During] the last bank stabilization project…it got kind of tough, and [there were] a lot of inspections, and it raises the expense, and you have to go for public review. I don't want to be a public person. All I wanted to do is ranch and do my thing. I had no idea I would become a public figure and be in the New York Times. (*Park County Agriculturalist*)

It's the people's river. So, that is what got me on the Task Force in the first place….If my dog goes over on the neighbor's, and causes difficulty, it is my responsibility. If that is the people's river, it is their responsibility to keep it within the bounds. (*Park County Agriculturalist*)

D. The Governor's Upper Yellowstone River Task Force

The Yellowstone River Task Force was formed because the local people here…are pretty recreational-minded. Fishing's a pretty big deal here in Livingston. They were trying to figure out, after the flood, what was the cause of the loss of the fish… That's how it all started, and then of course there was a lot of sentiment about building next to the bank, and there was a house that was too tall here, and they wanted to change the channels and stuff like that. And they were just trying to get a hold on the thing. They were just trying to prevent some of the things that have happened, which is not all bad. (*Park County Agriculturalist*)

I abandoned it when…they started talking about the morphology of the cottonwood trees and all that baloney, which I consider baloney, and maybe it isn't, but anyway. Then when the fish numbers came back, and it had nothing to do with the stream bank stabilization project? Hell….There was an agenda for a while that was going to blame the ranch for about everything. (*Park County Agriculturalist*)

A lot of the older, rural ranchers thought the make up of that Task Force was a stacked deck. There was a feeling that those with agricultural interests were not as well represented as they could be. I sat in on a few meetings. I wasn't totally comfortable with the make up of it. (*Park County Agriculturalist*)

A lot of the very active people on the Task Force probably have a different view of private property and things than I do. Though it wasn't expressed, I felt that a lot of the people would like to see tighter regulations….[I have a] more lassie-faire view. I understand the need for intelligent regulation, but I don't want to see government grow to the extent that we probably couldn't build here [on our property] if we tore down the old house. (*Park County Agriculturalist*)

I think the majority of the people would like to see more legislation or regulation along the river flood plain area. And I think that in this study the state conducted…they put a hell of a lot of land in the floodway and the flood plain. It encompassed a huge area, and I think that their numbers were jaded. They used a method of finding elevations which I think was sort of arbitrary. I don't think it was scientific and accurate. I mean, we should be underneath the Yellowstone according to their maps, [but] we've never had water flowing through here. (*Park County Agriculturalist*)

I know they did a lot of surveying, and they tried to maybe understand how this river flows, and what happens when the water gets high. I don't really know what its goal was, or what it accomplished, if anything. (*Park County Agriculturalist*)

I wouldn't have found out [about the new flood plain maps] if a landowner hadn't contacted me about what they had come up with. You know they didn't send those flood plain revision maps out to us. (*Park County Agriculturalist*)

The time I spent on the Task Force, I enjoyed. Some [of the information] was way over my head and my education level. I have a whole stack of material, and I don't think there is a human being alive that could take that stack and make sense of it….They were all experts in their field, but we didn't have a person that took that information and put it into any kind of program…. It just wasn't gathered up…I don't know if there was anybody that could do it… When I listened to all the experts…nobody put the thing together, and they still haven't. (*Park County Agriculturalist*)

E. A Promising Gathering in The Upper Yellowstone Valley Watershed

The Upper Yellowstone Watershed Basin group, they're amazing really. Because they handle all issues. (*Park County Agriculturalist*)

I'm involved in the Upper Valley Watershed, and they're trying to do some stuff with ranchers. They have education for the people that are involved in it, and yet everybody that's in that watershed are all in the same group. So everybody is welcome to come to those. They get to hear from both sides a lot of times. I think there has been a lot of good that comes out of those watershed groups. (*Park County Agriculturalist*)

They get together, brainstorm, and come up with ideas for fighting weeds, and conserving water, and helping the fish in the streams. They get together, and they try to bring down grant money from the government and stuff like that. And they're effective. (*Park County Agriculturalist*)

We were involved in a pretty good-sized range fire and the watershed group worked to get some funds for fencing and range rehabilitation. [The group] has been pretty active….[and it includes] twenty-acre and ten-acre people. We have a weed fair, and they get educated on what weeds are bad, and what works, and what doesn't work. (*Park County Agriculturalist*)

F. Other Local Non-Profit Organizations

The Greater Yellowstone Coalition, they're looking over your shoulder all the time trying to find something the matter with the rancher or the farmer. That's my sentiment, exactly. (*Park County Agriculturalist*)

Trout Unlimited…all these green organizations, you know they're all looking down your shoulder. You know that. (*Park County Agriculturalist*)

I was surprised that there wasn't ranchers [at the water symposium], because it's a ranching community. The sub-dividers were there, and the planner that was having all those problems was there. (*Park County Agriculturalist*)

We have numerous environmental organizations in the county that are very active. I don't think they have a total grasp on what they are trying to do.…DNRC came in with a conservation program that was totally unrealistic and so it failed. It might have worked down around Eastern Montana, but it was so far out of kilter here. They didn't believe what the value of the land was here….I think they had a valuation of $700 or $800 an acre. I knew of some property that sold at…$10,000 per acre….From here to Sweet Grass County and [their program] just wasn't realistic….It was just too confining. (*Park County Agriculturalist*)

G. Possible Partnerships

What is encouraging to me is that a lot of environmental groups also recognize the value of having ranches and farms because they guarantee open space. I think they are more willing to listen to us, [but] they still have more power, more influence, and more dollars. (*Park County Agriculturalist*)

It's just part of life around here….There's so much wildlife….You have to be not-too involved, but you have to be in communication with [wildlife organizations and authorities]. You have to be available to them so that they are available to you when you need it. (*Park County Agriculturalist*)

It looks to me like the agricultural lifestyle is going by the wayside. This community was an agricultural community at one time, and I think it's migrating the river, to a more recreational community. I think and feel there is some miscommunication between what the ranchers have to offer in this field of recreation. There are a lot of ranchers involved in recreation as well, and it just seems to me like there needs to be some education as to what everyone can offer. So it can work for everyone. (*Park County Agriculturalist*)

There's also a pretty big sentiment [among the newcomers] to keep the ranchers…to keep it open….Some of these people…buy a big ranch, and they don't want a big subdivision next to them. Some of them are [saying], 'Well, let's protect this guy because we want to protect our view of the scenery.'…So, we've got to the point now where a lot of them will help us, especially up in the Shields Valley. (*Park County Agriculturalist*)

I think that we need to have a voice so that people understand why we're doing what we're doing. (*Park County Agriculturalist*)

I think there are some people that want to see the agriculture survive just for the benefits for wildlife. They could see the handwriting on the wall, that there are going to be more and more homes built, and habitat for wildlife would become a premium. (*Park County Agriculturalist*)

I think in the long run it would be better to support Ag, even from [the newcomer’s] standpoint. Ag is what the people like about the valley now. (*Park County Agriculturalist*)

Springdale to Gardiner:
Local Civic Leaders Overview

Interviews were conducted with eight individuals holding civic leadership positions, including city commission members, county commissioners, flood plain managers, and city/county planners. Participants were identified through public records.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Springdale to Gardiner: Local Civic Leaders Analysis

I. Park County is Growing and Changing

A. The Allure of Paradise Valley

It is the last undammed river in the U.S. and that has a certain allure. (*Park County Local Civic Leader)*

It is easy to describe because people have a picture of what Yellowstone Park is even if they have never been there. I describe it as an extension of Yellowstone [Park]. You attach things like the fishing culture, the hiking, the outdoor mountain recreation. I don't think anyone gets a sense until they have been there. (*Park County Local Civic Leader)*

It is a place of unbelievable beauty….Tremendous beauty….[This area] is very pristine and clean, and wonderful air and light, and very clean compared to other parts of the country. Fantastic wildlife. The weather changes all the time. It is entertaining just to watch the weather. It is really beautiful. I don't tell other people that. I just tell them I enjoy it and leave it at that. No sense advertising too much. (*Park County Local Civic Leader)*

[People are drawn to the river for]…the surrounding beauty and the river itself. People like to be on it and look at it. They like to fish it. They like to sit and contemplate life. (*Park County Local Civic Leader)*

[The Yellowstone River] is the lifeblood as far as Ag and recreation goes. It is what draws people here….It is the main artery through Paradise Valley for sure. (*Park County Local Civic Leader)*

[The Yellowstone River] is an integral part of a greater thing…the Absaroka Mountain Range…Yellowstone Park itself and the massive volcano that Yellowstone Park is. All of that taken together is what makes this area what it is. (*Park County Local Civic Leader)*

I don't think there is a whole lot you can do [about population growth]. Unless you can build a wall around western Montana….[Or maybe] if they would just stop them at Billings and not let them come this way. I would sacrifice Billings….[Or] if they would just ban all movies like *A River Runs Through It*. We had more damn fly fishermen show up after that movie came out. (*Park County Local Civic Leader)*

It is also one of the few western rivers, or eastern rivers either for that matter, that has spring water year round coming from those huge underground springs under Yellowstone

Lake….[And] there are spring creeks that run into it, too. (*Park County Local Civic Leader)*

I have floated all the way down the river. It is amazing the diversity. The birds are incredible. You see warm water and cold water fish. I went clear to North Dakota. I went around the diversion dams. I watched them catch the paddlefish. The people that are into it, are into it….I love that country down there. I could move down there. East of Billings down is fabulous country. It is a neat float. You have these stretches that are like floating on a lake. There are not very many runs [with rapids]. Here you have one every quarter mile or so. There you have stretches that go for a mile. It is the only way to see the river. (*Park County Local Civic Leader)*

It's a picturesque valley….It's obviously…a great place to fish and a great place to just view…This fall is especially colorful. It doesn't always happen this way, sometimes it freezes and the leaves just fall off….I'm not a big fisherman, but it is kind of nice to be within three or four miles of a blue ribbon trout stream. (*Park County Local Civic Leader)*

B. The Transition from Agriculture to Recreation—A Rich Man's Disneyland

It's changing….There is a lot more houses than there used to be….It is just a reflection of the whole transition from an agricultural based economy…to a tourist and recreation area. (*Park County Local Civic Leader)*

We have CEO's from big companies…that fly in with their jets and helicopters. They will spend a day, or a few days, and then they are out of here. The rest of the year we are taking care of it. We worry about weeds and roads…[while] they have one little ranch manager whose authority is limited to keeping people out….We don't want to be a rich man's Disneyland. They come, they go….We are trying to maintain something and still be progressive. (*Park County Local Civic Leader)*

The land prices are high, at least agricultural lands. It's being influenced by recreational ranch buyers. (*Park County Local Civic Leader)*

We have seen such a change as far as industry and development. We used to be a logging [community]. We used to have a railroad going through here. Those are just about defunct in this area. We have a lot of people that have moved here recently and a lot of natives had to move out although the numbers may not show that in population. We do have a lot of new people with new ideas. (*Park County Local Civic Leader)*

When I was a kid, agriculture, and particularly livestock, was far and away what everybody was engaged in. They were all working farms and ranches. Recreation was interesting, but it was way down there [in terms of economic importance]. Now everybody that has any land out there has either sold it or is waiting to sell it. [There is] hardly any livestock….A lot of ranches exist in name, and maybe in area, but they are purchased by absentee owners or part-timers, and they don't have any interest in livestock. It has been a whole different slant on the vegetative and ecological part….The farm ground is worth so much…they can't afford to not sell. (*Park County Local Civic Leader)*

I think it's a more diverse economy than people realize. I think there's the perception that we're a tourism based economy, and we are to a point and in a sense, but it's not the typical t-shirt and motel curve. A lot of it's based on…guided fly fishing and a lot of outfitting….It's a fairly diversified economy based on manufacturing, commercial, motel, certain products…and agriculture, although it's a very, very small part…..It's very eclectic. We have a lot of artists, writers, musicians, and a lot of creative folks. And we have a fairly high seasonal element of residences, although…we're starting to see more people that are living here full-time. That's more true of the town than it is of the valley. The valley still has a very large seasonal component to residents. (*Park County Local Civic Leader)*

Livingston is going to be more economically diverse ten years from now. Not quite so heavily dependent on tourism for economic livelihood….[I also] I think Livingston will be someplace that continues to place a high emphasis on quality of life. By that I mean recreational programs, homegrown restaurants, a strong downtown, and all those types of things. We don't have a diverse economy right now. We are developing quality of life issues. (*Park County Local Civic Leader)*

When I was growing up, that whole valley was agriculture. You had people raising cattle, raising pigs and sheep. They brought all that to town and sold it in town. They brought their crops in. They supported the local businesses in town. We had clothing stores. We had grocery stores on about every block. The people were in here buying machinery. Everything is changed. Now we have 22 art galleries. You can't buy a pair of shoes or a white shirt in this town….All of that money is going out of town. We had a Penney's and a Montgomery Wards, we had two men's stores and two or three ladies stores…above and beyond Penney's and Hennessey's and The Bon. (*Park County Local Civic Leader)*

[In the past] everybody knew everybody. Now you are lucky if you go downtown and know anybody. We used to have cohesiveness and support for sports and things like the county fair. Now, with this new breed of people, they want galleries. They want lounges, not little hometown bars. They want classy eating establishments, not hometown cafes. They expect services like where they came from and we are not equipped to handle it. There is a lot of misinterpretation of expectations. This used to be an eight-to-five community. There were ten or fifteen bars. People went downtown all nights of the week. Now you go downtown at 10:30 and it is all rolled up. The events that you used to look forward to, like the rodeo and the fair…have all been diluted and changed. The fair is barely hanging on. The new rancher doesn't have four or five kids in 4-H. They are flying in and out, and their kids are going to private schools….The base of the community has changed. You don't have third and fourth generation families. (*Park County Local Civic Leader)*

There is a certain attachment to this land…The other thing is the feeling of community…although that is waning. I don't know many of my neighbors anymore. (*Park County Local Civic Leader)*

No one knows their neighbor is anymore. It has lost the cohesiveness. (*Park County Local Civic Leader)*

When I first moved here I enjoyed the culture. It was very unique to this part of the world. It was a working-person's town, the blue-collar worker. It was a tightly knit community. It had its definite own culture….That is going away rapidly right now. (*Park County Local Civic Leader)*

It's a conservation-oriented Commission who is faced with some very big decisions. We just looked at another potential development east of the river….Between that and another development across the highway, those two developments will double the footprint of Livingston, not necessarily in terms of population—it would add another about 2000 people—[but] the spatial foot print would double. (*Park County Local Civic Leader)*

C. Wide Open Spaces Aren't Wide Open Anymore

People come out to Montana and they are enthralled by the views and the attitudes of the people and….They settle in here and they want to have it all, but by some of their actions they are responsible for destroying the things that they admire….They want their big castle back in the trees, or up on a ridge, or right next to the river. They have destroyed what made it beautiful….The wide open spaces aren't wide open anymore. (*Park County Local Civic Leader)*

You see the new people that are decked out in waders and a $700 fly rod and their $5000 boat….The locals go out with their old bamboo rod in their tennis shoes….The local guy gets upset when [the new guys] pull in…to [the local guy's] fishing hole. And the [new] guy gets upset when [the local guy] throws rocks….These things go on every day. (*Park County Local Civic Leader)*

In the last 20 years it has changed so much….I live on the west side of the valley and…when I was a kid, growing up, if you had a yard light you were lucky. You would look across the valley and it was black. If you go in that valley now it looks like suburbia—it is just incredible the number of lights. For the most part it is concentrated very near the river which puts more pressure on the river. (*Park County Local Civic Leader)*

When I first was growing up here, you could drive to a high point in the valley at night and you could look down and say there is Feldman's ranch over there, there is this ranch and that ranch. Now it is awash with lights. (*Park County Local Civic Leader)*

I look for more people. We have a beautiful way of life here, and we have everything…and we aren't hidden or obscure anymore. They came to Aspen and Jackson

Hole. They came to Whitefish, Big Sky, and they will be here. They will come and develop it. (*Park County Local Civic Leader)*

I don't want any more [people] to come. (*Park County Local Civic Leader)*

We are in kind of a boom and we are becoming a bedroom community for Bozeman. These people are used to driving hours in five lane traffic, with solid traffic. It isn't a big deal for them to drive 20 minutes with beautiful scenery. (*Park County Local Civic Leader)*

Twenty years ago, a lot of ranches were saved by the ability to sell ten acres to some guy from Florida….Now the cost of splitting-off ten acres is pretty major so you're going to see developers come in here and buy whole ranches and subdivide them….A developer…has to spend $200,000 to just get it ready for marketing and the typical rancher [doesn't have the money]….On the other hand, there's the guy that can come in here and buy a ranch and has the money to run the ranch with long term investment in mind. It'll be either one of those because the land values have been [increasing at] 15 to 20 percent in a year, which is way better than the stock market. So it's a good investment. [The new ranches vary in size] from 160 to10,000 acres….Some new ranches…cluster housing and then [create a] homeowner group….They still call it a ranch, yeah. [They are not the people] with five-million dollars….[who] want to buy an….8,000-acre ranch….Typically [they] want to put a buffer around themselves. (*Park County Local Civic Leader)*

Ag lands contribute to the beauty of the area, the open space of the area….I like the conservation easements....The conservation easements are controversial, but I see them as protecting us from developers. Do we want open space or do we want houses? And the other side of that is, …if you see the beauty of the Paradise Valley, a lot of the beauty is [in] the open space the ranchers are protecting….Which people don't even see, especially environmental groups, which really aggravate me. That's why you have wildlife on those fields and birds. If you had houses there, you're going to have a groomed lawn and too many horses. (*Park County Local Civic Leader)*

D. A Crowded River, But Let's Not Protect it to Death

I'm expecting to see more recreational ranches more houses on the river, more houses in the mountains….more of the high income, non-resident, second home people that don't rely on this county to provide their income….The people that can afford to have a second home can afford more recreational activities. They tend to use the recreation harder than what was done 20 years ago when the majority of the land was owned by Ag people. (*Park County Local Civic Leader)*

A future issue is how much traffic that river can stand. When I was a kid we never thought much about the river as far as floating it. Nobody even thought about it until the '70's….[Some of us] floated it in inner-tubes. There wasn't any guides, now you have hundreds of them. (*Park County Local Civic Leader)*

It used to be you put your boat in the river, and you would see two or three boats all day. Now it is bumper boats. I used to float it twice a week, at least, and now I do it twice a summer, at most….Now there are fifteen cars at every access and they are all out-of-county plates. They come to take care of the fishing for us. (*Park County Local Civic Leader)*

I won't float [above Livingston]…because the etiquette of a lot of people is not very good. If you are standing there fishing they will run you over with a boat. (*Park County Local Civic Leader)*

[Fish, Wildlife and Parks has] done less than a stellar job of controlling people….Those fishing accesses are typically acquired [where there is] private land on both sides. The fishermen tend to walk up the river, which is their legal right if they stay below the high water mark, but what is the high water mark? Is it the 100-year flood or the 500-year flood, or the typical high water mark in an average year? So you have landowner-fisherman conflicts. (*Park County Local Civic Leader)*

You have a lot of complaints on access sites that aren't well kept….People pull in and have a campfire, or walk their dogs to take care of nature's call….Some have restrooms, some don't. You get a lot of complaints of people going to the bathroom along the side of the river. (*Park County Local Civic Leader)*

It seems to me like Fish and Game could be a little more landowner-friendly by putting up outhouses….You see these guys going in the bushes….And then the dogs, there's a lot of dogs on those boats, and [when they pull off onto the] bank, the dog runs all over. And they wouldn't tolerate that if you stopped on their front lawn and turned your dog loose….They've got to be more cognizant of courtesy, and the guides may be the worst. To me the typical guide doesn't care about the river, he doesn't….We've got islands on the river that are full of knapweed, and some guides will pull some weeds here and there and fiddle around, but the other guys just sit in their boat and wait for their client to get tired of fishing. They're goal is to get their 300 bucks or 400 bucks and go. (*Park County Local Civic Leader)*

You're trying to graze cattle along the river and some fisherman is out there whooping and hollering—the conflicts are there. And then the boaters, you consistently see boaters, floaters. (*Park County Local Civic Leader)*

It isn't that we have to change it or protect it to death. We need to maintain it and respect it. I hate to say it, but the usage is going to have to be limited. You can't just send 200 boats a day down that river. There has to come a point, like with the Smith River, it will have to be limited or on a permit basis….You will have to be a resident, and they will give out so many non-resident permits….I don't know what the answer is, but we have to do something to change or we can forget it. (*Park County Local Civic Leader)*

II. Resource Concerns

A. Fisheries and the Ecosystem

[As fishers] we used to follow the Salmon Fly hatches from…Laurel to here. Now you can't find any [hatches] here….They are real sporadic until Yankee Jim Canyon. I don't know if it is pesticides or traffic or what. You don't have the aquatic insects that you used to. (*Park County Local Civic Leader)*

With regard to pesticides, there is very little agricultural activity up there. There are a few that spray alfalfa, but very few. They spray some for bud worm on the mountains….I always thought the fires in Yellowstone might have had something to do with the insects, too. I don't know. When I was a kid there were billions of them. Now you are lucky to see one. There are still some from Carbella up…once in awhile….You still get the Mayfly and the Cadis Fly. I thought it was the railroad for awhile but I saw them disappear up further. (*Park County Local Civic Leader)*

I worry about is all the catch and release. They say, 'Oh, it doesn't hurt the fish.' I don't believe that for a minute. You don't put a barb through an animal's mouth and…drag it through the water. I don't believe for a minute it doesn't hurt the fish. The fact that they might come in and unload something from their tackle box that comes from a different area that might be a disease that you are entering into the ecosystem. And the weeds. There are invasive species of plants and animals that might get in the water. You worry about the biological stuff that might go on. (*Park County Local Civic Leader)*

From a fishery point of view [we must] maintain the quality and quantity of the water….This section of the river is heavily impacted by the National Park, of which we have no control over. The Park Service continually says, 'We aren't a ranch and we shouldn't manage our wildlife like a rancher manages cows.' However, buffalo and cows eat the same thing. And it concerns me when people get all excited about saving the buffalo when in reality they don't understand the long term impact that the buffalo, or the elk, are having on the range grass ecosystem up there. (*Park County Local Civic Leader)*

My biggest concern is if this drought keeps up….When you don't have a drought, the Yellowstone has tremendous flushing systems. There is a tremendous amount of water every year that we haven't been having lately. (*Park County Local Civic Leader)*

The Governor's Task Force…did focus a lot of attention on the riparian zones…[They brought attention to questions such as]…What are the alternatives of grazing management? And, what are the implications for riparian zones? What are the effects that riparian zones have on avian productivity?...[On] diversity and preservation of fish habitat?....There is more public awareness…than there was say ten years ago. There's an awareness that a lot of what we've done to the river is to diminish the productivity of the riparian zones. (*Park County Local Civic Leader)*

We haven't seen the leafy spurge infestation that some parts of the state to the west have, but we do have it here. (*Park County Local Civic Leader)*

[Set-backs can function as] a public safety component, and there's also a river health component. You don't want to be in situation where you see…concrete sides and sedimentation runoffs in the river? So far, this river system has been fairly resilient….there is a fair amount of seasonal rehabilitation that the river does for itself, but that's limited in terms of capability, and it's hard to know what the limits are without bumping up against them.

The Governor has proposed spending a sack load of money on new public access. What is typically not in those acquisition dollars is maintenance dollars. And Fish, Wildlife and Parks has always been short of maintenance dollars. It's easy for them to get federal money or grant money to buy land, but they don't take care of the weeds, they don't take care of the trees, they don't take care of the whole ecosystem, if you want to talk about that….I continually say that the tree-huggers, or whatever you want to call them, don't give enough credit to private landowners…They'd like to see the whole valley owned by the government, but the government can't take care of what they've got. (*Park County Local Civic Leader)*

B. Agricultural Uses and Practices

We used to drill nitrogen every year [as fertilizer]. I haven't seen anyone doing that….There is some pretty shocking things about nitrogen….If you have a hard rain it goes down and it sits down at four feet. There is an unbelievable amount of nitrogen just sitting there. There are no plants to absorb it [when it is that deep]. (*Park County Local Civic Leader)*

The river is obviously a major source of irrigation water….There's several operations that use the river to supplement their ranching income….Agricultural producers…divert water out of the river at a relatively low cost and use the water to produce crops. (*Park County Local Civic Leader)*

People come in and buy a ranch and they have the choice of…letting the property sit idle, employing the use of a ranch manager, or leasing it out to a neighbor. Typically those [new owners] are…profit motivated so they don't like it to sit idle. They want to generate some income so typically they either employ a ranch manager or lease it out….[Their choice can depend on] who they meet. If their realtor happens to introduce them to a neighbor and they build a trust, then it will be leased. If the realtor happens to suggest a ranch manager then it will be managed. A lot depends on the size [of the ranch], but even [with] the small size [ranch]…a buyer will employ a manager so he can have control….verses [the owner who says] 'I just want to show up and know the place is relatively safe.' (*Park County Local Civic Leader)*

C. Drought—A Semi-Arid Place Pushing Arid

If you go by average annual rainfall in most of Montana, and you compare that to what constitutes the definition of desert, this place should look like the badlands of Nevada. But it doesn't, and the water in that river is why. (*Park County Local Civic Leader)*

We used to be semi-arid and now we are pushing arid. We used to get 17 inches [annually] but our average is way down….We have had eight inches this year so far [October]. (*Park County Local Civic Leader)*

We're going to see more de-watering because of climate change. There's a lot of irrigation in the valley….As agricultural land is being converted to residential subdivision development [it will] probably will create fewer demands on the river itself, [but] probably more demands on groundwater, which will impact the river in a secondary way. (*Park County Local Civic Leader)*

D. Water Rights and Impacts on Neighbors

The more people that you have moving in, the more problems you have with water rights and underground water. There has been a tremendous amount of water identified in parts of the valley. If you put a subdivision, here, you could drain the guys down below you….For the most part, the west side of the valley has a problem with water. On the west side of the river there are definitely places where there are problems finding water. On the east side there is a huge aquifer up against the mountains. They figure there are 800 feet of gravels there that store water. (*Park County Local Civic Leader)*

[We deal with] subdivisions that are on the Yellowstone and water quality issues. The sanitarian [is in charge of] permitting septic systems….[The permits] have to be looked at and signed off by the DEQ and our local sanitarian. (*Park County Local Civic Leader)*

It is amazing [that] only one-half the county is zoned. You might buy a piece of property and create a nice place…but your neighbor could create a gravel pit. You get a lot of conflicting land use because there is no zoning. People fight [zoning] because they want freedom to do what they want with their property. (*Park County Local Civic Leader)*

People complain about their neighbors, and we referee….Sometimes they can get a lawyer and sue. There are not a lot of regulations, and we can't go out and wing it….We refer to the County Attorney to see if it is something we can pursue. We can't make up our own rules. We try and do the best with the rules we have…[We try to] not appear to be heavy handed, but not appear to do nothing. (*Park County Local Civic Leader)*

III. Dealing With A Growing Community

A. Problems with an Undefined Flood Plain

We will listen…and advise….We look at hydrology, [to see] if it is…in a hazard area. We have regulations about altering the flood flow or armoring the banks or putting fill in. We look at all these things. The best thing we can tell them is, 'If you get near the river, you will get your feet wet.' (*Park County Local Civic Leader)*

The floodwall that we have is supposedly at risk because it has trees growing in it. It has all kinds of mitigation problems. At the same time, since it was built…the dike has not given way. [The dike] doesn't [pass inspection] in terms of 100-year flood protection, but it has withstood two 100-year floods in the past decade. So you look at it and say, 'What is up with that? (*Park County Local Civic Leader)*

We have flood plain issues that are dealt with on a continuing basis….They are actually completing a study in the valley trying to re-establish the actual flood plain. It has been fairly controversial….[One set of designations affected] a lot more land area than what they had anticipated….The elevations weren't right and so it kicked a lot [of property]…into the flood plain and….nobody really wants to be in the flood plain very bad because you can't do any building or anything….On the flip-side, [an area] above Emigrant was in the flood plain [before] and when they redid [the designation] it was out of the flood plain….So, which one do you go by…..Trying to get flood insurance is a problem….They used the wrong formula…[but] they haven't really come back yet with anything new….The DEQ is involved, and the Corps, and FEMA as an insurance part….The interesting thing is the Corps of Engineers and the Montana State definitions of the flood plain are different….The boundaries…aren't the same….We don't really know [when they will make the final determinations]. It is still pending. I would guess within the next two to four years….Not having a flood plain [defined]…we have no idea what to expect from year to year, especially since we have been in a seven- to nine-year drought in this area. Water flows are much lower than normal and we don't have the flows like we used to have in the '70's and '80's. In '96 and '97 there were back-to-back flood years. That was a 100-year and a 500-year flood….The biggest issue is the flood issue not being resolved. (*Park County Local Civic Leader)*

The Corps of Engineers is determining the integrity of the levy. We have a levy that is questionable at best….[The levy] withstood two back-to-back 100-year floods, [but] they still question whether the integrity is there. If they cannot establish and guarantee the levy, it changes this whole end of town….[it] puts the whole end of town in a flood plain. There are a lot of houses involved. You can't build or rebuild in the flood plain. (*Park County Local Civic Leader)*

Our old maps are terrible to use and the new maps with elevations and overlays on aerial photos are so wonderful to use. What little we have been able to use them has been very helpful….[The maps] have to be accepted by the commissioners, and then they go to DNRC…then to FEMA, and then they have to review and put them on a rate map to drive the flood insurance. Some of the meetings that are scheduled for approval are [scheduled] for 2008….It has gotten political. They have talked about moving the flood plain and it is a big financial burden on those people. (*Park County Local Civic Leader)*

With respect to the river, I am not panicked about the river in the next ten years. I feel pretty good about where we are going with the Corps of Engineer's works and that they will come up with some measures that will prevent big floods. I have also lived around rivers enough to know that sometimes a river will just jump. Unless you have 14-foot flood retaining walls, there may come a time…despite the best efforts…[when the river] will jump. That is somewhat incumbent on living by a river. I certainly realize it is something that we may have to go through. (*Park County Local Civic Leader)*

The City Commission's involvement in river issues is situational rather than long-term or programmatic. I guess our involvement with river issues is somewhat reactive because we get involved if there are problems, like the '96-'97 floods. (*Park County Local Civic Leader)*

I'm really hoping we get something in the way of creative solutions, something beyond the floodwall. I think the floodwall was the reactive solution to the situation—it's sort of a 1950's solution. And we know better now, we know more about rivers…[and] I don't think the existing levy gives much in the way of real flood protection. I think we're going to have to have some kind of engineering solution….In a perfect world [the solution will] involve some kind of service step-back, designated floodway, and flood plain area, versus trying to build a structure that would require a fair amount of maintenance on the City's part, and [that would] also be fairly destructive of the resources we have in terms of recreation…trails [and] amenities along the river. (*Park County Local Civic Leader)*

B. The Value of the Flood Plain and a Meandering River—Who Should Pay

I think at some point the government is going to have to be willing to step in and help the landowners along the river. That land has value, but it has value for many different possibilities, not the least of which is wetlands. The flood plain is what lets the river spread out during these floods. I think that there is going to have to be some programs where the landowners get some compensation [if they] allow the river to go where it wants to….And it has to be in the same context as if they are raising a crop. It has to be a long term agreement [with] the landowner, be it a rancher or a farmer or someone who bought in for aesthetic purposes. They need to be compensated. I don't know any other way to do it. The local landowners…don't have the means or the money to just donate that. That is what they are being asked to do now. That isn't right. (*Park County Local Civic Leader)*

The governor ordered a river study. One of our former commissioners was a member of that task group….They spent six years on it….They came out with a stack of stuff that deep….They talk about protecting this resource….They didn't want to armor banks and stuff like that. They want the Yellowstone to be free-flowing and let it meander where it wants. (*Park County Local Civic Leader)*

You try to protect [the river] as much as you can through setbacks and trying to maintain water quality, making sure it is used right…..It is not just the river itself, but all the animals and the birds that depend on [the river]. And its watershed…[including] all of the streams. There are a tremendous amount of streams that enter it. (*Park County Local Civic Leader)*

You have to be careful…as far as setbacks and stuff like that. People living there don't want to see these big setbacks….Right now it is 150 feet. (*Park County Local Civic Leader)*

You get these people that are taxed as agriculture and it isn't fair because they aren't using the land for agriculture. They should be taxed as residential. (*Park County Local Civic Leader)*

[The task force] was a waste of money. They told us where the ripples are, and…told us where the river floods. Anybody who's lived here for more than two years could figure that out without a PhD…..I guess what bothers me about the task force is it comes back to the ranches should be the buffer zone….just let it flood over the ranch….Ag should not be the whipping boy….The sacrifices should not be borne by just the agricultural properties on the river, it should be borne by all, including the highways….Do we need to build a highway right along the river?...Or should we move the highway over a little bit [so we don't have to rip-rap it]. (*Park County Local Civic Leader)*

C. Dealing With Erosion—You Do Have To Be Careful

You do have to be careful when you rip-rap because you may protect yourself but you are pushing it to someone else….[and] pretty soon you would have a big channel if everybody rip-raps. Once you let one person do it, you start the problem. (*Park County Local Civic Leader)*

I don't know that there is a whole lot you can do [about erosion]. The river starts to move and…you can plant trees. That is probably what is holding the dike together right now. Tree roots are a great thing. (*Park County Local Civic Leader)*

There is only a certain amount of [stabilization trees will] do. You try and get willows started in a sand bar…sometimes that works and sometimes it doesn't. (*Park County Local Civic Leader)*

[People] have to actually apply for a 310 permit. Once they apply, the District Conservation Board will go out and observe, and look at the project and make recommendations, and either pass or ask for more details and a better plan….They try to re-vegetate everything now. They used to throw a bunch of rock over the edge. Now they are actually putting rip-rap on the bank. They aren't allowed to put it into the river. (*Park County Local Civic Leader)*

If one person rip-raps, the next one does, all the way down. It speeds up [the river]. They don't want that constriction….On the flip-side you have the landowners…that are subject to the whims of the river and that is their property that is being washed into the river when it creates a meander. It was kind of ironic during the course of that study that there was a house that was on a 100-feet high bluff, about 500 feet back, and during the major floods it undercut the bank so much they torched that house before it went in [the river]. It was pretty dramatic. It was even more dramatic the way the banks fell off….[The house] was on a big gravel slope….The river was so high it kept washing away that bench. It just gradually eroded that thing back hundreds of feet. (*Park County Local Civic Leader)*

[The river] usually takes from one place and deposits it somewhere else. That is one of the things about living on the river. (*Park County Local Civic Leader)*

I would armor the banks only in extreme cases of emergency….Otherwise we will be like the rivers in Oregon where it is armored all the way, on both sides. It is bad….I am against modifying the banks in any way except in extreme cases like to protect a bridge or somebody's house. I think that is the way it should be done. (*Park County Local Civic Leader)*

I think the river is threatened. We have rules, but we are only [a few] eyes up and down the valley. If it weren't for a lot of caring people, and a lot of snitches…[we couldn't do our job]….We need to update our regulations. We need to look at them and revisit them, and make more people mad at us. (*Park County Local Civic Leader)*

I would like to see some better science on the effects of hard armoring and rip-rap on the…fish production…[and] habitat areas [such as those created in] flood stage….We've lost a lot of that. (*Park County Local Civic Leader)*

Bank erosion is concern to the agriculture producer because it's taking away land. And then the free-flowing river advocates say the agricultural land should be a buffer…so the river can go where it wants to. But…different parts of the river have different erosion factors….The erosion is not really a big issue until you get below Pine Creek Bridge. Where the river tends to be flatter and it tends to erode, and if I had land on the river, I'd be very concerned about it and I'd want to protect my property…[People use] rip-rap or the hard facing…Soft facing is where you lay the cottonwood logs down and bury the cottonwoods so the roots face out upstream. That typically doesn't work here in a major flood. (*Park County Local Civic Leader)*

IV. Managing Resources—You Do the Best You Can

A. Make People Aware, But It's Difficult to Save People from Themselves

You do the best you can. People have the right to live where they want to live. I think there is a growing awareness that [rules sometimes] change. It is tough to deal with, but just making the people…more aware of the problems that we all face, and having them taking some responsibility…[will] help make that change positive instead of negative. (*Park County Local Civic Leader*)

It's difficult to save people from themselves, so I think that one of the most important things a governmental entity has to do is persuade rather than demand. And I think that's where the involvement in the decision making process is critical….You have to be open and receptive to public comment—you have to be empathetic without necessarily having to agree. And I think in the instances when we don't agree, you have to convey [that you are] understanding without necessarily being in agreement….The Corps, in the past, has not been as sensitive as they might have been in terms of conveying to the public that they are listening, not necessarily agreeing….[With] set-backs, you're trying to save people from themselves—it's a very hard sell. (*Park County Local Civic Leader)*

It's a real tussle sometimes between property rights and community values and who owns community resources. The river, like it or not, is fundamentally and primarily a community resource with very private sector edges, and that dynamic is not going to go away. The problems there and the conflicts are only going to intensify….I saw a really different dynamic when I worked in Colorado….They don't have the stream access law that we do….At least [in Montana]…there's a little bit more power held by the public than there would be in other places. The problem is how do you mobilize the public support for valuing the public aspects of this resource. I think there's not that realization that things could be different. And people have always lived within this environment in terms of river ownership, the public ownership of river rights, not understanding that it's not the common situation, it's very exceptional. (*Park County Local Civic Leader)*

To some degree the Corps has been maybe to quick to grant the permits for hard armoring without…necessarily educating land owners that there are alternatives. And I'd like to see that. There are certainly a lot of soft armoring techniques that are quite feasible and, in the long run, have lower maintenance [costs]. I think a lot of landowners, if they were aware of those options, might choose those [soft] options….I think we need to look at alternatives. (*Park County Local Civic Leader)*

The new people—whether they've bought five acres or 5,000—see the river as a beauty…They're more concerned with the overall beauty of the area and not so concerned about the natural resources…[such as] what grasses are growing there or what weeds are growing there….One of my goals, and I don't know if it's ever going to happen, is to bring their level of education up so that they can look out in a leased field and say, 'Yeah, this is good.' One of the goals on the flip-side is the cattle owner who needs to do a better job of …monitoring the range….Ag Production 101, so to speak….[For some people] time is the most precious commodity….So if you're going to do a range management class for a recreational ranch buyer, it's got to be July 10th, but you wouldn't dare have [a class in July] for the natives…Then, [if you schedule a July class for the seasonal residents]…you get the natives saying you're being exclusionary. (*Park County Local Civic Leader)*

It takes some persuasion and education in terms of the public. The public is so used to thinking of the river as being something you need protection from and I think we need to understand that it is a dynamic resource, and we need to learn to live with that dynamism in a way that doesn't degrade the river in terms of fish productivity…aesthetics…natural functions…[or] seasonal changes. (*Park County Local Civic Leader)*

[The Task Force] was helpful because it opened people's eyes….Any publicity [showing] that we need to protect the river is useful. (*Park County Local Civic Leader)*

B. It's a Battle of Engineers—Go With the Winners

Every time you armor the bank it deflects the water to the other side. That has been going on for a long time. To tell people they can't do that is hard because it is hard to stop somebody from protecting their property. We do have some limits and recommendations to keep a handle on it. That is our flood plain regulations again. You can't excavate in the flood plain without a permit. We try and watch that. It is a battle of the engineers. We turn it over and let them fight it out and we go with the winners. (*Park County Local Civic Leader)*

[We might want to assume] people are rational actors, that they process things and they act in rational ways. Well, they don't always. A lot of times people will act in ways that are not only not maximizing their profit, but…they act contrary to those ways because…[their] biases and heuristics and rules of thumb…systematically, and very predictably, distort their perception….[For instance] someone buys property right on the river for the accessibility of fishing…then he puts a bunch of rip-rap down there to save his property….[The rip-rap] is damaging the resource in very predictable ways and diminishing his property values….[If] he'd built back, say 150 feet, [he would have] maintained the productivity of the river along that reach. So I think that's the heuristic that's based on ignorance of how the resource works, how the system works. So to that extent, education is helpful, but you also need persuasion in terms of the credibility of the argument. (*Park County Local Civic Leader)*

I don't know, at this point, what you can do other than encourage responsible planning…and really being careful if you allow somebody to rip-rap. You have to think about the consequences…Some of the biggest problems here are these old bridges that constrict the river. They need to redesign those bridges, of course it would be millions and millions of dollars. (*Park County Local Civic Leader*)

The models [are helpful]….They have this thing set up on a trailer and you…can put your house [in the model], and release the water, and see how well you did at protecting it. (*Park County Local Civic Leader)*

C. Nobody Sweetens Their Tea—A Community of Strong People

[In this] culture…nobody sweetens their tea. It's the attitudes. It is a very self-reliant culture….[an] everybody-takes-care-of-their-own type of culture. The view of government out here is not just suspicious. It is flat out distrust. If government is involved, something is wrong….In other communities they at least give you a chance to screw up. Here they assume you already have and they haven't found out about it. (*Park County Local Civic Leader)*

Some of these people don't take no for an answer. Now, developers come and bring a staff of lawyers, hydrologists, engineers….They will come to the planning board meetings with their attorneys. They will set up their own sound systems so they can record everything. This is a kind of intimidation where they will sue you if you don't do something they want, 'We are recording every word that you are saying.' They have a whole entourage of people working for them, and you are one person, trying to do the best for the county, and you have to face their staff. That is how they are now….They will hire their own stenographers for meetings. They will go to the commissioners meetings when it is their turn to decide something. They intimidate….First they will try and schmooze you. They will put on a luncheon. If that doesn't work, they will get tighter and angry. Then come the lawyers. (*Park County Local Civic Leader)*

[Our former] planner….noticed the local people don't like the local people telling them what the regulations are, but if it comes from the state or the federal government they are fine with that. They don't want a local official bossing them. They feel [the local official] could be more biased than a state or federal agency….We get it constantly….If I can say, 'I have to administer [this way]…it's from FEMA and I don't have a choice'…then they say, 'Oh, okay.' (*Park County Local Civic Leader)*

Montana is interesting to me in that it goes beyond public information and public comment to public decision making. Folks don't just expect to know what is going on or have access, or be able to make comments, they expect to be seated at the table with the ability to put their hand in the air and cast a vote. I appreciate the interest that people have. It can present challenges if a lot of people feel like there has to be a consensus before a decision can be made. That can be difficult. (*Park County Local Civic Leader)*

This City Commission is a strange combination of being a very conservation-oriented commission, a very progressive commission, but also a very libertarian commission in that we don't take a leadership role in terms of development. We feel that [development] is an issue that should come from the community itself. And I think we act more as supporters and facilitators than we do as initiators. (*Park County Local Civic Leader)*

To some extent…irreconcilable situations occur when ideologies start from a position….and therefore [the person] only admits the evidence that applies to that position. I think that's the danger. (*Park County Local Civic Leader)*

We have a wide variety of land. We have wetlands, rock, high desert, whatever. We have it all. We look at access and all the different things that would go into making a piece of land livable. We review all the regulations, and someone comes in with an idea and we look at it and analyze it….It goes through the planning board and the commissioners and they get an approval….We enforce zoning regulations. (*Park County Local Civic Leader)*

We hand out the permits to develop along the river. We use the flood plain regulations. We see what kind of flood zone they are in. If we have a section of allowed uses in the flood plain….if it fits, they are eligible to apply for a permit. If it doesn't fit they can't apply for a permit. They can apply for a variance. (*Park County Local Civic Leader)*

There's a culture of property rights and courts and so I think that the County Commission is certainly faced with a difficult balancing act in making decisions regarding things like set-backs. (*Park County Local Civic Leader)*

Both [newcomers and long-time residents] are very protective of their property and they feel it is very valuable. Maybe the people that come lately are more staunch and have high expectations. Then again, the people that have been here a long time are set in their ways. (*Park County Local Civic Leader)*

County commissioners have a say. The planning people, but what it really takes is the people that actually live there to organize and protect what they have through zoning. The community leaders who are willing to get up and do something. That usually ends up a small group of people. Unless the people really have a strong feeling for starting zoning it takes strong people to get it all the way through. (*Park County Local Civic Leader)*

D. The Role of Development

From a recreational stand point, how many houses do you really want to see sitting on the river bank as you go floating by?...That is a resource quality that we take for granted, but it's not necessarily going to be here 20 years from now. We're seeing an awful lot of development right along the river and…I think that effects property values long term, it degrades property values. And it certainly degrades the marketability of the fishing experience for a lot of the river guides. (*Park County Local Civic Leader)*

Real estate agents…influence people. They want to have more lots to sell, and they encourage people to buy a lot that they can't afford and they say you can subdivide and the land will pay for itself. If you buy these forty acres you can pay for the five you want to keep by subdividing. They encourage development. They encourage people to sell their property. I think we have seen a feeding frenzy of these people that want to make a killing in land development and I think the real estate people have a lot to do with it. (*Park County Local Civic Leader)*

Some [real estate agents] support what I would call good planning. Some of them want to see a good community come out of all of this. They would support parks, or trails…the schools, [and] community building, as well as making money for themselves. A lot of them don't, though, and they only see the profit margin. That is one thing I like about some of the real estate agents is they do want to see a good community to leave behind…. I would say we have three or four local companies that do the majority of the business. (*Park County Local Civic Leader)*

Some of them don't think about the community. They only see the big money sign and that is what they are driven by….A lot of them are hit and run. They come and buy a piece of land and develop it and if it is shabby they are gone to somewhere else to do the same thing….That is what we try to fight….A lot of developers want to be cheap about everything they do. A lot even flaunt what they do…and think it is funny, 'We got one over on the county. I don't care about the future residents, I got my money and I am gone.' It is very tiring. (*Park County Local Civic Leader)*

Enlightened development…not only protects the river but that protects property values as well….There are other interests in the county, some real estate development interests…that have taken an opposite position and been fairly hard-line in saying that private property rights are, not only the most important consideration, but the only consideration….[But] we have a common interest—it's in maintaining the resource base we have here in terms of the river. The river is an amenity and it's an economic driver. I think that everybody realizes that at some level. And I think the only difference that we have is in terms of who owns that value….There's the side that places more [emphasis] on personal…[and the side that emphasizes] public--That's always the dynamic. (*Park County Local Civic Leader)*

E. If I Don't Do This, Who Would?

Maybe I would like to do something else. But…the thought goes through my mind, 'If I don't do this, who would?' There isn't anybody else….Other people [are now] working and learning…and thank, God. (*Park County Local Civic Leader)*

I feel I am a bastion of rationale in the midst of what is going on. I am trying to protect the area. I am trying to keep it clean and safe and see that the locals aren't run over. I believe in keeping the river clean and safe. It isn't for the money or the glory. I can affect some changes and protect some things. (*Park County Local Civic Leader)*

It is hard to change regulations. That is a hard thing to do. We talk about rewriting the regulations, but that is a scary thing. People go ballistic. Not because of logical reasoning, it is because they don't want anymore regulations from the government. It ends up in the same kind of fight. (*Park County Local Civic Leader)*

When something happens out there and they come and say, 'Can't you do something about it?' And we say, 'We have no regulations.' We just need to balance regulations and rights….Right now [the community is] so anti-regulation….[but] we need more effective regulation. We need rules…that have some teeth. The things that are in place…we need help enforcing. You are talking 2700 square miles, 14,000 people, and [a very few people to watch] the rivers, subdivisions, and drainages….If we didn't know people as well as we do, we would have a hard time. (*Park County Local Civic Leader)*

As anywhere, [we have] a very complex stew of interests. I think the County Commission that has a lot of power that they are reluctant to use because [they are] balancing interests. I think you've got some fairly enlightened folks on the County Commission, I think that they're only now gaining enough confidence as a commission to take steps to protect the river. (*Park County Local Civic Leader)*

[Agriculture needed a voice on] the Yellowstone River Task Force…[Also, with] county commission meetings and subdivision boards, an agricultural entity needs to be on the board. Obviously the Conservation District [includes] agricultural people….[I] even suggest that they become members of environmental groups to know what they are doing. Or, at least go to their website once in a while and look at their mission. You know, Trout Unlimited, Montana Water Trust, Greater Yellowstone Coalition, and Park County Environmental Council….[Agriculturalists] are not really receptive [to the suggestion]. They're nervous about it. It takes a lot of time, obviously, and…typically it's only the larger operations that have employees or family members to pick up the slack. (*Park County Local Civic Leader)*

F. Comments and Lessons For Non-local Regulators

The state and federal government input needs to be sensitive to the local commercial economic needs…[and] the concerns of residents, especially on the east side of town that are currently at risk of either flood damage or having to leave their homes. And one of the options in that 205 study is a buy-out….I think that those kind of options certainly need to be discussed in a way the community is comfortable with….We've seen cases in which there were decisions made at the federal and state level that appears to be made at the city level. The city government takes a lot of heat for things that have actually occurred in a different level of decision making….I think it needs to be a process by which there's not just a public meeting, it needs to be a neighborhood by neighborhood communication [process]….Convey [information about the risks] in a way that's understandable and a way that allows participation…both directions, from the residents to the governmental agency, and vice versa. I think that all too often the government agency does the research and makes a decision on their own, and then conveys their decision to the public. There doesn't seem to be a lot of opportunity for public participation in terms of understanding. (*Park County Local Civic Leader)*

The most important thing is to be proactive and not assume that problems will solve themselves. The only thing that happens with that passage of time is the two sides of the issues become more concrete in their positions and less willing to look at the common elements of interest. So if I were to talk to someone in a county that's maybe twenty years behind where we are in terms of growth…[I'd say] start from the perspective of trying to determine what values are generally held in common by the whole community. Work with those commonalities and keep the focus on the commonalities…It won't [necessarily] prevent the polarization, but it will certainly keep people focused on avenues to solutions that recognize commonalities. (*Park County Local Civic Leader)*

Local government builds roads, hires the police and fire department, and provides water systems. In my opinion local government has a narrow scope of activity. Then it has a scope of what I call cheerleading and encouragement of private sector development and issues. There is no escaping the river and the big part of what the city is. We just simply do not have the resources and the funding and the expertise to become river management agencies. I feel like that is one of the expectations that some of these groups have. There was one group in here not too long ago and they wanted a best management practice…on how the culverts would go in [a local creek to see] if a fish could swim through….To me that goes beyond the normal expertise that you should expect in local government. We don't really even have a storm water system. To start on one end, and say we should have best management practices about the pipes that are going into that creek, when we don't even have a storm management system…[makes no sense]. When it rains, it starts at the hill and runs down. I am still struggling with the idea that local government should be involved with the environmental issues to a greater scope…because we honestly don't have the time or the expertise or the resources to do that. To put that burden on the local government of 7,000 people or a county of 17,000 is extremely unrealistic. (*Park County Local Civic Leader)*

Sometimes the information that comes from public agencies, governmental agencies, is suspect. At least that's the perception. And I think that there is also a perception that the best practices benefit the public at large, but they may not benefit me personally from an economic standpoint. And I think that's where the persuasion comes in, demonstrating how those incentives really work on a personal level….People know what they know, and how do you get through that. (*Park County Local Civic Leader)*

I think that [the Yellowstone River Conservation District Council] has a lot of opportunity. The thing that they have to avoid is looking like they're a gorilla….[Avoid] breeding defensive reactions….Work at a community level and genuinely engaged people. It sounds like such a simple thing, but it's all too rare that an agency genuinely appears to show concern for folks….Encourage people to define goals and force some rationality that wouldn't otherwise be there….offer guidance in terms of what works mechanically and what works within the framework of the river as a river. (*Park County Local Civic Leader)*

One of [the local groups] is Concerned Citizens of Park County. That group traditionally hounds the city more than the county. They tend to show up on a lot of different issues….They are loyal to their community, but they are 'opposed.' Whatever the issues are, they are 'opposed.'…[Then] you have a definite environmental group. There is the Park County environmental group that gets real involved in those types of issues….I think they are helpful in the sense that they create a perspective…..The other group that shows up is not organized and doesn't have a membership list, but would be what I would call the 'Native Montanan' group. The first two groups include native Montanans, but they also include folks that aren't….That third group tends to be the people that have lived here year-in and year-out for decades. They tend to be tied back to the railroad, and they tend to be the don't-get-in-my-way-I-won't-get-in-your-way sort of folks. They aren't hyper-environmentalists or hyper-development people. Their families have ridden the waves for generations in Livingston. There is a stark contrast between those that have been here for generations and those that haven't….They tend to be more in the middle. They would be the folks that wouldn't want to see you cut down all the trees for the sake of cutting down all the trees, but they might have family members that work in the timber industry. They kind of have this balanced approach, whereas a lot of times the ones that you hear from are on the extremes: you shouldn't cut down any trees, or you should give me a license and a chainsaw and let me cut down whatever I want. (*Park County Local Civic Leader)*

It goes beyond, 'I want to know and I want to be able to see the documents.' It's, 'Well, we haven't had much public participation on this,' [even though] we have had three public forums. There is a redefinition here about how far the public should be able to insert themselves into a decision. (*Park County Local Civic Leader)*

They definitely know each other. They don't tend to fight with each other that much but they also don't seem to have any informal alliances…Even on an issue of common interest, they tend to come and take their own position, not hook up with somebody else and form a coalition. (*Park County Local Civic Leader)*

I think development gets a bad rap. I think that a lot of things get blamed on development when [those things are the results of] the river. Rivers are what they are. They change, they move. If you take an area around Livingston and develop away from the river, that doesn't leave you with a whole lot of land….[The Corps wants a] safe-zone around rivers where nobody can develop in and no activity can occur, and I find that very unrealistic….Groups like FEMA and the Corps, and the outside groups,…are willing to cooperate as long as they get their way. They come with such an agenda that I don't trust. (*Park County Local Civic Leader)*

It seemed like there were a lot of different interests [on the Task Force]. Maybe [they needed] a tighter agenda. They had people coming from all different walks and concerns. You have people that make money from it and guides and developers and you get the people that actually live there and have lived here for years. It got quite dicey at times and it got hard to stay focused on what the job was….Everybody had a different perspective. Very strong opinions and all different opinions. You can't put a label on anybody. There were ranchers, sportsmen, developers, environmentalists. They all had very different ideas. Their meetings would go until 2:00 in the morning. Everybody had to say what they had to say and they would go on and on and on. (*Park County Local Civic Leader)*

[Non-locals should] remember that at the same time that all of these decisions are being made about management of the river, that there is a community here—a community that gets up everyday and goes to work, lights that have to get turned on and off. Don't get so overwhelmed with the issues of the river that you forget that there are people that live next to the river. Some depend on it for economics. Some of them don't. (*Park County Local Civic Leader)*

Springdale to Gardiner: Recreational Interest Group Overview

Interviews were conducted with sixteen individuals in the Springdale to Gardiner are who use the Yellowstone River for recreational purposes, including hunters, fishers, boaters, floaters, campers, hikers, bird watchers, rock hunters, photographers, guides and outfitters who use the river for relaxation and serenity. Participants were recruited from referrals provided by members of the Resource Advisory Committee of the Yellowstone River Conservation District Council. Participants were also identified and recruited by contacting various organizations such as Ducks Unlimited, Trout Unlimited, and the Audubon Society and by contacting local outfitting businesses.

Participants in Yellowstone River Cultural Inventory—2006						
	GEO SEG I: Missouri River to Powder River	**GEO SEG II: Powder River to Big Horn River**	**GEO SEG III: Big Horn River to Laurel**	**GEO SEG IV: Laurel to Springdale**	**GEO SEG V: Springdale to Gardiner**	**TOTAL IN GROUP**
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Springdale to Gardiner: Recreational Interest Group Analysis

I. Valuing the Yellowstone River

A. The "Magical" Yellowstone River

The word Yellowstone is a very magical word. But …when [the] Yellowstone is threatened there is an incredible rally worldwide. When you talk to people from elsewhere it means the last free-flowing [river], the last preserved river. (*Park County Recreationalist)*

Little slice of heaven. (*Park County Recreationalist)*

The river itself is a big freestone river that can be extremely moody. Sometimes the fishing can be productive and sometimes it can be tough. You think you can be a smart fisherman and sometimes it doesn't work that way and the river teaches you a lesson. (*Park County Recreationalist)*

We [can] live in a small rural type environment…still have frontage on one of the major fly fishing rivers and the Yellowstone obviously is one of the prime Blue Ribbon streams…[and have].. Just more large ranches, more open country…more of a ranching character...It's a good place to have your coffee in the morning. (*Park County Recreationalist)*

[It is a] good place to start your day. If you can't be happy looking at that, you just don't deserve to be….It's a good place to get old. (*Park County Recreationalist)*

It's always changing because it's a wild un-dammed river…And it's beautiful of course, I mean it's gorgeous, especially I'd have to say…around Springdale [and on towards the] east is my favorite because it's not developed. You can still float through that area…it's all big ranches, it's not a bunch of houses on the river so it still looks like maybe it did 100 years ago. (*Park County Recreationalist)*

If you live on the banks of the river, it's a jewel, it's a free river….take care of it…it may be a little battered a little worn, but it still deserves a little TLC. (*Park County Recreationalist)*

One of the few [rivers] that flows north in the world. (*Park County Recreationalist)*

Hopefully into the future, this river will throw a flood every now and then and will astonish everyone with its power. (*Park County Recreationalist)*

[The Yellowstone River is] temperamental. You can go out there today and just have an incredible day, 60 fish a day, go out there tomorrow, [into]…seemingly the exact conditions, use the same fly, and you'd think there wasn't a trout in the Yellowstone. (*Park County Recreationalist)*

B. The River as a Refuge

First and foremost probably the fishing, the quiet, and some days the hunting, some days just sitting on a rock,…it's just a wonderful beautiful place to be and…I'd have to say just the quiet natural beauty of the place is what draws me to the Yellowstone. (*Park County Recreationalist)*

It is a totally spiritual connection….[There is] nothing better than being able to be down at the river…I don't go to church, but I definitely go fishing….I'm not a heathen or anything…But yeah…every day you spend fishing you add a day to your life; so I'm doing all right. (*Park County Recreationalist)*

When I got into fly fishing that's when the whole catch and release really hit….It's more about the whole process rather than just catching fish; just being in the mountains; seeing wildlife…One of my favorite quotes is, 'Some go to church and think about fishing, others go fishing and think about God.' (*Park County Recreationalist)*

It's a pleasure [to live by the river], I don't even like to go on long vacations. (*Park County Recreationalist)*

I've been all over the world, and this place is about as good as any, I love the peace and the quietness, and close to Yellowstone Park. (*Park County Recreationalist)*

Not just the fishing, people come just to float, to walk by it. We have a bench down there by the river, they come down and sit and just look at the river. (*Park County Recreationalist)*

The scenic beauty of it is dominant, and you can see that with the gold and yellow colors and the acreage that we have along the river we try to keep it as quiet and peaceful and be the best stewards for the Bed and Breakfast guests and the tourist guests that we have…they too have the tranquility and the beauty of the river, and the peace of mind. (*Park County Recreationalist)*

The Yellowstone [River] is my cathedral, that's my church, that's my spirituality, …it's where I charge my batteries. It's my connection to the natural world. (*Park County Recreationalist)*

C. Free-Flowing and Natural

It is the longest free-flowing river in the United States and it should be maintained as that. (*Park County Recreationalist)*

It's the longest flowing river in the United States without a dam on it…when it's clean, it's clear, it is a beautiful river. (*Park County Recreationalist)*

I describe it as the longest free-flowing river in the United States. It is pristine. It is clear. It is fast flowing and the surrounding areas are beautiful. I say we're in Paradise Valley and that's aptly named. (*Park County Recreationalist)*

One of the things that is going to be one of the most difficult hurdles to get over is recognizing that even with landowners that have a vested interest that there will be situations that allowing the river to function in a somewhat normal or natural way is still important. (*Park County Recreationalist)*

This Yellowstone River is the longest remaining free-flowing river in the lower 48 states. It's…unique in that sense. (*Park County Recreationalist)*

D. The River's Resources

Superb trout fishing…and none of those fish are bred in a hatchery… Every fish is wild, stream bred, wily and smart. They've made their living there since they were an egg….they don't fool easily… And there's a huge difference in wild fish and hatchery fish, just no comparison….The fly fishing paternity generally refers to hatchery trout as rubber trout. (*Park County Recreationalist)*

We have deer, whitetails, muleys, an occasional moose, occasional bear….Lots of eagles, lots of ospreys; …the river holds all that here…it's kind of a nature preserve right there that keeps a lot of game close by…An unofficial nature preserve. (*Park County Recreationalist)*

The Yellowstone…[is] famous for its hatches of bugs. The caddisfly hatch in late April early May is called Mother's Day hatch and it's world famous…and also the salmon fly hatch. (*Park County Recreationalist)*

I do feel like we have a fairly healthy river system. (*Park County Recreationalist)*

The river corridor is basically the river and its surrounding lands, the whole riparian area…it's not just the river, it's the trees,…animals,…insects,…birds, the worms,…the dead leaves that fall on the ground…. 90 percent of Montana's nesting birds use riparian areas, close to 60 percent actually lay their eggs there….If you fly over in a airplane, you look down at the Yellowstone River, you see this big green lush strip running through the countryside. (*Park County Recreationalist)*

Tourism is I believe the second biggest industry in Montana….tourism relates to the beauty of that river out there and the fish in it. And people come here and spend their money going fishing and hiking and camping. (*Park County Recreationalist)*

We have three osprey nests…and they have three young ones every year….We have eagles all year long.... Without the river, we wouldn't have the osprey, we wouldn't have the eagles, and we wouldn't have a lot of things. (*Park County Recreationalist)*

They know it's a world class, classic fly fishing area. (*Park County Recreationalist)*

I think the Yellowstone River is…the center of this valley…if the Yellowstone isn't in good condition, this valley is going to deteriorate very quickly. (*Park County Recreationalist)*

Open space is so important along the river. (*Park County Recreationalist)*

The river corridor is exciting. I often get excited seeing a family of river otters or the deer getting a drink….I think clients get excited and remember that as much as the fish. (*Park County Recreationalist)*

This river is a tremendous resource for this state, for all the local people here…for people who don't have money; who aren't the lucky people who own a piece along the river…that's the message. (*Park County Recreationalist)*

We try and keep a little control on the beavers; put chicken wire around some of our favorite trees. Those cottonwoods along the river are very important. (*Park County Recreationalist)*

E. Human-River Connection

It's spiritual…speaking from a fly fisher's standpoint…fly fishing is definitely a challenging way to catch fish. You need to be a weather man;…be an angler; …an entomologist; …a water chemist; …a little bit of everything so you're in tune with your surroundings…People…that fly fish are informed…and probably lean pretty heavy toward the conservation side of things….There's a lot of people that practice catch and release…[they] tend to put a lot of their own time volunteering for conservation programs [and] for education programs. A lot of their money also goes back into preserving those places too. (*Park County Recreationalist)*

When I'm fly fishing, …you seem more connected….especially with entomology because you have to know…what the fish are eating. You have to look in the water, look under rocks and it's all about…matching the hatch….The quality of life in the river, it all starts with the plants, the tiny bugs eat the plants and microorganisms, fish eat the flies and bugs that eat them. It's just that big huge food web. I think fly fishermen tend to have more of a sense of connection with that web. (*Park County Recreationalist)*

We're on the river a lot with our students whether it be fourth graders or eighth graders…teaching them about the river….if they get out of one of those lessons that water quality effects…the bugs and bugs effect the fish…if they're somehow connected to the fish in Montana, somewhere for the rest of their lives they'll be more apt to join a conservation program…or even just recycling to make the water clean. (*Park County Recreationalist)*

People tend to know here they are connected by the water. (*Park County Recreationalist)* It's a privilege to share it [the river] with others, we enjoy the cabin over here and a cabin here…we have tourist homes and the quality of people we get, it's so rare that you get a lemon. Makes you believe in the world. (*Park County Recreationalist)*

You're dealing with a raw force of nature…this river…it won't tell its secrets….you turn those rocks over;…you find those nymphs; …you watch the river year round…You put it all together and after three or four years of study, the river might just give you a trout or two…but…by then it becomes not a matter of catching fish, it becomes a matter of you're…one with the river… it has different character around every bend…it acts different in the spring than it does in late summer, it's different in the winter, it's an incredibly complex ecosystem, that if one person in their lifetime can figure out a little bit of it, it's quite an accomplishment and that's what transcends the actual fishing. (*Park County Recreationalist)*

II. Shifting Scenery: Development Along the Riverbanks

A. Homes on the Riverbank

If we're not careful it's going to look like a bunch of squatters all the way down [Highway] 89. All the way along the river, it's going to be ugly. (*Park County Recreationalist)*

These people have built beautiful homes. They're not junky. They're beautiful but there are too many, too close to the river. (*Park County Recreationalist)*

I think one of the things that we see more is encroachment of development in the river corridor….Now you see a big house on the skyline instead of a natural habitat. (*Park County Recreationalist)*

In the long run I think that it is not the Ag community that is detrimental to the river. It is the development along the river. That is why I felt like we needed to band the ranchers and the environmentalists together. That way we preserve the open spaces. (*Park County Recreationalist)*

Back in 1968, there was a big effort to dam the river…three guys…stood up against some real moneyed interests…But one of the ways that they decided in the aftermath of that battle that the Corps of Engineers wouldn't be able to revisit that plan is to bring people in; get some houses down there. There's a lot of ranches. Get some houses down there because that will increase property values and help make it financially preventative for anyone to say, 'Ok we're going to dam the river.' So I think we're starting to become a victim of that success….I've…seen more and more development right on the banks. (*Park County Recreationalist)*

The land values are such that…It makes that river corridor the domain of the upper class. (*Park County Recreationalist)*

I keep telling people…in the early 70s the dam was really proposed…. and this is where you make the tradeoffs in life. You only had to buy about seven ranches and you had most of the land under the area where they wanted the dam. We need more people out there. Do I prefer more ranchland than people? Yeah, otherwise we might not have the river. I decided that we needed more people out there because they won't dam it. It would cost so much. (*Park County Recreationalist)*

From the overlook…20 years ago there was a small handful of lights from the valley floor at night. That is not the case anymore. It is no longer a farmstead here and a farmstead there. It is a community today. (*Park County Recreationalist)*

B. Housing Developments Threaten Water Quality

Of course you've got septic tanks and lawn fertilizers and the cutting down of the trees. I think that development is probably one of the biggest things [and] one of the main problems…on the Yellowstone. (*Park County Recreationalist)*

Development brings sewage…my neighbor…[has] the sprinkling system, [he] waters that five acres every night and then he puts chemicals on there to keep the dandelions down…and all of that is just going right back into the river eventually and into our aquifers. (*Park County Recreationalist)*

We have a cabin here that we rent to people. And every once in a while my husband will say we should build a couple more and I say, 'I will not….that's more sewage on this small plot.' That's not being a good steward of the land that we've been given. (*Park County Recreationalist)*

It's not great for the riparian area where someone has cleared the vegetation of the river down to the cobble of the riverbank and then mows their lawn down to that point. (*Park County Recreationalist)*

People say they are polluting badly but I don't have any proof of that. (*Park County Recreationalist)*

C. Setbacks: Benefits and Impediment

Have those homes set back from the river…this was the last best place in Montana and it's been discovered, so you've got to have rules. (*Park County Recreationalist)*

This county is going to be subdivided. There's not any way of stopping that, but I think we should have 200 foot setbacks on the river both for the houses and for the septic tanks and drain fields. (*Park County Recreationalist)*

How do you set an arbitrary 300 or 500 feet? It has no bearing on the river. We have a 300 now….These arbitrary lines don't make sense…They have a 500 foot in Madison Valley but they seem to give exceptions all the time…If you think of how different rivers are, you need to do it by reach tide. (*Park County Recreationalist)*

[Setbacks,]…That should be an easy answer but it isn't….we are concerned with the function before the aesthetic wants….Knowing that in some areas there may not need to be a setback at all. In other areas there may need to be 500 feet or half a mile depending on what you want to maintain. As you come to the lower end it meanders a lot more. At the upper it is naturally armored and doesn't meander as much. Since we are heavily dependent on tourism the aesthetic qualities are very important for the floater and the fisher people. (*Park County Recreationalist)*

We [are] recognizing that a pretty big part of the economy is based on real estate. The one thing that would be nice [is] to…get people to recognize…that…as we deal with private property rights, …if we are able to preserve something of the valley, property owners are not going to be on the losing end… It is a lot nicer to float through stretches where…someone isn't riding the lawnmower around the lawn ten feet from the river…. If we are able to preserve some natural character those property values will go up and not down. We need to get people over the social hurdle and they realize that is true. (*Park County Recreationalist)*

D. Growth Policies: Benefits and Impediments

The real-estate developers…know it's wide open…there's no constraints on developers and I think that's holding a knife to the heart of the Yellowstone…there's no plan. The county planning commission is populated by real estate developers… I see a very deep connection to the river of all of the people here, but nothing that says, 'Wait a minute this is a real gem and let's keep this at least like it is, without further degradation.' (*Park County Recreationalist)*

The real estate developers have a huge amount of power both in the property and the way they market them and how they are organized….We have this huge issue between these people that can't see the change and are unwilling to accept the adverse change and the people who say it is going on other places and we need to stop it right now. Both sides have these real knee jerk reactions. (*Park County Recreationalist)*

Part of the draw for being here is you want to be in a rural ranch type community, so the goal of this thing [growth policy] is obviously not to put the ranchers out of business and not to regulate to the fact that they can't make a living. (*Park County Recreationalist)*

It was a classic case of public participation. A bunch of the landowners didn't participate and then they saw it and went bananas and they got it repealed… It is a tough one. You have these landowners….They can't make a living ranching and we are asking an awful lot of them to not cut it up. If somebody wanted to buy my business we would sell it for as much as we can. (*Park County Recreationalist)*

I was on the growth policy committee…the discussions came down to when it was all said and done, property rights…not the general good, but what should happen in Park County to keep it afloat. Do we admit that most of the dollars here come from tourism? Do we admit…that the people moving into those properties with bazillion dollars…don't have much concern for the local economy…? The schools suffer,…the whole structure is tricky, and the ranchers know that… And so…to protect the river,…the open space…You're asking them to admit to something that is hard to do, that it's no longer an agrarian society because it truly isn't for very many people, and that's the good and bad news. (*Park County Recreationalist)*

Personal property rights, …Every thing begins and ends with it. And it's part of the western independence that got everyone here in the first place, the rugged individualism that we all applaud, and the inability to let go of any little bit of power that people feel they still have. When you think about it, if you were one of the families that fought Indians and put up with all the hardships that settling a place like this took in its very recent history…it would be awfully hard to let somebody from Seattle come in and [they] say, 'Well by God nobody's telling me [what to do].' And I understand that, but it just doesn't work. (*Park County Recreationalist)*

Private property rights are very important to these people and I can understand that but I think my property will be de-valued if the next guy doesn't take care of his property. So it's not just a one person street, the whole community has to get together on that. (*Park County Recreationalist)*

And the big ranchers are going to sell out anyway, because there's too much money to be made if there aren't some kind of restrictions on what can [be] buil[t]. (*Park County Recreationalist)*

If development is left without checks and balances, it could totally ruin…the river, not only aesthetically, but also biologically. (*Park County Recreationalist)*

It took three years at least of really difficult meetings to come up with a plan for Park County that was a comprehensive plan…the only way they were brave enough to approve it was to specifically preclude any zoning…it was all about private property rights…there's many people who don't like planning, think its sort of a communist plot; it is breaching their private property rights. Well I also own private property…I see it as…a balancing between my rights and my neighbors rights, and…if the neighbor does something that is really obnoxious to me, do I have any recourse?...So I view it as protection of private property rights…and others view it as an infringement. It's a fundamental difference in outlook. (*Park County Recreationalist)*

Growth is going to happen and it should be done in a smart, well-planned manner….If we had done that it would be a different footprint here today. (*Park County Recreationalist)*

What is the viewshed? Is it to the mountain top? We haven't defined the viewshed. It is different through town. You have a high bluff and cottonwoods and the viewshed is right there…I would like not to see houses…The conservation easements are a way. We have been trying for years to get the viewshed bought over across from Livingston and now it is being subdivided...there is no money for viewsheds. The viewshed is more social in my mind. (*Park County Recreationalist)*

Anytime the public makes a decision that affects a private person's right, the private person is going to bear 90 percent of the burden and the public gets 90 percent of the benefit. That is tricky….Hopefully you get progressive landowners or you do it by fiat. I think you just kind of muddle along and hope that you get landowners that are willing to sacrifice a little to promote the well being of this area. (*Park County Recreationalist)*

I think it is still in danger because there is no zoning whatsoever. I don't think most people realize that Wal-Mart could buy a chunk of land down here and there isn't anything we can do about it….I am not someone who likes to see a whole pile of regulations but I think there has to be some regulation with development. (*Park County Recreationalist)*

People…on the growth policy did not want even to mention those words [conservation easements]….they say, 'They're telling me what to do with my property.' But I can't tell them what to do with their property. A conservation easement is all voluntary…, we [should] suggest to people that that is an important thing. We have a conservation easement across the river from us. That's what sold us on our property because no one is going to build over there. (*Park County Recreationalist)*

[The] lights that are on all night long [distract from the beauty of the valley]…we need to have night sky here. It's part of the beauty of being out here. And again that goes back to the private property rights. People don't feel that they should adhere to that. (*Park County Recreationalist)*

III. Access Dilemmas: Demands, Limits and Controls

A. Increasing Uses and Overcrowding

The proximity of other users of the river…doesn't affect us that much, but it's always a factor living along a free body of water like this. (*Park County Recreationalist)*

It's busier. (*Park County Recreationalist)*

People complain about overcrowding on the river. I just smile because it is more friends of the river….They only come when it is hot. The rest of the year we have it to ourselves. (*Park County Recreationalist)*

It is not just all the Bozeman people coming over to fish our water, it is now the inner tubers and the kayakers and the canoeist, it really becomes impractical to try and fish. You can't expect a fish to eat a dry fly if they have just been run over by 50 drunk college kids in inner tubes. (*Park County Recreationalist)*

The fishing is as good….The quality of the experience has degraded. We see a lot more people on the river than we used to…. It is good for businesses like ours that are in the fishing business but it doesn't make it as much fun. (*Park County Recreationalist)*

B. The Importance of Public Access Laws

I know that there are some disagreements…with fishing along private property when they [guides are] fishing along. But actually in Montana you have a right to be on up to the high water mark. (*Park County Recreationalist)*

Having all of these access points is a good thing…you don't have to be the monied gentry to get to the river and enjoy it. And our stream access law allows…you [to] walk up and down that bank a little bit and you can fish and that's a great thing. (*Park County Recreationalist)*

I have been involved in the fly fishing industry all my life….those access points are crucial to my business and my soul. (*Park County Recreationalist)*

[Ranchers] have sold…the hunting and fishing rights to corporations or private concerns and so only those people can hunt and fish on their property…it's harder for my husband now to find a place to hunt. (*Park County Recreationalist)*

C. Decorum: Respecting Others and the Resources

I have a lot of respect for our river guides, almost all of them are stewards of the river, the land…They pass that along to the fishermen as well. (*Park County Recreationalist)*

There was a motor boat that came screaming up the river and that really put a burr under my saddle…they…just totally put all the fish down and it was so loud and that's the last thing you want to hear…you know the river's not mine…it's not anybody's really…I think they should be able to use the river…as long as they're responsible while they're out there and courteous of other people. (*Park County Recreationalist)*

I think we're very fortunate here that we cannot have motorized boats. (*Park County Recreationalist)*

I don't see fishermen leaving trash. Once in a while you'll see some, but basically your guides are good; your fishermen are good caretakers. (*Park County Recreationalist)*

I've seen many times where a guide will stop his boat and jump out and pull a beer can off the bottom. You know it's a small gesture, but you don't see tin cans on the side of the river. (*Park County Recreationalist)*

Lot of landowners have a problem with [stream access laws] and it's because some of the public is thoughtless and abuse…the river and therefore are abusing the landowner who abuts the river, and that's a little flaw in human nature that's pretty much a constant. (*Park County Recreationalist)*

IV. Ideas About Erosion and Rip-rap

A. Erosion is Not Necessarily a Problem

There was a time when a property owner was at a loss but to just accept the influence of the river and they just accepted it….I guess there is a certain communion with owning the land and understanding how it works and knowing you take the good with the bad. The river changed course and I lost that bottomland but at some point I will regain it. It might not be my generation; it might be through my kids. (*Park County Recreationalist)*

We have a little erosion every year…There always will be some erosion inevitably. (*Park County Recreationalist)*

B. Rip-rap and Its Effects

Do you rip-rap the south bank and leave the north bank natural? It is a slippery slope. Once you go there it exacerbates itself and it changes the ecosystem and there is no going back. (*Park County Recreationalist)*

One of the saddest things about the Yellowstone is you go down between Hysham and Forsyth and there are some of the most incredible cottonwood forests you have ever seen. I would assume it was here too. That is the problem with rip-rap: you get the floods coming over the top and they don't get re-seeded. (*Park County Recreationalist)*

It's not great for riparian areas when you have a rip-rap bank. That wrecks it. (*Park County Recreationalist)*

When you channelize the river, it takes away its wild characteristics….but every time you stabilize that bank, you tame the river more…. the Yellowstone isn't allowed to spread out…it stays in one channel and it just digs a big deep trench over the years.…a lot of people think [rip-rap] provides great habitats for fish [but]…the fish studies that have been done have documented that surprisingly the [smaller] fish aren't there like they thought they would be. (*Park County Recreationalist)*

[They] put the rock in and forced the river to come over to our side. (*Park County Recreationalist)*

You armor these banks, you lose some of that wildness, and it has predictable effects... the water ricochets to the other side…and usually increases the speed. (*Park County Recreationalist)*

The full force of the river came straight into that area and came over the banks and basically washed into the creeks…the sediment…silted in the spawning habitat, a lot of the macro-habitat…their good…aquatic plants, a lot of that stuff got washed…out…and it took quite a while for that to regenerate….They decided to reinforce the banks so that the river couldn't do that again…they really armored the banks with huge boulders the size of Volkswagens and they are trying to keep the water out of there. And there was a lot of animosity from people both ways from people who want to protect it [and those who oppose rip-rap]…but the spring creeks…bring a lot of money into Livingston. (*Park County Recreationalist)*

In terms of long term health of those spring creeks…any time we clean the gravel no matter how we do it, the fish respond, the insects respond and the fishing is better….What would be nice is if we could mimic the natural flooding and wash all the silt out and that appears to be the natural cycle on a spring creek. Instead we have armored the banks and done everything possible to keep the river out. (*Park County Recreationalist)*

The flood of 1996 took out Armstrong's Spring Creek. I was the one that said they couldn't do what they wanted to do. It was bad…Then it hit the press and they finally brought in experts. The landowner spent $800,000 [on rip-rap] and it washed down the river in four days. I lost a lot of business because I stepped on the fishermen toes. They wanted it back at any cost. My family has been involved in stuff a long time and people hurt, because it was $100 a day to fish the spring creeks. (*Park County Recreationalist)*

The Yellowstone left to its own devices would take care of itself because it is a wild river, but if you continue to rip-rap it…it can't handle that amount of rip-rap. The river goes where it needs to go, and when you change it, it doesn't just affect the flow, it affects many, many things …It reaches a saturation point. (*Park County Recreationalist)*

C. Alternatives to Rip-rap

So what's our puny little efforts to control the river and keep it from your house? Your house should not be built in those flood plains, or if you're going to build it there, you have to be willing to let it go. And letting it go has some consequences too because you're putting all that stuff in the river if your house goes downstream, besides being expensive and stupid. (*Park County Recreationalist)*

My preference would be that it would be nice if we didn't have it [rip-rap.] (*Park County Recreationalist)*

I kept throwing at ranchers…that conservation is nice…[It is nice] to do as little as humanly possible and to be economically conservative as well as environmentally conservative, [to] not immediately thinking you need to throw rock at the river to solve the problem. If we are able to preserve some natural character those property values will go up and not down. We need to get people over the social hurdle and they realize that is true. (*Park County Recreationalist)*

Up here they are putting in 40 foot barbs....they could be much shorter…. they become a navigation hazard [and].…They are certainly ruining good fishing banks. (*Park County Recreationalist)*

Try to use natural solutions first as far as planting things…. Layering the bank, anchoring root wads in the bank. (*Park County Recreationalist)*

I'm just glad they finally decided not to use car bodies anymore [for rip-rap]. You still see a few of them when you go down…We just have to learn that this river will not stay pristine unless we take care of it. (*Park County Recreationalist)*

D. Governor's Task Force

The Governor's Task Force…came together [because] we had seen a lot of bank stabilization projects without a lot of planning in my view. (*Park County Recreationalist)*

I think you need to try your best to go way out of your way to make sure the public is brought into the process as much as possible. (*Park County Recreationalist)*

I suppose there's…more awareness…about stewardship of the river….We've gone to a few of the meetings down there, watershed meetings and you'll always get a few diehards that are not open to change. It doesn't seem like they've progressed very far. (*Park County Recreationalist)*

I thought it was interesting when they talked about the studies of the cottonwoods and you could see where the river was by where the cottonwoods are….it was good conversation between groups: environmental groups, government groups, the Corps [of Army Engineers], ranchers. (*Park County Recreationalist)*

My sense was that we were going to try and move toward some kind of census on how the management of the river would take place. I had hoped we would move towards that and I don't think we ever got over the polarization of the reality community, and some of the bigger ranchers…primarily because they are concerned how private property rights are to be handled….I think it boiled down to the fishing community and the environmentalist community….. It was a little disappointing to go through that long of process and not have much common ground. (*Park County Recreationalist)*

We got a lot of data and a lot of discussion. If we have another flood we will be light years ahead. (*Park County Recreationalist)*

I think we funded a lot of good research…and the findings will be useful. At least there is better information than those kinds of polarized conversations. There is more information for those on either side. (*Park County Recreationalist)*

The Corps of Engineers…is the ultimate arbitrator on the Yellowstone….when we brought people here from Omaha and floated them down the river. 'Oh my God, there are big boulders in the river.' Most of the rivers in Omaha have a sand bar. It doesn't take very long to see where poor decisions get made. They had no idea. …It is based on old science ideas and it is difficult to get them to change…They went, 'Oh when we talk about the Yellowstone, we need to use different criteria.' (*Park County Recreationalist)*

V. Comprehensive River Management

A. Common Ground

What resonates from both sides…is water quality….[But what is] water quality? Is it simply the chemical analysis?....Or is water quality [connected to] the system?…If you started from water quality, and worked gently outward…describing the mountains that create water quality, then there may be an incremental way to bring people into consensus. They [need to]…fundamentally understand why this water is good and why it is bad. Start from why is water so important to us. It may sound elementary. (*Park County Recreationalist)*

[We need] some common ground where people could realize that the river is the most important....Hopefully it doesn't take something really bad to make people realize, 'Hey we need to help this river.' Usually by the time things are bad, they're really, really bad…[and] can't be helped, so hopefully it doesn't ever get to that point. (*Park County Recreationalist)*

You can't impose your ideas. You need to involve everybody and all sides. The difficulty is…all sides feel threatened.…A good process has to be inclusive and usually that is tedious and difficult to do….The hard part is paring away the rhetoric and getting down to what it is you actually value, and what threatens that. Not your fears, but the reality. It's really hard to…trust people enough so you can actually talk about the real issue. (*Park County Recreationalist*)

It is just like you see in southeastern Montana, nobody gives a damn in Park County about Yellowstone County. There is no cohesive council or management process. (*Park County Recreationalist)*

All too frequently we are ready to find the differences…I think in my mind there is a bond between the ranchers and the environmentalists but socially they can't find it. (*Park County Recreationalist)*

We worked with the ranchers and we worked with the state to come up with this [blocking] system and it's been pretty successful, and the ranchers are happy with it. It's saving them a lot of money… I think it was monumental in that we were able to get the two sides to actually work together although it was mandated by the feds and the state, but it happened…and it's made progress. (*Park County Recreationalist)*

[The] River Recreation Advisory Council…tried to have the different user groups represented, some landowners, some recreational paddlers, recreational fisherman, commercial paddlers, commercial fishermen, representatives, two people from the legislature…[they] had a good facilitator...she was firm…she'd look us all over, 'Now do we agree on this?' If you have a problem you need to tell us now'…one of the things that she kept emphasizing is... to honor these other people's concerns. If the builder wants to build, you have to hear that then. If the landowner wants to protect his private property rights and doesn't want these fishermen walking up on the banks, well then you have to honor that. And where there really is a conflict, then we have to figure out, 'Is there a way we can honor this person's concern and still go there with this guy's thing?' (*Park County Recreationalist)*

It ends up not always being an issue based decision….the Ag community finds their identity with being opposed to the environmental community, whether it restricts the water or property rights…A lot of the time I am disappointed with the environmental community as well for always having a ready opponent. Whatever the issue is they feel like there is always a scapegoat on the other side of the fence….I have been trying to teach my students [that] you may never find common ground. In some cases, that is what comes to the table. Here is an issue that I feel this way and you feel this way and we are going to set it aside because it won't do us any good to yell at each other. (*Park County Recreationalist)*

How do you bridge that gap?...it takes time…generations some times…it's well known in recent years that tourism whips extractive industries in Montana, but when you go up to Helena, or in the Legislative session, the old power bases are still based on mining, lumbering, ranching…even though they are a ghost of what they once were. People as you know, politically are very reluctant to give up power…will it be quickly enough to maybe have some kind of a flood plain zoning or building ….for the river? I don't know, I'd like to think so. (*Park County Recreationalist)*

I think one group that is woefully uninvolved is the fishing guides….I think the ranchers need to be involved. Every time I was in one of these groups…they made it clear that they weren't going to change a thing. (*Park County Recreationalist)*

B. Control: Local Versus State

I think local control is always going to be a good idea as long as local control isn't a cover for the fact that we want to keep things the way we have always done them. (*Park County Recreationalist)*

I think it needs to go on record, [the violation of dredging the channel] was not solved locally, we had to go to the state, and you could not depend on local law to enforce anything. And that's understandable in a small community too because it pits neighbor against neighbor and you know. (*Park County Recreationalist)*

Without good environmental policies this river isn't going to be worth coming out to see. (*Park County Recreationalist)*

Yellowstone River has all of the protections in place that it needs to have, the laws are in place…so…see to it that the laws in fact that are in place to protect the Yellowstone River are enforced equally and unilaterally across the board, not selectively. (*Park County Recreationalist)*

Initiative 54…says that if anyone has zoned and the government or anybody wants to come in…[and] change…we have to pay those private property owners….It is well documented that…the government doesn't have money to pay them. Consequently, the zoning doesn't do any good…we just have to have some laws from the top down that stick. We can't have loop holes all over the place. (*Park County Recreationalist)*

I think the river deserves a designation…if not wild and scenic then certainly a state designation…[that] protects the river from certain developments. (*Park County Recreationalist)*

State regulation would have a better opportunity to retain or at least discourage local conflict…. It seems like if there was a state orchestrated process then perhaps more generally accepted scientific principles could be applied…Within a…local community, science gets tossed out and it becomes neighbor against neighbor and an emotional type thing. (*Park County Recreationalist)*

C. Managers of the River

If they do not articulate a vision, it is an invalid process. They should spend as much time as possible formulating a vision for the future….If there is not a vision, not a goal to obtain, it is an invalid process. (*Park County Recreationalist)*

Make sure the people…that are making those decisions are educated to make good management choices so you can have preservation and conservation. (*Park County Recreationalist)*

Decision makers need to know that…the river's important, agriculture is important, to some degree you've got to have some kind of development, as long as it's done responsibly.…The decision makers…need to make decisions where the river will not be sacrificed; where the river will be preserved and conserved. (*Park County Recreationalist)*

They broke it up in seven different types of river…You have to manage by type…. It has to be tied to the reach tide. The river responds differently. If the river is entrenched, it doesn't move. Other places it is moving all over the place. (*Park County Recreationalist)*

What does keeping it in good shape mean? It means protecting the riparian area and it means protecting the wild nature of this river….you ought to have effective flood plain regulations and enforce them. (*Park County Recreationalist)*

The thing that people really dislike the most is regulation and restriction…but there are other things that you can do besides restricting people from the river, or you know requiring a license or a permit,…it was harder to come up with the things that you can do. But we did come up with a mini-list of voluntary things people could do, but I mean it was instructive to say, ‘It’s not all or nothing…..Can’t we get more creative?’ (*Park County Recreationalist)*

I have sat through several meetings in that ranchers like to say that they are the original stewards of the land. In a lot of ways that is correct. In a lot of ways they are not. I have seen BMP mentioned and they [the Council] needs to mention best managements practices are there for a reason. (*Park County Recreationalist)*

This Council got going to protect their interest. My only problem with them is they are not inclusive enough….My hat is off to them. They took a lead and somebody needed to….[They]…need to break that [river] thing up. It is too big. You have cold water, warm water; you have urban, all different sets of issues… they talk a different language and the issues are different because it is a different river…It is a major undertaking. (*Park County Recreationalist)*

I think they [the Council] could have a pretty persuasive effect on planning along the Yellowstone as long as they adopt an approach that is more ecologically sensitive than economically sensitive. (*Park County Recreationalist)*

I don’t think they are getting enough input. One of the things is the public wants to be heard. They have no place to be heard. It is astounding if they got heard. They feel better. You go to the local council meetings and they cut you off. They cut the newspaper guy off. I wouldn’t cut the press off ever. (*Park County Recreationalist)*

D. Education

Madison County has written a little booklet that is entitled “Code of the New West” and they make suggestions that down lighting only, setbacks from the river, large plots of land, conservation easements, it’s very good. I may be Pollyanna, but I really do think that people moving in, if you point these things out to them, most of them will say, ‘Oh, I never thought of that. That’s a good idea.’ (*Park County Recreationalist)*

Short of regulations and restrictions…is public education. I mean people might not realize they are being bone heads….people might not realize that it’s really a bad thing to park exactly in the place where you have to back your boat down to get boat access…. Every now and then, somebody will build a fire on the beach…which by itself isn’t so bad, but leaving all that charcoal is bad, you shouldn’t do that…so unless someone comes along and picks that stuff up…it’s going to stay there and diminish the beach. (*Park County Recreationalist)*

VI. Sympathies and Concerns

A. Agriculture, Economies and Land Prices

The power base that's here, and the fact that it appears that Ag really has the hand on the throttle as far as the power base in this valley, and it may always….. Things are changing rapidly, and we hope it will remain basically an agriculture and rancher community. (*Park County Recreationalist)*

Land values are such now that landowners want to make sure the river is healthy. The cows aren't worth as much. (*Park County Recreationalist)*

Agriculture does not necessarily mean good stewardship, and environmental concerns for ranchers and Ag folks are not necessarily the same environmental concerns as the general populace might have. And I think therein is the stumbling block…Personal property rights, period, nothing else, nothing else beyond their property. (*Park County Recreationalist)*

To be fair environmental concerns have put them [Ag] in a heck of a bind, they have the BLM land that is sometimes closed to them and limited in terms of what they can do with it, and then they have the river constraints, keeping cattle fenced out, and the irrigation stuff that might be more limited. (*Park County Recreationalist)*

Montana [has] always been an agricultural state. In the Paradise Valley…there's still a lot of agriculture there, but a lot of that Ag land is [where] houses [are] built now…with part-time residents that are here for a few months out of the summer. (*Park County Recreationalist)*

I have no problem with irrigation; I just want them to do it right. (*Park County Recreationalist)*

Theoretically ranchers should be the greatest environmentalists in the world because they are taking care of that land, [but] economics say they can't make a living. Consequently, their thought is subdivide and get out. (*Park County Recreationalist)*

B. Local Values

[It's the] way of life. People don't live here because of what they are paid. I mean it is the amenities…of the outdoors [that] are very important…Rivers are a very important part of that. (*Park County Recreationalist)*

People get along at least on the face of it…it's just part of the culture here. …87 years old, as far right-winged as you can get and me and him are great buddies, but we're very careful about what we talk about. (*Park County Recreationalist)*

It depends on which way you are looking from….People who look from the river out… see a different world and have an appreciation for some of the natural intrinsic values of the river and often not revel in its violent activity but would understand why that violent activity occurs…as opposed to people looking from outside at the river….From the landowner looking at the river they often see it as an enemy…an infringement on their property rights….People who appreciate the intrinsic values of the river will be much more receptive to management of its own benefits as opposed to someone who sees the river as a varmint that you have to constantly watch. (*Park County Recreationalist)*

I took his [blocking system] plan to the irrigators and said look here's a plan that you need to think outside the box you've been doing this thing the same way for 80 years now, and it's pretty well demonstrated that it's not working real good. Try to think outside the box….we got state funding to fund the project, we got state grants to fund it. (*Park County Recreationalist)*

Whenever you move into a small rural area, there's so much cohesion…and [it's] isolated. So you can't go in with the idea that you're going to change a lot of things, and that wasn't ever our intent anyway, I guess living next to the Yellowstone, you get such a loyalty to it. (*Park County Recreationalist)*

It was pretty intense [when we were dealing with dredging of the channel] because we came off as hating ranchers and not wanting them to get water, and that wasn't ever the case, it was just equality before the law, you have to have that. As it turns out though, it resolved itself in a fairly positive manner. (*Park County Recreationalist)*

I thought everyone recognized that [planning] was the one thing that was missing. They were granting permits on a landowner by landowner basis and we needed to look at a bigger picture. That was the failure in the permitting process…I remember having these discussions…that if I were a landowner on the Yellowstone I would be really concerned about what the guy upstream was able to do. That was a lot of the problem….because a permit on a neighbors place created a problem for the other neighbor. Any time I tried to get that [discussion] going…a landowner was more willing to deal with damage on his own property rather than say that the guy had to be responsible for what he had done because that meant he would be next. That thinking scares me. (*Park County Recreationalist)*

I think there would be an awful lot of distrust for any kind of program to compensate them [Ag] when they would rather do it all themselves. It is not so much how profitable the ranch operation is going to be but that they want to do it their way and not the way that someone else wants them. Like the wolf issue…the rest of the people want to see the wolves. So they will just compensate them for the calf that they lose. There are other intangible issues. Some governmental boy is going to tell them how much they are going to be paid for their cows ? It becomes more of a control issue. (*Park County Recreationalist)*

We've got a new group of people coming to town. Livingston is changing very, very quickly….in Livingston they'll tell you real quick, 'You know a nail that sticks up is going to get pounded down fast.' But there are a lot of new nails sticking up in town, and they can't pound them all down. (*Park County Recreationalist)*

But the wedge issues are continuing to be played. The farmer versus the angler and several others…then there's the old western thing of, 'I'm going to do with my God damn land exactly what I want to do and there ain't no God damn body going to tell me different'. Well that's what built the west, but it's starting to hurt it. (*Park County Recreationalist)*

C. Concern: Water Quality

Preservation is important…If our water is unhealthy, we're unhealthy. That's been kind of an environmental little cliché…And [the health of the river] could be documented through fish population studies and all the macro-invertebrate studies and all the water quality studies that they have. (*Park County Recreationalist)*

We have a special thing on our well, it's an ultraviolet light that keeps the water in good shape in flood time….the way the water table is here, we have quite a shallow well, it's legal, but it's quite shallow. And we were always concerned about that because we really do need to make sure our water is safe…[because] it fluctuates with the level of the river. (*Park County Recreationalist)*

Raw sewage was being dumped [at] Gardiner, Montana….It's when the electrical power goes off, they don't have a shut off valve, so the raw sewage…goes right into the river. (*Park County Recreationalist)*

I mean that's often the assumption…you know a little bit of pollution here won't matter because the river…disperses it so much that it makes it insignificant. If you lived out in Glendive… at the receiving end of all that, maybe it does become significant. (*Park County Recreationalist)*

I've seen…very little if any movement to try to mitigate….the amount of pesticides that go into the river from ranching. And there are more and more folks moving in down the valley and…they've got lawns…and there's a lot of nitrates now going into the river. (*Park County Recreationalist)*

I remember the flood of 96 and 97 very clearly…after those two flood years, we had a salmon fly hatch in town, it's the triple cheeseburger of a bug to a trout…The warden…told me he couldn't remember one being for 20 years…he said…the volume of the water…was huge…[and] washed out all the heavy metals and the phosphates…and the pesticides, and it gave the bugs a chance… that was the only hatch because the nitrates and stuff were still being pumped in….it should have served as a heads up.…When do you start saying this is a finite resource…it can't look out for itself. It can't handle that load of pesticides. (*Park County Recreationalist)*

D. Concern: Water Quantity and Water Rights

We basically don't have a water quantity problem, we're the headwater….But I'll tell you there is a quantity problem as this river is used more and more for industry…[and] city water uses, and agriculture, and then compromised [by] coalbed methane….Quantity is an issue down in the eastern part of the state. (*Park County Recreationalist)*

We've had three or four subdivisions that have gone in, from Emigrant towards Livingston…where they subdivided [the land into] twenty, ten- to five-acre plots. I don't know where all that groundwater is going to come from. We have so many homes up above us…and we know that a lot of the wells are not very productive up above…We've had sufficient water here, [but] it doesn't mean it's going to be that way ten years, twenty years from now. (*Park County Recreationalist)*

You've got the ranchers with irrigation, and then you've got the recreational users, and water in the west is tricky. (*Park County Recreationalist)*

On the other end of this, there's a diversion where the canal comes off. [It] goes all the way through Paradise Valley and irrigates all of the alfalfa growing in the whole valley…. By the state [accounts] it is a natural channel…but a lot of the local people and the irrigators claim, 'No, we dug this channel and this is our channel.' [It has been] a big bone of contention….So, this is a very unique situation we have living along this particular piece of the river. (*Park County Recreationalist)*

E. Concern: Fish Populations

Whirling disease…effects cutthroat trout and rainbow trout. It's a parasite that basically burrows into the…skin and pries…into their vertebrae….It eats away, causing their vertebrae to bend.…and so when they swim it causes them to spin or whirl which is whirling disease… It eventually kills the fish. (*Park County Recreationalist)*

Hopefully the Yellowstone cutthroat can…get their populations up…They…just keep going down more and more every year due to habitat loss…to the whirling disease…[and] to the inner breeding of rainbow and cutthroat making a hybrid called a cutbow. Some people call them that for lack of a better name. (*Park County Recreationalist)*

When push comes to shove between the Yellowstone and other uses…the trout are way down in the hierarchy. I mean…there's…never talk about restricting irrigation in an extremely low water year to keep a minimum stream flow. (*Park County Recreationalist)*

The cutthroat population is headed in a not very positive direction. They have talked about listing the cutthroat [as endangered]. I am not sure if that is necessary, yet, but I would think it will be at some point. I would like to stem the tide before they have to be listed. (*Park County Recreationalist)*

F. Concern: Invasive Species

You know invasive species, like the noxious weeds…[well] the New Zealand mud snails are another invasive that's a problem…and there's an algae called Didymo. (*Park County Recreationalist)*

Development brings weeds. (*Park County Recreationalist)*

I'm very upset with our government…To control knapweed, we need to spray every single year….We pay mega-bucks…to a professional…and yet our land borders state land, and it's nothing but a dump full of knapweed….Then we have a neighbor on the other side of us, from New York, who never sprays….[Knapweed] ruins all vegetation of grasslands. (*Park County Recreationalist)*

Noxious weeds along the banks are…an important issue….I don't think anyone in the county would argue on that one. (*Park County Recreationalist)*

The darn beaver…I hate to say this, but they are so destructive. They'll cut down these trees that are hundreds of years old and then there's nothing left. (*Park County Recreationalist)*

A tree deserves to live longer than any beaver in Montana….A tree is light, it is oxygen, it is air, and it gives much more than any dirty rotten beaver does. We have to preserve and save…the tree, which saves our lives. (*Park County Recreationalist)*

G. Concern: Ice Jams and Floods

[The] flood issue is always a problem….We have an affidavit that shows, back to 1865, that this property has never been under water. But in 1996 and 1997 it came [and we had] one or two inches of breeching back here. We sand-bagged portions of it. Of course, when a river is that big, you can't stop much….We didn't flood but a lot of people did. (*Park County Recreationalist)*

The '96 and '97 [floods] were so refreshing, in many respects, because the river was just huge and nobody had ever seen it like that. And it was rampaging all over the place and doing wholesale channel changes down there in Livingston. (*Park County Recreationalist)*

Springdale to Gardiner: Residential Interest Group Overview

Nineteen interviews were conducted with property owners holding 20 acres or less of land bordering the Yellowstone River, or within 500 feet of the bank. Names were obtained through a GIS search of public land ownership records. These names were randomized within counties. Other people living very near the river and whose primary incomes are not generated by agriculture were also recruited.

Participants in Yellowstone River Cultural Inventory—2006

	GEO SEG I: Missouri River to Powder River	GEO SEG II: Powder River to Big Horn River	GEO SEG III: Big Horn River to Laurel	GEO SEG IV: Laurel to Springdale	GEO SEG V: Springdale to Gardiner	TOTAL IN GROUP
AGRICULTURAL	22	22	16	12	14	86
CIVIC	14	14	18	14	8	68
RECREATIONAL	15	16	16	13	16	76
RESIDENTIAL	15	11	16	15	19	76
GEOGRAPHIC SEGMENT TOTAL	**66**	**63**	**66**	**54**	**57**	
NATIVE AMERICAN						**7**
PROJECT TOTAL						**313**

Springdale to Gardiner: Residential Interest Group Analysis

I. Living Near the River

A. They Call it Paradise Valley and It Is

I feel real fortunate to live here. I mean, they call it Paradise Valley and it is. (*Park County Residentialist*)

It's very peaceful at times, most times, not all the time…[and we like] to see the changes of the river. But probably most [importantly we like] it because it's close to the water….We're pretty active water people. We fish a little, but we mostly just enjoy being around the water. (*Park County Residentialist*)

[I enjoy] the serenity of being here along the river and all the mountain views and snow….I just love all this natural beauty. And we all live in this plastic cement world today so it's just wonderful to be able to get away from that. (*Park County Residentialist*)

The river is actually magical. I made the mistake of actually taking relatives on the river and now they want to come back every year. (*Park County Residentialist*)

I like living by the river….It is extremely pleasant in the summertime. We have two creeks. We are almost on a peninsula. The sound of the water is awesome. I like to go and sit by the river and look at the mountains. (*Park County Residentialist*)

[Our home] is a haven. We consider it a haven.…It is almost like you are living alone, 50 miles from town. (*Park County Residentialist*)

The river…has a personality. It's different everyday. Sometimes it's your friend, sometimes it ain't your friend. (*Park County Residentialist*)

It is a free-flowing stream that is clear except during the high water until you get to the Billings area. It is very beautiful from Billings on to its headwaters….It is part of the community. (*Park County Residentialist*)

[The river] certainly is a focal point.…It's a great resource for the people who live along the river, for agricultural purposes and ground water purposes. (*Park County Residentialist*)

It can have a water cooler existence….'Hey, what's the river doing today? River's running high. River's running low.'…[It's] a conversation piece. (*Park County Residentialist*)

It's just a real benefit to be able to go down and chill out and relax, very calming and soothing….[It is] spiritually seductive. (*Park County Residentialist*)

The mountains have a…type of impact on the individual, even if that individual doesn't acknowledge it….The river has an impact as well. Without the river, the mountains have too much power and actually impact your ego. The river provides a balance,…a healing,…a strengthening of your ego. (*Park County Residentialist*)

You could be an atheist and still appreciate what the mountain and the river have to offer, because it doesn't attach itself to any type of philosophy or train of thought, but it still reminds people that there is something bigger than them…..People come and go. The mountain is still going to be here; the river is still going to be here….That's the constant of its existence; that's what attracts people to something like the river. (*Park County Residentialist*)

The river [provides] spiritual unity….Water is a calming influence on people….We consider this as sacred ground. The river does play a role in it in distributing that sacred essence down to the…rural communities….We actually use the river as a conduit for prayers and a conduit for spirituality. (*Park County Residentialist*)

It was a way to get away from the traffic….[We're] close enough to town where we could work in town and not have to drive so far and still enjoy some of the nature. (*Park County Residentialist*)

What we have is about perfect. We would like some more access like a walking path along the river. Maybe some day they could maybe have a trail all the way into town. (*Park County Residentialist*)

It's part of your body, not your physical body, but it's part of your awareness. So if the rivers' being traumatized, by whatever, it hurts….During high water and things are just washing out and the river is recharged, vibrant and alive, you feel nourished. (*Park County Residentialist*)

B. Fish, Wildlife and Habitat are Important

We have a lot of mule deer who always give birth to their young on the island and that's right at the time…the spring run off comes so I think they feel very safe by giving birth on the islands….There were 12 here this morning and it's neat to see last year's young and then this year's young. (*Park County Residentialist*)

We're in the elk migration route. They've been migrating from Yellowstone down here for 10,000 years….They migrate off that flat up there on the top and come down here to the lower lands and…and they feed in that big grass field across the river….[and] they…come across the river to the islands….I just enjoy watching them. (*Park County Residentialist*)

I was down there one day and I heard a mountain lion roar and he came running through there. He was roaring and raising hell. That kind of surprised me. I don't know what he was fussing about but he ran right through there….I heard him raising hell and that is what caught my attention….I didn't get close to him, and he didn't get close to me. He moved on out. Something had disturbed him. I don't know what it was. (*Park County Residentialist*)

We…even [had] a black bear last week, right in the yard….My son was sitting across from me and he said, 'There is a black bear,' and I thought he was being funny. I said, 'Yeah, sure.' He said, 'There is a black bear!' And sure enough there it was. The dog saw it and when it barked it took off. We haven't seen it since. We keep anticipating it will come back. (*Park County Residentialist*)

It's hard to believe but,…about two months ago,…way up on the top of the hill, there…[was] a mountain goat [and] I went out on the porch one day and a pronghorn was walking down the road and looked as us, and a moose. (*Park County Residentialist*)

It has wildlife…ducks,…osprey,…deer,…antelope,…raccoons, elk and skunks,…swans…just a lot of different birds, especially after…bugs hatch there's a lot of activity down by the river. (*Park County Residentialist*)

In '96 and '97 they had a tremendous flood….It brought down a lot of beavers. And they cut down probably somewhere in the neighborhood of at least 200 trees that were on these islands which was really kind of sad. (*Park County Residentialist*)

Occasionally [we see] a bear….There have been sightings of cats. (*Park County Residentialist*)

One of the positive things that have happened since I was small is the abundance of game. I can remember when I saw my first deer in the river bottom and now they are everywhere. Whitetails were almost unheard of and the only time we saw a goose was during migration season. No raccoons. (*Park County Residentialist*)

It is not like when my father was small. There…[were] a lot of native cutthroat. He told me he would ride along the river and fish would get trapped along there. There was that many there. I think the introduction of the brown trout and the rainbows probably had more to do with ruining that than the actual fishing. (*Park County Residentialist*)

They've had trouble…with whirling disease…here on the Yellowstone River. (*Park County Residentialist*)

C. Recreational Uses, Needs and Pressures

We're not all rich people that can buy ranches and have our own private…hunting and fishing.…I think we have the highest per capita participants in hunting and fishing that live in Montana compared to other states and part of the reason is…the opportunities…we have. It's still good for the average person.…They can have as good of access to hunting and fishing as the rich people do and that's real important to keep it that way. (*Park County Residentialist*)

Our grandson walks down and goes fishing….He just loves it here. He is going to be eight. (*Park County Residentialist*)

The outfitters and fishermen are probably the main recreational users…and when I say fishermen, it doesn't have to be clients. [They can be] locals, too. (*Park County Residentialist*)

The increase of traffic along the river….I think tourists are finding out this is a great spot and I think it is increasing. Every year there seems to be a little bit more of an increase in how many people float the river…and fish. (*Park County Residentialist*)

I really do believe that at these fishing access should have one of these portable toilets…and…keep them clean….I think that's a real need for the people…coming down the river and also for the people who live on the river. (*Park County Residentialist*)

[More people on the river causes] over fishing,…more risk involved for people,…maybe rafting in places where it may not be still enough….I see people not wearing life jackets, [and I see] people drinking….It seems like once or twice a year somebody goes in the river and doesn't come out of the river, which I suspect would be a problem for someone. (*Park County Residentialist*)

When I lived in Billings, we came up here every weekend and floated the river. Now that I live here, I go three or four times a year. You get to taking it for granted. (*Park County Residentialist*)

We have seen…the increase of fishermen on the river and I'm not so sure for many of us folks that live so directly here on the river…really appreciate it to the degree that it is. Some…use language that's not so desirable. They're very loud. They don't seem to have any regard for the wildlife. They get their dogs in the boat…then [the] dog is out there chasing these deer who have just given birth to their young. (*Park County Residentialist*)

A neighbor…has small children and she said, 'It's to a point now that so many of these fishermen are so rude and it's getting so bad I don't want my children exposed to that.' She has moved.…Human consideration—…it's missing. (*Park County Residentialist*)

There is just boat after boat after boat coming out to the valley so there is a lot of traffic on the river. (*Park County Residentialist*)

We enjoy going out by the river,…walking around, sitting out there fishing and watching the otters….We spent a lot of time out there. We never thought about it as money thing….It's more entertainment. (*Park County Residentialist*)

I don't fish. I don't boat….Early on, I had a healthy respect for the river as far as high water and getting into trouble….I was raised on a ranch south of Livingston along the river. I never swam in the river….Once you see the river in high water and see a cottonwood coming downstream with the leaves on it and all of the sudden it goes under water for a few hundred yards, it is kind of scary. These logs along the stream, you can't run fast enough to keep up with them. (*Park County Residentialist*)

I live next to the fishing access….I went out there with a garbage bag…and filled it in nothing flat with garbage….They take our signs down. They've got trails through our property….People are really rude….They don't respect other people's property. (*Park County Residentialist*)

I think that you've got outfitters that want to see things for their clients, and their decisions are largely based on money….Their income depends on what kinds of experiences their clients have on the river. (*Park County Residentialist*)

Growing up on the river we fished it,…just watching the wildlife and floating the river. I used to guide raft trips on the rivers too, and we'd get a lot of fishermen. I have three younger brothers and we all have been avid outdoorsmen and it was a pretty piece of property. (*Park County Residentialist*)

D. The River is Public, Trespassing is a Problem for Some

I am trying to remember if people that have been trashing my property, but I don't believe they have. It is clean down there around the river.…They can get down there through a gate on my property. They have kept it clean and haven't messed it up. I don't care if they go down there and have their picnics. It is fine with me. I like for them to enjoy the river. (*Park County Residentialist*)

I'd like to see public access maintained. I'm a real believer in the stream access law….Let's use the resources. I'd like to see sensible use of it. I don't want to see wildlife adversely affected by or during a drought year. I want to see enough water maintained to keep the fisheries stable and in good condition, if that's possible. (*Park County Residentialist*)

We have a lot of rafters that float by. A lot of fishermen. I enjoy that the river is being used. (*Park County Residentialist*)

Last year there was a guy that had a great big canoe and he spent the night there on the sand bar….We don't know who owns that. Lots of times they will spend the whole day with the family. (*Park County Residentialist*)

One year we had a flood and there were tremendous waves down here. The kayakers found out about it and they [came] in—some of them were changing clothes right on people's property and they were trashing the properties….We did have a problem when we first moved here. People would drive down here and I had to post the property. (*Park County Residentialist*)

Trespassing can be a problem along the river. We have people go across our property to get to the river. (*Park County Residentialist*)

II. Floods of 1996 and 1997 Precipitate Public Debates

A. The Floods Changed Everything

The flood of ’96 changed my property….The island broke in half and…when it broke the force of that came over and hit that island and doubled back. My neighbor had very poor rip-rap and [the water] found the weak link and just kept coming to my house….I lost 100 feet [of property]…and part of the house. (*Park County Residentialist*)

[After the flood was over] I said, ‘Couldn’t we move some of the rocks so the river would go back where it was?’ [The Commissioner] said, ‘The fishermen wouldn’t like that.’ I said, ‘What is more important?’ and he said, ‘Around here, the fish.’ Can you believe that? (*Park County Residentialist*)

The reporter for the Park County paper said, ‘You were the hardest hit in the flood so I am doing a story.’…[They took pictures and the story explained that we not living in the house]…so then [thieves] took our stuff.…They didn’t get an awful lot…but they got all the stuff we had put in boxes—all kinds of pictures. (*Park County Residentialist*)

I got a letter from the County telling me that I couldn’t rebuild because I lost more than half my house and if I decide to move it nobody could use [the property for a home]. They were going to take my place away….My brother-in-law said, ‘Let’s go see that [county] woman—we haven’t lost half of your house.’ So, she [came] and walked around, ‘Oh, you haven’t lost half of your house. You can rebuild.’ (*Park County Residentialist*)

After the flood, they built concrete all across the front of the house up to this floor. Then they put the huge rocks in….It is [a] concrete wall…[and] there is the barb. I am pretty safe. It was nothing like this before….They are saying you shouldn’t rip-rap, but this is my home. The engineers will allow me to repair this….If anything happens, they will let me fix it. I am grandfathered-in. They will let me do that. (*Park County Residentialist*)

See, no one is supposed to build here [now] because it is a floodway. The house next door that was the last one built on the island. (*Park County Residentialist*)

B. Need for Balance, Information and Assistance

1996 and 1997 were historical record flood years and…conversations have really been stark because of those two major floods….I think people got scared about protecting their properties and some properties were lost. And so with the protection of property and living on the river, there's controversy. And I think, before the [floods, the] controversy probably wasn't as strong….I think we can be good stewards to the water and the river ways but also [we can] protect our homes….Somehow we have to come up with a balance instead of just saying, 'Oh, you can't do this, and you can't do that.' Somehow we have to work together to come up with what is the best thing for the river and [the people]. (*Park County Residentialist*)

In 1996 we lost quite a little bit [of land]….We lost quite a bit this year….We recently…got it re-surveyed and found out that there isn't, and never has been since we've owned it, as much land as we've been paying taxes on. We've been trying to obtain two titles on this property….Once we get that done we will take it to the county treasurer and see what we can do about that. (*Park County Residentialist*)

Initially I didn't really know what to do and I was looking for advice [on the permit process]. None of those people give you advice, not the Conservation District, not the flood plain people, and not the Corps of Engineers….I just talked to people. (*Park County Residentialist*)

None of [the users] should be allowed to overtax the facility. Every once in a while you will see maybe six or eight guides with fishermen out. I am sure that they get on each others' nerves. The common sense thing you mentioned,…you know people are basically greedy by nature. (*Park County Residentialist*)

When we first moved here and we knew we had problems with our banks just because of, well, poor management. So we called up several different professionals….We wanted a conversation about what would be the best thing for us and the river. And we didn't get a lot of good information. In fact, very little. And I think that's one of the things that is missing….There's not a lot of people that can afford a major study on how to protect their lands….Somehow we have to have that information available and be willing to work with people on the river so they don't do something that's going to damage someone else, or damage the river, or straighten the river….This is a meandering river. It's great. It should stay that way. (*Park County Residentialist*)

The public, and myself included, we need to have some available information….We [weren't] really good stewards when we moved here. We've done some rock work along our bank, and there wasn't anyone there [to advise us]…unless we could have paid for professionals….But at the time we couldn't afford it….If there's some kind of grants that may be available so you can hire a professional—if those professionals really have the answer—that's a question…I have. (*Park County Residentialist*)

C. Ideas About Erosion and Stabilizing the Banks

We did have a flood those two years '96 and '97….It did tear away a lot of my bank.…The topsoil that is gone….It's done so much damage to our property out there in those two years of floods we haven't been able to get picked back up again….We're not millionaires; we couldn't get it all done. (*Park County Residentialist*)

I think you have to have rocks. If you do it right with vegetation, I think you could do a pretty fair job. I could show you on our place…one place where it has worked very well with vegetative growth, but [it doesn't work] in every place….I think vegetation with rock would be a great way to go, so long as it's done in a way that you're not going to cause damage downstream from you. (*Park County Residentialist*)

The Conservation District encourages people to put the barbs out….The barbs seem to be working pretty good, and then plant vegetation there….I think [those methods] cause less impact down stream. (*Park County Residentialist*)

Don't be too hard on the people that live on the river. I don't have the money to make big changes….I had a bunch of cottonwoods growing and the beavers came and ate every one of them. There went my stabilizing….[The beavers] are really destructive. I am trying to keep this place,…[even though] the moose come and they eat everything they see and…I am not going anywhere. I am going to stay here. (*Park County Residentialist*)

A man down the road here…made a berm out in the river….It caused that river to go right into our property. (*Park County Residentialist*)

We've never experienced any [erosion] here because we have a lot of willows on the river bank right here. (*Park County Residentialist*)

I haven't really seen any noticeable [erosion] change at all. And we had a lot of water through here in the spring. (*Park County Residentialist*)

When they put in that rest stop, they put a rock barrier along there….The people in the cabin felt…it diverted the water, pushed it over to their side, and they've almost lost the cabin. (*Park County Residentialist*)

Vegetation is one of the key factors [in helping with erosion,] if it's done…right. (*Park County Residentialist*)

I have seen the river deepening the channels and cut the riverbank….[There are] on the places on the river bank [that were] four or feet high when I was young…[and now they are] 10 or 12 feet high. (*Park County Residentialist*)

Our bank changed.…The rocks used to go way out in the river. The main force used to be on the other side. We lost at least two feet in one area of bank. That changed the whole flow of the river. Now it comes around the bend and comes at us and then swings out the other way....It changed dramatically with the flood. You don't notice a flow change as much. (*Park County Residentialist*)

[Rip-Rap] can divert water. It can shift the problems up or down….The reason that I probably might not do the rip-rap is I'd lose ten years of vegetation that's out there since the last flood and the vegetation is as good or better than hard rip-rap…[and] once I talked to some people who explained that to me, I don't really want to tear it up to put some rock in…but [the information] didn't come from any of the [government agencies.] (*Park County Residentialist*)

I was interested in one technique [to prevent erosion.] I saw on a ranch that used root balls along the river to start collecting rocks to start building the bank up again....It is a natural form of rip-rap. I saw some of that and was interested in that although when you call somebody that does that natural stuff it costs a lot of money. I don't know if I have that much to put on the bank of the river. (*Park County Residentialist*)

D. Concerns About Spring Creeks

The Armstrong and DePuy and Nelson spring creeks….are a valuable asset…[that] brings a lot of money into the economy and they are a unique fishing experience….[At the] campground fishing access, the river eats directly into the gravel. This fills up the river bottom with gravel and it spreads out. It elevates the flood plain. It damages the spring creeks on the east side of the river in that area….These last two high water years really devastated the spring creeks. Nothing has been done as far as I know. No one wants to acknowledge that it is a problem, but it is.…They don't know how to deal with it….When you get these large floods and especially if the river is pushed out of its channel, it tends to go down those channels and the spring creeks are located along the western edge of the low lands. (*Park County Residentialist*)

III. Growth in Livingston and Paradise Valley

A. Growth Changes the Physical Landscape

The development is just unreal….At night…I used to drive around and see a dozen lights in the old days, and now there are just hundreds of them, thousands of them, literally. So a lot of the ranches have been chopped up. But it's dollars….They can make more selling it for a house site than they could making hay. (*Park County Residentialist*)

It isn't the houses so much as the people that are coming with the houses. They change what we need. I don't need Wal-Mart; I don't need to be going 100 miles an hour all the time. When my kids were little we would walk out here, they would ride bikes. There used to be a single lane wooden bridge out here. They had to upgrade that and now there is a 35-mile an hour speed limit and nobody pays attention to that. There is all the strip mall development. Pretty soon we will have all that development along there I guess. Maybe that is good for some people. I don't know. (*Park County Residentialist*)

Developers...go and dangle two million dollars in front of somebody's little ranch….[The ranchers] are going to take it. And that's happened a lot. So you're actually losing some of the rural people….[This began in the] late '70s. (*Park County Residentialist*)

Everyone is dividing [the land] up and selling it off because they can't seem to make as much money keeping it as they do with the people [coming in] that are willing to pay. (*Park County Residentialist*)

I wish that people that moved here, would move here…just for the beauty of Montana and…to get away from the city….[But] it seems everybody that moves here has to put in an…outside light and I'm thinking, 'Why? Are you scared the bears are going to get you at night? Why are you ruining this beautiful night vision of the stars?'...They want to bring the city with them. (*Park County Residentialist*)

Paradise Valley…may change quite a bit. Yankee Jim [Canyon]…won't change a whole lot because of the Forest Service and the Park. But in Paradise Valley, as land prices go up and people start seeing…money, people will start selling their ranches. (*Park County Residentialist*)

I think [change in Paradise Valley] would still be minimal because you still have some expansion of Bozeman that will happen, maybe some from Livingston to Bozeman, but,…once you get into Paradise Valley, I don't see [it] over the next ten years. (*Park County Residentialist*)

What the real estate agents saying is that…[it will] be the next boom….Bozeman's in a boom right now. Once that…reaches a homeostasis, then Livingston, which is already experiencing it, then possibly the Emigrant area will experience the boom. (*Park County Residentialist*)

B. Results of Development and Change

It's kind of a good/bad thing because…the tax dollars still roll into those places, but yet the people are only here for a small part of a year. So the population, in a sense, is down, but it's still the tax dollars….it's a good/bad thing. (*Park County Residentialist*)

There's an influx of people in the summer, of course, because most of the people aren't here in the winter….Everybody has their own viewpoints on that. I think it doesn't tax our system as much as the people living here [all of the time]….If they're paying their property taxes, I think we're getting a benefit that isn't causing us a lot of problems. (*Park County Residentialist*)

[My kids] will be lucky to afford to live here, I'm afraid. We're lucky we bought our property when we did because we couldn't afford it today….We just got a new law passed by Congress on conservation easements that's a lot more user-friendly. Before, the only people that could use those conservation easements were multi-millionaires, basically. And this new one, in fact I was reading about it this morning, you can defer this for, like, 16 years, where before you had to take your tax deductions in six years. So there are some positives there, although you mention conservation easements to some people and they think they are wicked. I think it will help me for estate planning to be able to pass our place on to the kids easier. (*Park County Residentialist*)

If I could stop the influx of people, I would….Properties [are] gone. I look at my grandkids and I don't see how…they're going to be able to buy a home. I mean, wages just haven't kept up with the prices of homes….We're pushing our own kids out of the state….How in the world are they going [to] live here unless they get a piece of land and build their own little house? (*Park County Residentialist*)

Livingston has turned into nothing but a tourist town, nothing but art….There's nothing. We have to go to Bozeman to get almost anything. (*Park County Residentialist*)

Most of the ranchers are looking down the road and thinking, if they get in trouble, they can subdivide. From what I am hearing, the price of the lots on subdivisions is going down. They aren't selling like they were. (*Park County Residentialist*)

C. Responsible Development

Some [developers] are doing a good job, and some of them are just looking for the quick buck, I'll be quite honest….A guy from Wisconsin did a subdivision down here by Mill Creek, and he did a really nice job….[But there are] not a lot of local people doing development because you're talking high dollars now to buy these ranches and develop them. (*Park County Residentialist*)

I think that most of the property owners recognize the importance of the river so any type of development that may go on will…[be] responsible….They [will try to] blend…with the natural scene of the river. (*Park County Residentialist*)

We actually did a little development on our ranch….We did the 20-acre tract thing because it was easy to do. But we also went through the planning office and county sanitarian and tried to do everything that they suggested. (*Park County Residentialist*)

I think what their plans are…to develop…a…cluster development so…it leaves a lot of wild open spaces….People buying there will be able to enjoy the beauty, and the people traveling through the valley will still be able to enjoy it….That would be a great thing. (*Park County Residentialist*)

Paradise Valley doesn't have much good farming ground in it. It is a large gravel bar. It isn't like the Gallatin Valley, which is really being raped…..If they keep the subdivisions over on the gravelly parts, it isn't going to hurt somebody. That is probably good use of the ground. Billings used up all the good land for miles….They could go [away from]…the irrigated ground and build forever, but they choose to build on the good ground….People can come here and should be able to if they choose to live here in a responsible manner. I would have the same right if I wanted to move somewhere else. (*Park County Residentialist*)

[The canal] was first built in 1890 by the Armstrong family. It is an important part of the valley for agriculture. It furnishes water to both sides of the valley....[We need to educate the public about] the economic benefits of it to the community [and that] irrigation…takes a lot of floodwaters out of the streams, especially the small streams and lets it back into the groundwater system….They are entirely dependent on the recharge. It isn't important as far as the Yellowstone but it is important along the rivers. (*Park County Residentialist*)

We think that [when] people have bare land there has to be some thought as to what goes on there. Some planning. (*Park County Residentialist*)

I do want to see a good growth policy plan….I certainly don't blame the ranchers for selling their property and making money because that's all they had and you know they can make enough to retire on so you can't blame them. But on the other hand people have got to kind of plan for the future because I just think that these are kind of the good old days. We aren't going to have less and less people. We are going to have more and more people and change is going to happen whether we like it or not. (*Park County Residentialist*)

I think it's important to have the planning....You have to have those discussions....I live in Montana not to make money, but because I enjoy the outdoors….We have to protect the environment....I do think that you have to grandfather in [the] people…here before those decisions, especially local people. We don't make a lot of money…and everything that we own is tied up in this property….We could sell this and make a profit but I couldn't buy property anywhere else. It's just gotten so high. (*Park County Residentialist*)

There needs to be a direct growth policy from a diverse group of people. You can't have one special interest trying to dictate. It's got to be give and take. You're not going to stop them from coming in here. You can stop them putting raw sewage in the river. (*Park County Residentialist*)

D. Irresponsible Development and Changes

The subdivision regulations [were written] by the professional planners for Park County and they actually did a pretty good job….Now we have citizens, [and] I think a lot of them are developers or people working with developers, that are trying to oppose the growth policy that was established….[The policy] is very broad, but they just want to see subdivision regulations thrown out….It's the old, 'Don't tell me what I can do. I can do anything and if you don't like what I'm doing then you have to buy it.' That's the attitude….There are a lot of local developers that are really outspoken….They may be leaving soon after they develop, I don't know. But they are local….I know one [who] will be out of here once they develop and sell their property. (*Park County Residentialist*)

You'd like to see it stay as wild as possible, but…common sense tells you that that's…not going to happen….Development here is just absolutely the major thing…. When the County tries to do anything,…[the developers] say, 'We're going to sue you for this' and the County thinks, 'Well geez.' They've got all these lawsuits. They can't afford to fight all that. These people that are developing, they're making millions of bucks so they have the money to threaten. (*Park County Residentialist*)

Some of the developers are wanting services yesterday and not wanting to pay for them until tomorrow. Of course they said, ‘Oh, bring in three more planners. We just want this system to work fast. We’ll pay more.’ Of course, soon as the County raised the rates, they squawked. I think there’s three lawsuits against the county right now because of some of those problems. (*Park County Residentialist*)

You have developers that obviously want to be able to build right up to the riverbank and build big trophy homes to sell….I’ve been a contractor for most of my life and in the construction business around here. So I can see certain points, but I sure don’t want to give up what’s good about Montana just for the sake of [my] job as a contractor. (*Park County Residentialist*)

We’ve been fighting this road project now for the last five years….This is a country road…[and] people built here…because they wanted the serenity….[The proposal to make it a State highway will create] a hazard because people are going to fly….[and] people are not going to pay any attention to [the debris-falling signs]. People are going to die on this road because you’re going to create this speedway….The County’s saying they can’t afford to maintain it…[and] the State will not listen to the people that live here and pay taxes here. They’re more concerned about the people coming in and visiting for two weeks then they are about the people who live here. (*Park County Residentialist*)

It depends on how the lands along the river sell as to what happens. It is zoned [as] agriculture lands and they are putting subdivisions in on ground that has less value. The biggest danger I see is…the string of houses along the roads with no open space. I think that is the biggest challenge is to preserve open space so it isn’t one subdivision after another. (*Park County Residentialist*)

One man [is developing] a gated community….He’s doing some appropriate things—he’s doing a lot of studies and spending a huge amount of money. It’s going to be second homes—and very, very expensive. He’s calling it a Private National Park….He wants to buy two sections of State land, and I oppose that. I’ve been writing letters…[because] public land is basically being sold for privatization and development. It’s happening, but whether it should is a whole other question. (*Park County Residentialist*)

IV. Observations Regarding the Governor’s Task Force

A. They Could Have Done Better

I did go to some of the meetings. I just thought they weren’t really getting anywhere in the meetings….They weren’t allowing the professionals to be a participant and a voting party, so basically they had task force members, but a lot of the scientists and people that have the expertise, I felt, were not part of the equation. I mean, they came and they presented things, but [the professionals] weren’t a voting mass….The scientists and the professionals…need to be participants in the Task Force, not just presenters. Because they are the people that know, and they should be the people that are helping this balance that needs to be met here. (*Park County Residentialist*)

There were tons of recommendations [from the Governor's Task Force] but I don't see where any of their recommendations were followed at all….The people…on there…did a good job….It's a sad thing because there's a lot of good-meaning people put a lot of time into that and really cared about what they were doing. Then to see nothing happen out of it is kind of discouraging. (*Park County Residentialist*)

B. They Did A Pretty Good Job—They Didn't Hurt Anything

You know, [the Task Force] didn't hurt….I know several of the people that were on it and some of them came away with a better feeling, some of them came away with a worse feeling….[The one's that thought it helped] felt they did some good and that the government was honest with them. The other group…[says] it's the old conspiracy theory, 'They used us.' (*Park County Residentialist*)

[Regarding the Task Force] I think…[they made good decision about] the flood plain and how the rip-rap was done to prevent erosion. Overall, there was a lot of good, sound thinking and they reached compromises. The health of the river came first and will be maintained. (*Park County Residentialist*)

C. When Groups Fight, Bad Decisions Follow

I don't think [the various groups] really work well together….I'll give you an example: After the floods of '97, our bridge, that is right up stream from us, is called Carter's Bridge. [It] was determined…dangerous, and that it needed to have some major repairs….During those floods [the bridge] was creating a dam situation….[But they never considered] changing…the bridge so that the bridge would work better during major floods because of its historical [value]. Never; it didn't even come up. Wasn't even a part of the equation….I've asked several times [for information concerning] how much money was spent on repairing that bridge—and I know it was phenomenal….I know it was a historical bridge, fine. They could have kept the historical aspect [but] there are a lot of problems with that bridge….[And] they did damage to the river when they did the construction….They started bulldozing the island at five o'clock on a Sunday morning and I got on the phone to everyone I could possibly [think of] to get it stopped….They did some pretty major damage. In fact, they did some channel changes by doing that. (*Park County Residentialist*)

V. Other Concerns

A. Water Quality and Industrial Uses

The sewage overflow…[at] the plant…in Gardiner….If we have an outage, they didn't have a switch that would cut it over to emergency generator to keep it going…until…the guy…working part-time get[s] there to start the generator….The concern that I have is Yellowstone Park should have their own facility and not be using Park County's facility. (*Park County Residentialist*)

Gardiner sewage was going into the river….Gallons of raw sewage. It was so sad. (*Park County Residentialist*)

In the last two years, in the spring run off…the river turns…orange and…it's coating over the rocks and everything….So there's run-off that's coming from somewhere. (*Park County Residentialist*)

If you have a major industry setting up somewhere downstream,…just putting a burden on the whole ecosystem, that has ramifications all over the river. (*Park County Residentialist*)

I think people treat the river with more respect than they used to. It used to be that the place to get rid of the trash was right on the river. When I was a boy there were all kinds of old tires on the river. Gardiner would just roll them down the hill into the river. If you wanted a big fish, they fed on the sewage. I don't think they were especially good eating. Those things have been cleaned up. (*Park County Residentialist*)

B. Weeds

We're involved…with weed control and have an…early summer project every year on different ways to control noxious weeds….I would go there and hand-pull…a lot of noxious weeds on the island, and it's getting to the point here where it's beyond that…and the State doesn't do anything about it. (*Park County Residentialist*)

We have had some problems with weed control….I noticed Fish and Game…spraying the weeds but in the past they were doing the moth thing, …which never worked. We pumped thousands of dollars into spraying knapweed. (*Park County Residentialist*)

When you float the river you notice there is a lot of knapweed. We have a lot here. We see a lot of it and it runs off everything else. (*Park County Residentialist*)

C. Cottonwoods

The cottonwoods…are dying here….There are trees…right along the water, getting plenty of water, and you'll see…a branch that will die and next year will be another one and another one….And…the canopy does a lot of things. It's a great thing for wildlife…when we have heavy rains, it keeps the silt run off and all these things….And I really don't see a response from the state or the federal government really trying to figure out exactly what's happening. (*Park County Residentialist*)

VI. Changes in Management and Controls

A. It's Tough When Things Change—Water Rights

We're going to have a leasing meeting over on Mill Creek with the watershed group next week, and a lot of people are feeling that they're coming up short because [one guy is] leasing his water rights [to provide for the fish in the creek]. It is going to effect me, but we have a law that says, if it's beneficial use, you can do that…..Fish and Wildlife is beneficial according to our legislature, now….And, let's face it, I'll be the first to say, that sometimes the fish in that creek are worth more than the hay I'm raising….[Most people] got their irrigation systems put in by the government—not totally free, but with lots of grant money—that was ten years ago….[Now, with this guy leasing his water, another] says, 'It's not fair.' Well, it may not be fair, but you did get a new pivot…for half-cost….So, I don't know. It's tough. I mean, that's going to be a real contentious meeting….We have water rights, but we dry up Emigrant Creek every year. So I can see both sides. But sometimes I [ask about the] outfitters and how much money they make on the Yellowstone River—it's tremendous. (*Park County Residentialist*)

B. Stop Building Near the River

We need to be looking pretty seriously at why we're still allowing homes to be built on the river. And…I'm kind of speaking out of two ends here because I do live on the river, but I do think that since the floods we need to look more seriously at what we are allowing….Each place wants to protect their property….Are we all going to be able to do that and still allow the river to be healthy? (*Park County Residentialist*)

It will put more people on the river. It will impact the visual aspects of the river. I think there should be setbacks from the river, for aesthetic problems and pollution from septic tanks. (*Park County Residentialist*)

C. Need for Consistency in Controls

During the '96 flood they started losing bank along Highway 89, and they went into panic mode. The Park Service, the State, came here and brought trucks loads of rock….During the major part of the flood they were dumping truck loads of rock along 89. And they were losing tons of money, but they felt like they had to do it. But it was interesting to me that they can do that, but if you have a homeowner…[who] starts to do that, you would probably be handcuffed….Even if it is the highway [department], I mean, still….[Whether] it's the Department of Transportation [or] it's a homeowner….Are we all going to work together? Because, if we don't, we're just going to continue to have problems. (*Park County Residentialist*)

I often feel that the State and the Federal government are far more lackadaisical and do not implement rules….We were told by the county when we built here, 'You better not let a pebble go into the river while you're building'.…[But] I've watched…when part of the bluffs falls down, they just plow it…right into the river….They don't abide by the same rules and regulations. (*Park County Residentialist*)

The Army Corps of Engineers [said] the levy in Livingston…does not follow specifications. If you were to walk that levy, you couldn't believe it would ever break, but I understand the standards….[This means] those people on the Northeast side of Livingston [will be affected]…and that's not a real high income area. Being told that you can't do changes to your property, that's going to be a hardship….We'll see what happens with all of that. Not to say they need to not be concerned [about flooding]. They do. But I think it's kind of a funny deal. They're allowing building in other places...that flooded [in the past]. They know it. (*Park County Residentialist*)

I think the local decisions can be made as far as growth policy and planning....But I think the State needs to be in charge of the resources and the wildlife....Access to public lands— that needs to be a state controlled thing. It's best managed that way. (*Park County Residentialist*)

[The State] is following all the rules. The Legislature makes rules. Sometimes they are knee-jerk rules and State agencies have to follow those because that's what the law says. It's not necessarily that they agree with it all the time….But Legislature is influenced by special interest groups….It's a nasty, dirty process [and] probably the least favorite thing that I've ever had to deal with [was] go up there and talk to those guys….There's also the bureaucratic thing:…one person [is] not willing to stick their neck out and make a decision and they pass the buck to the next person….So you end up talking to half a dozen people before you get somebody to that has the guts to make a decision. (*Park County Residentialist*)

D. Policies Need to Change as Demands Grow

The latest the efforts have been a lot about growth….They've been trying to work on the growth policy and the subdivision regulations….So that there are setbacks from the river. And Park County Environmental Council is definitely behind setbacks, and I agree. I agree that new building needs to be different than the old….It shouldn't be that we say, 'Well, you live like that so why not [the next?]'….You know, things change. We need to be better stewards because there are a lot of us. (*Park County Residentialist*)

We're going to get more regulations….And, of course, you have all sides….You get the guys that say, 'They are taking our property rights.' I try to tell people that what you do [on one side of] the road sometimes does affect the other side of the road. They don't like to hear that, of course, but we have to be honest….It's the conspiracy theory, the government's-got-too-much-control theory. I get a lot of that here. (*Park County Residentialist*)

It was so important then that the Park County Environmental Council and myself worked on trying to get a growth policy and subdivision regulations that were going to be thinking about smart growth, thinking about if this area is going to be developed, [do it] in a manner that's best for the landscape and the residents. (*Park County Residentialist*)

E. Listen to Locals

The largest input should be from the local people and what they want…because each county here has different circumstances….Even though you have a lot of similarities, each one has their own uniqueness. (*Park County Residentialist*)

The people that live here and ranch here and have businesses here,…they have a lot of concerns about regulations…because it might effect their property and their values….A good example of that is the rest of the United States wanted wolves in the west, but…they don't have to live with them….I have friends where they've killed their sheep,…their cows,…their horses….The people that live here have to deal with this and everybody else just thinks it's wonderful…and there's a big concern about the buffalo…and the brucellosis. (*Park County Residentialist*)

I would like to feel like somebody's listening to me because I live here.…I care about it and…I want to see it still be here for my grandchildren and generations to come….God gave me this [to me] and he made me the caretaker and this is my job. I don't do it for money. I do it because this is my job. (*Park County Residentialist*)

[The Chair of the County Commission] he said we want to have a growth policy committee with members of the community…and have [the plan] percolate from the bottom up….I attended meetings with the Livingston group…for five or six months and the county hired…a facilitator and…each of the 13 [geographic] parts of the county met and presented [their thoughts] to the planning board….[Then the plan] was adapted…by the planning office and the County Commissioner….Our concerns were totally nullified….What really got me was [that we put in] a concerted effort….They said they had 34 statements from individuals…[and that] if you have a certain number of letters that say the same thing they get the same weight as a bunch of people that sit in a room and bang heads for five months. (*Park County Residentialist*)

There was a bridge…that we had to have removed. During high water we were worried about it creating a log jam in that channel behind the house. It was very hard to get the State to do that. We almost had to threaten [them].…Their fishing access actually crosses our property and…my neighbor's property. So if they weren't going to pull that bridge we were going to shut their access off….It had to come to…that to get them to do something….They just passed the buck, you know….Typical bureaucratic bullshit. (*Park County Residentialist*)

VII. We All Need to Get Along

A. We're So Polarized But We Have to Accept Controls

We all need to get along and see each other's side—and that just doesn't happen because we're all so polarized anymore. It's a really fine line…when you're in business….I try to walk that line all the time and try not to upset too many people, but sometimes you have to. (*Park County Residentialist*)

My boys were...out on the river fishing…and [the neighbor] down the road calls the Sheriff on them every time. They fish off the bank….Now, these boys grew up here. Their grandpa has worked really hard on stream access laws. They know what they can legally do. He calls the Sheriff on them every time and the [Sheriff] can't do anything about it. [The neighbor is] the one who would like to see no one on his riverbank fishing. He thinks it's his river bank and it isn't. (*Park County Residentialist*)

There is a segment of the population that thinks there shouldn't be any irrigation water taken out of the river, which is entirely against my upbringing. I was on the Board of Directors for the Park Ranch Canal for many years. It was a constant hassle with environmental regulations as far as getting the water out of the river. It was quite an expense to the canal company to try and get the water out….I am not on the board anymore. It was a headache. (*Park County Residentialist*)

You have people that come here from other areas….There are tents laid on the islands and they've got bonfires going. And it would just be devastating if it…got out of control….I just think that there needs to be some policy set….We all like the freedoms and don't really like the federal government…telling us what to do, but…you have to look at the overall protection of something that's beautiful here. (*Park County Residentialist*)

They just don't want [zoning]. I was raised on a ranch and I lived in town for awhile and the townspeople gave up the right to zoning. They just exchanged one right for another. I wouldn't live in town without zoning….When there isn't any zoning, they can't tell you what to do, but when you have zoning you have the right to stop a big farm next to you, for example. You give up one right and acquire another one. (*Park County Residentialist*)

The high school…was built on right on an old channel. I mean, some of those mistakes were made a long time ago…[and] they have to determine how they're going to live with it. I think Livingston…[and] Paradise Valley…[have] a lot of concerns….I'm not saying you shouldn't be allowed to build along the river; I just think there needs to be certain setbacks. (*Park County Residentialist*)

B. Private Property Rights Are Important

Private property rights are always an issue along the river. They often are trampled on by regulation and then those regulations cost the private property owners along the river money….There is always a balance and to find that balance and for everyone to be responsible along the river.…I think that's done through education not through regulation. (*Park County Residentialist*)

Conservation easements, for a lot of ranchers,…[mean] you are giving up rights to your ground. Once they are gone, they are gone. (*Park County Residentialist*)

The ranching community has had an aversion to any zoning or control and I think that mindset has prevented a lot of these things from happening. I think that is changing but they just don't want any more regulation. (*Park County Residentialist*)

[In our subdivision] there are 13 lots and 60 acres on the entire island. We have the largest lot and ours is 3.17 acres. The common ground belongs to everybody. Everybody in the subdivision has access. We have a liability insurance problem if they just open it up. (*Park County Residentialist*)

C. Stewardship—Private and Among Agencies

I think [we need] to be good stewards of the river and to the environment. I think that's probably the most important thing that we need to be right now. (*Park County Residentialist*)

If you want to protect your property, try to get some information, if you can,…[about what's] going to be the most appropriate thing for the river and your property….If you're going to buy on the river, then you need to be somewhat responsible in what you're doing, especially because the river is the most vital thing we've got probably. Water is going to be the biggest issue in the next decade, especially after a fire season like the one we just had. (*Park County Residentialist*)

The Army Corps of Engineers…needs to look very seriously at the roads that are in proximity to the river and the bridges. If bridges are dams, they need to be repaired and they need to be looked at….[The Army Corps of Engineers needs] to be [a] good steward because they are the ones that really have the say on what is going to happen….And if they're asking us to be good stewards, then they should be too. (*Park County Residentialist*)

I don't anticipate any changes for our place. I have two sons…and I'd like to leave it just like it is for them. (*Park County Residentialist*)

The most painful…[thought is to] treat the river as an object…that's up for negotiation and that can be abused….That would really hurt because you couldn't have a relationship with the river. (*Park County Residentialist*)

D. Why Get Involved

I'm on the watershed group....I'm on the local fire board here, and I'm on the electrical Co-op Board…[and I] used to be on the refuge board, but not anymore. So, yeah, I'm pretty active in the community….You know, you can't complain about things if you're not trying to help solve the problems….And there's pros and cons….I get more public input than anybody else because I am out in the public all the time. (*Park County Residentialist*)

A few of us just got to kicking around ideas [about] what we could do and maybe there was some grant money out there to help do things better….[We got involved with the watershed group] and it is kind of Ag oriented, I'll say….[We're trying to keep] the Ag producers in the area profitable….We have a wheat grant…and we have a cottonwood grant [so] that we can plant cottonwoods along the river….Anyone that owns property from Livingston to Gardiner [can join] the Upper Yellowstone Watershed Group….We encourage that, especially the 20-acre tract people…that don't know knapweed is a weed.

They think it’s a pretty flower and they’re watering it. [They don’t know] we have bugs that we released [to kill the knapweed]….One of our grants, two years ago, [provided money for us to] release bugs on seven sites along the river. (*Park County Residentialist*)

A lot of these new people come in here and buy these big ranches and the first thing they want to do is close off access on a previously used county road….We as citizens need to fight for…our access to the public lands because these people make no bones about it, they’re trying to fence off their own little piece of heaven. (*Park County Residentialist*)

My big thing is the public access and the public’s right to use the resources and enjoy the wildlife….Most of us live here because of what the outdoors has to offer.…We just really need to safeguard that. (*Park County Residentialist*)

The squeaky wheel gets the grease. If you want to have something done you’ve got to make some noise. It’s good to think about doing it the right way. It’s good to understand the process. I just think your average person doesn’t understand the process. They don’t know how to go through it. (*Park County Residentialist*)

Not everybody sees things the way I do. But…it’s good to have different opinions too, because that’s how you get problems solved. You can’t have everybody agree on everything. You need to be able to have good healthy arguments about things and hash out the details. (*Park County Residentialist*)

I think your typical person isn’t up-to-date....[They] usually…don’t want to be bothered with things…until it actually affects their pocketbook.…People are not really proactive….So…residents do get left behind to a certain extent. They’re not going to get involved until all of a sudden their well gets contaminated and they have to drill a new well and then they’re fined. (*Park County Residentialist*)

SOCIOECONOMIC REPORT

Regional Profile of the Yellowstone River Corridor

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DISCLAIMER: This report is a contributing section to the Cumulative Effects study which is not yet released. This is not a standalone publication and should not be cited or referenced until the full report is released.

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Abstract

The Yellowstone River Corridor, located in southern Montana and eastern North Dakota, spans 12 counties. This report details socioeconomic data for each of the counties grouped, according to economic characteristics, into five segments. Each section of this report provides historic and current demographic and economic data for each segment along the River Corridor. In some cases, data are provided at the county level to highlight important differences between the counties within a single segment, while in other cases, aggregate data are provided at the segment level. For those instances where aggregate data are provided at the segment level, a county level breakout of the data can be found in the appendix. Finally, a discussion comparing the most recent data for each segment within the River Corridor is provided at the end of the report to emphasize current differences between segments.

Introduction

The Yellowstone River Corridor, located in southern Montana and eastern North Dakota, spans 12 counties. The corridor covers a geographically and economically diverse area. For ease of discussion, the 12 counties have been grouped into five segments that reflect economically similar areas. It should be noted that this is the same geographic grouping applied in the Yellowstone River Cultural Inventory Report. Segment 1 encompasses the counties located in eastern Montana and western North Dakota: Prairie, Dawson, Richland Counties, MT; and McKenzie County, ND. Segment 2 spans eastern central Montana, including Treasure, Rosebud and Custer Counties, MT. Given the uniqueness of the economy of Yellowstone County, it is the only county included in Segment 3. Segment 4 includes Sweet Grass, Stillwater and Carbon Counties, MT. Segment 5, similar to Segment 3, only consists of Park County, MT. Again this is due to the unique economy of this county. The region shares a unique history and is culturally important; while each of the counties is distinct in its own way, together, they are facing many of the same opportunities and uncertainties moving into the future.

The twelve-county River Corridor is both historically and culturally significant. The area was explored during the Lewis and Clark Expedition, with several important historical landmarks located throughout the corridor (National Park Service, 2014a). Counties in Segment 2 were extensively explored during the expedition, while Pompey's Pillar, located in Yellowstone County (Segment 3), bears the signature of William Clark, signed on his journey home following the expedition (National Park Service, 2014b). Many of the counties in the River Corridor served as important railroad and mining camps during the early 20th Century, including those counties in Segments 2 and 4 (Montana Department of Labor and Industry, 2012a; Jones Lang LaSalle, 2013a). The Enlarged Homestead Act of 1909 promoted the settlement of many of the eastern counties, located in Segment 1 (Eastern Plains Economic Development Corporation, 2006). Counties within the corridor are home to two tribal reservations, the Northern Cheyenne Tribe, located in the counties in Segment 2, and the Crow, located in counties in Segments 2 and 3 (Montana State Governor's Office of Indian Affairs, 2013; Northern Cheyenne Tribe, 2013).

Today, counties in the River Corridor are experiencing an increase in the diversity of economic sectors driving local economies. Natural resource extraction continues to drive the economy of many communities within the River Corridor. The Bakken Oil Field is having notable effects on communities in Segment 1, coal mines continue to be an important source of employment for residents of the counties in Segment 2, and coal and metal mines are still fully operational in Segment 4 (Southeastern Montana Development Corporation, 2010; Bohnenkamp and others, 2011; Montana Department of Labor and Industry, 2012b). In addition to extractive natural resource industries, counties along the corridor are well known for abundant recreation opportunities. Yellowstone National Park, Gallatin and Custer National Forests, several blue ribbon streams and rivers, as well as over a hundred lakes and reservoirs make the counties along the River Corridor a heavily-used area for recreation. These recreation-based industries are viewed as important economic drivers for several counties within the corridor, especially Park County (Segment 5) (Northern Rocky Mountain Economic Development District, 2012). In the future, the continued development of extractive industries may conflict with the emerging tourism and recreation industries.

This report details socioeconomic data for each of the five segments. Each section of this report provides historic and current demographic and economic data for each River Corridor segment. In some cases, data are provided at the county level to highlight important similarities or differences between the counties within a single segment, while in other cases, aggregate data are provided at the segment level. For those instances where aggregate data are provided at the segment level, a county level breakout of the data can be found in the appendix. All data are presented in 2010 dollars. Additional changes between the reporting methods by Bureau of Economic Analysis of pre- and post-2010 data are captured in the methods section found in the appendix. Finally, a discussion comparing the most recent socioeconomic data across segments within the River Corridor is provided at the end of the report to emphasize differences between segments.

Segment 1 - Prairie, Dawson, Richland Counties, MT, and McKenzie County, ND

Introduction

Segment 1 of the Yellowstone River Corridor encompasses a four-county area, spanning Prairie, Dawson, and Richland Counties in Montana as well as McKenzie County in North Dakota. Historically, this area is known for both its agricultural importance as well as its rich oil and gas resources. The Enlarged Homestead Act of 1909, which promoted dryland farming by allowing individuals to claim up to 320 acres of nonirrigable land in parts of several western states, including Montana, caused an increase in the population of the four-county area in the early part of the 20th century (Eastern Plains Economic Development Corporation, 2006; Bragsher, 2012). This expansion in dryland (non-irrigated) farming and ranching on the eastern plains of Montana and western plains of North Dakota was soon followed by another population boom in the mid-20th century triggered by the discovery of the Bakken (formerly Williston Basin) Oil Field (Bohenkamp, Finken and others, 2011).

The discovery and subsequent drilling of the Bakken Oil Field caused an economic boom for the four-county study area from the 1950s until a peak in the 1980s. The 1990s were marked by the bust cycle that often follows an oil boom (Bohnenkamp, Finkenand others, 2011). In addition to the economic downturn experienced in the oil and gas energy, the farm economy also suffered during the 1990s. Much of the 1990s, extending into the early 2000s, was marked by drought conditions similar to those experienced during the Dust Bowl (Montana Disaster and Emergency Services, August 2007). Adding further stress to the agricultural economy, drought conditions were paired with declining commodities prices (Jones Lang LaSalle, 2013b).

Currently, due to the advancement of extraction methods, the area is once again experiencing an oil and gas boom. There is a strong belief that this boom cycle may last longer than the previous cycles, given technological advancements. Once more, the oil and gas sector is a driver of change in eastern Montana and western North Dakota. Many of the “oil patch” counties are experiencing high rates of net in-migration as people move to this area seeking financial opportunities (Sylvester, 2013). Additionally, oil and gas is helping to bolster the economy of the area through an increase in the number of job opportunities, increased tax revenue, and an increase in the population in areas that have previously experienced net out-migration due to a lack of employment opportunities (Bohnenkamp, Finkenand others, 2011). Although there are many positive outcomes, there is still concern regarding the other effects of an oil and gas dependent economy, including stresses on infrastructure, a lack of available housing, and a changing face of the population, that local economies may not have the financial resources to manage (Bohnenkamp, Finkenand others, 2011). Though there may be uncertainty regarding the specific changes the four-county study area will experience in the future, it is certain that this area will continue to develop given the continued influence of the agriculture and oil and gas sectors.

Demographic Trends

Population

The total population within the Yellowstone River Corridor has been steadily increasing, leading to an overall increase in population of 74.5% from 1950 to 2010. Conversely, the population within Segment 1 of the corridor has shown fluctuations over time, increasing from 1950 to 1980, and subsequently decreasing from 1990 to 2010 (see table 1).

Table 1. Population Total, 1950-2010

Segment 1	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
McKenzie County, ND	6,849	7,296	6,127	7,132	6,383	5,737	6,360	-7.1%
Richland County, MT	10,366	10,504	9,837	12,243	10,716	9,667	9,746	-6.0%
Dawson County, MT	9,092	12,314	11,269	11,805	9,505	9,059	8,966	-1.4%
Prairie County, MT	2,377	2,318	1,752	1,836	1,383	1,199	1,179	-50.4%
Segment 1 Total	28,684	32,432	28,985	33,016	27,987	25,662	26,251	-8.5%
River Corridor Total	133,723	162,839	161,516	194,822	196,814	214,004	233,355	74.5%

Source: United States Census Bureau, 2010

Much of the increase in population from 1950 to 1980 within the four-county area may be due to the expansion of dryland farming and ranching, coupled with the oil and gas boom. The subsequent decline that occurred in the 1990s can be seen in the population totals, as each county in the four-county area experienced a population decline from 1980 to 2000. Two of the counties in the segment, McKenzie and Richland, have recovered from the economic downturn and the population is increasing (United States Census Bureau, 2010). Though at a lesser rate, the population of Dawson and Prairie Counties continues to decline. Overall, the segment has witnessed an 8.5% decline in its population, contrasted with the nearly 75% increase in population that has occurred in the River Corridor as a whole (United States Census Bureau, 2010).

In addition to declining, the population within the four-county area has also aged significantly since 1950. Table 2 shows the median age of the population from 1950 to 2010.

Table 2. Median Age, 1950-2010

Segment 1	1950	1960	1970	1980	1990	2000	2010
McKenzie County, ND	27.4	25.5	28.2	27.3	32.9	39.5	38.0
Richland County, MT	26.3	26.2	28.0	26.9	33.1	39.2	41.3
Dawson County, MT	27.7	23.8	25.3	27.3	35.5	41.0	43.5
Prairie County, MT	28.0	28.7	36.3	34.4	43.0	48.9	53.6

Source: United States Census Bureau, 2010

From 1950 to 2010, the age of the population in each of the four counties in the segment has increased. McKenzie County, ND, has had the slightest increase in the median age of the population, with a recent decline in age from 2000 to 2010. This is likely reflective of the net in-migration driven by the oil and gas industry. The population of Prairie County, MT, has experienced the greatest increase in median age, with a total increase in median age of over 25 years from 1950 to 2010. This may be linked to higher rates of out migration and natural population change (Montana State University Extension, 2011c).

To further examine age distribution within the segment, Table 3 shows a detailed breakdown of the percent of population under 5 years of age, 18 years old and older, and the percent of individuals 65 and older. McKenzie County, ND, where the median age is the youngest, had the highest percentage of the population under 5 years of age as well as the lowest percentage of the population 65 years and older, in 2010. Again, this may reflect families moving into this area seeking higher wages from oil and gas-related jobs. As expected, Prairie County, MT, has the lowest percentage of the population under 5 years of age and the highest percentage of individuals 65 years of age and older (United States Census Bureau, 2010a). This may indicate an out-migration of families from the area.

Table 3. Detailed Age Distribution, 2010

Segment 1	Median Age	Percent of Population Under 5 Years of Age	Percent of Population 18 and Over	Percent of Population 65 and Over
McKenzie County, ND	38.0	8.1	73.4	14.2
Richland County, MT	41.3	6.5	76.6	14.9
Dawson County, MT	43.5	6.1	79.2	17.9
Prairie County, MT	53.6	4.9	82.3	26.0

Source: United States Census Bureau, 2010a

Across the River Corridor as a whole, the population density is 7.6 persons per square mile. Segment 1 has fewer individuals per square mile, as compared to the River Corridor, continuing to reflect the decline in population. Prairie County, MT, is both the smallest in land mass as well as population, making it the least densely populated county in the segment, with less than one person per square mile. Richland County is the second smallest county in land mass but has the greatest population, making it the most densely populated county in the segment (see Table 4), but it is still considerably less dense than the River Corridor as a whole (4.7 and 7.6 persons per square mile, respectively; United States Census Bureau, 2012)

Table 4. Population Density, 2010

Segment 1	Land (mi^2)	Population (2010)	Population density ($persons/mi^2$)
McKenzie County, ND	2,760.3	6,360	2.3
Richland County, MT	2,084.1	9,746	4.7
Dawson County, MT	2,371.9	8,966	3.8
Prairie County, MT	1,736.7	1,179	0.7
Segment 1 Total	8,953.1	19,891	2.2
River Corridor Total	29,859.9	226,995	7.6

Source: United States Census Bureau, 2012

Housing

Although the total population of Segment 1 has declined by 8.5%, the total number of housing units has increased by over 35% from 1950 to 2010 (see Table 5).

Table 5. Total Housing Units*, 1950-2010

Segment 1	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
McKenzie County, ND	2,183	2,451	2,227	2,944	3,178	2,719	3,090	41.5%
Richland County, MT	3,343	3,580	3,514	4,690	4,825	4,557	4,550	36.1%
Dawson County, MT	2,961	3,895	3,755	4,637	4,487	4,168	4,233	43.0%
Prairie County, MT	788	878	706	808	749	718	673	-14.6%
Segment 1 Total	9,275	10,804	10,202	13,079	13,239	12,162	12,546	35.3%
River Corridor Total	44,383	54,887	57,593	80,151	88,808	95,967	109,295	146.3%

Source: United States Census Bureau, 2010

*A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

Dawson County, MT, had the greatest increase in housing units from 1950 to 2010, 43%, and also had the smallest decline in population, -1.4%, during this time period (United States Census Bureau, 2010). Prairie County, MT, which had the greatest decline in population, was the only county that showed a decline in housing units from 1950 to 2010. As compared to the River Corridor, which had an increase in housing units of nearly 150%, Segment 1 showed significantly smaller growth in the number of housing units and accounted for only 11% of the total housing units in the River Corridor in 2010 (Table 5).

As mentioned previously, the four-county area has experienced a flux in population due to in- and out-migration over the past six decades. Table 6 compares current place of residence to place of residence 1 year ago to illustrate migration in 2012. This indicates the number of individuals that have moved within the county, or have moved into each county from another county within the same state, from a different state, or from a different country.

Table 6. Percent Individuals by Residence 1 Year Ago, 2012

Segment 1	Total Population 1 Year and Over	Same House	Different House: Same County	Same State/ Different County	Different State	Abroad
McKenzie County, ND	6,570	88.1%	2.4%	3.1%	6.4%	0.0%
Richland County, MT	9,747	83.7%	8.8%	3.2%	4.2%	0.1%
Dawson County, MT	8,879	81.8%	8.4%	4.1%	5.5%	0.1%
Prairie County, MT	1,176	93.3%	0.9%	5.4%	0.4%	0.0%
Segment 1 Total	26,372	84.6%	6.7%	3.6%	5.0%	0.1%
River Corridor Total	236,143	83.4%	9.2%	3.6%	3.9%	0.1%

Source: United States Census Bureau, 2012a

As a portion of the population 1 year of age and older, Prairie County had the greatest percentage of residents living in the same house as they were in the previous year, 93.3%. This is above the percentage of the population living in the same house for both Segment 1 and the River Corridor, 84.6% and 83.4%, respectively (United States Census Bureau, 2012a). Of the four counties in Segment 1, Richland County had the greatest percentage of residents move within the same county, 8.8%. Prairie County had the lowest percentage of residents moving within the county, 0.9%, but the highest percentage of Montana state residents who moved into the county in the previous year, 5.4%. McKenzie County, ND, had the highest number of residents, 6.4%, who moved into the county in the last year from a different state (see Table 6). Residents moving into the counties from abroad accounted for less than 1 percent of the population 1 year of age and older for all counties within Segment 1 as well as the River Corridor as a whole (United States Census Bureau, 2012a).

Economic Trends

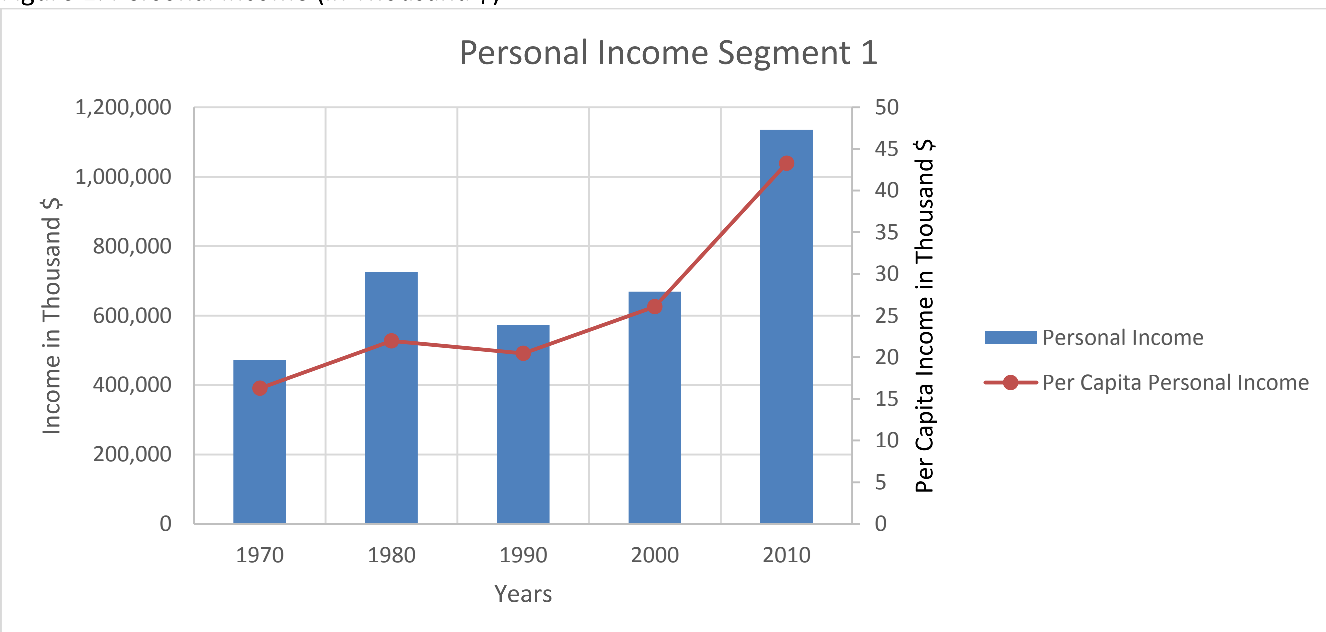
In 2010, Segment 1 had the second highest personal income in the River Corridor after Yellowstone County, $1.1 billion and $5.6 billion, respectively. Across segments in the River Corridor, Segment 1 had the highest per capita income in in 2010, $43 thousand (Bureau of Economic Analysis, 2010). Segment 1 derives nearly half of its proprietary income from farm proprietors, while the rest of the River Corridor derives the majority of the proprietary income from non-farm ventures (Bureau of Economic Analysis, 2010). As of 2010, farming, mining, construction, wholesale trade and government enterprises sectors are the major sources of earnings in Segment 1. Historically, the unemployment rate in this segment has remained below that of the River Corridor (Bureau of Economic Analysis, 2010).

Income

Segment 1 experienced an increase in personal income in 1980 and again in 2010 (Figure 1) (Bureau of Economic Analysis, 2010). Though the population of Segment 1 increased only 2.3%, between 2000 and 2010, (Table 1), the personal income increased 69%, and as a result increased the per capita personal income 66% (Bureau of Economic Analysis, 2010). This growth can likely be attributed to the oil and gas boom occurring once again in this segment. Since 1970, the area has seen an increase in dividend, interest and rent, and personal current transfer receipts incomes (Figure 2). Dividends, interests and rent typically represent investment income or property income while personal current transfer receipts capture government payments such as retirement and disability insurance benefits, Medicare and Medicaid. The development of the Bakken Oil Field is a likely contributor to the increase in investment and property income, while the increase in the median age (Table 2) may be causing the increase in government payments. Although proprietors' income has fluctuated over the last 5 decades, the proportion of farm to non-farm proprietors' income has remained fairly consistent, moving between 40-60% and 60-40% (Figure 3) (Bureau of Economic Analysis, 2010). Proprietors' income increased between 2000 and 2010 from $80 to $146 million, with $70 million from non-farm and $76 million from farm proprietors' income (Figure 3).

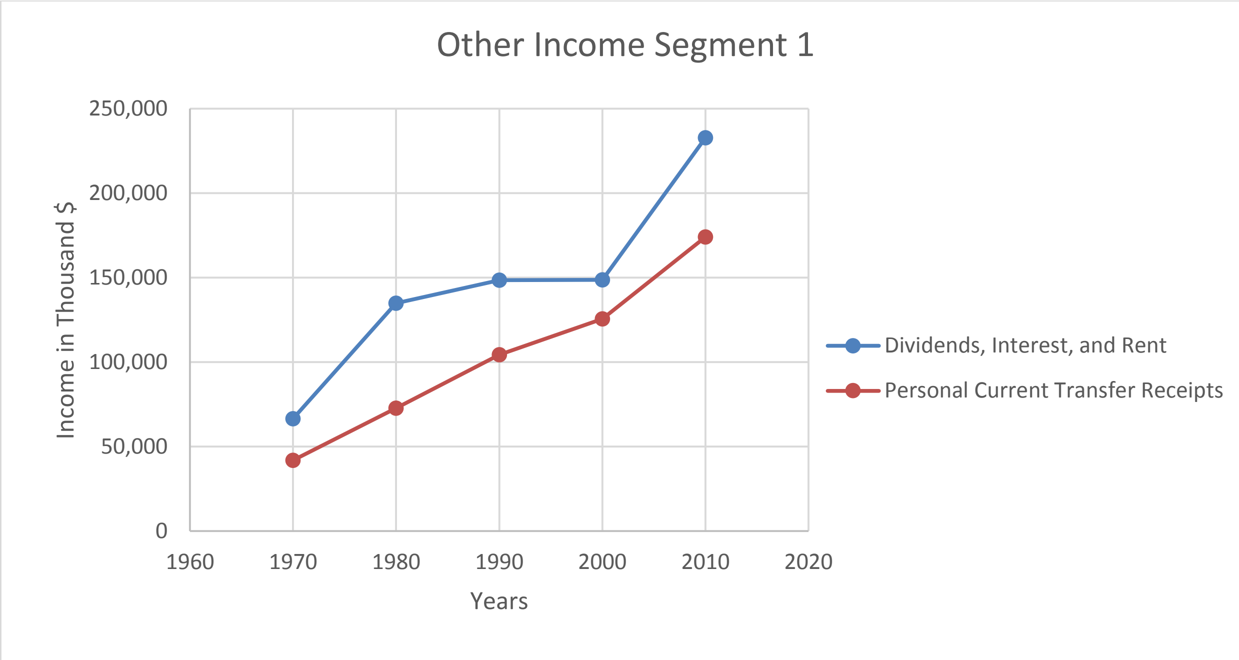
Table 7 provides income data for Segment 1 and the River Corridor for 2010. McKenzie and Richland Counties are primary drivers of the income data, with Dawson County contributing only slightly less than McKenzie County (Bureau of Economic Analysis, 2010). Prairie County contributes to only a small fraction of personal income for Segment 1, likely due to its much smaller population, as compared to the other counties in the segment. At $56 thousand, the per capita income of McKenzie County is highest within the segment and is also higher than per capita income in the River Corridor. McKenzie County has the highest ratio of proprietors' income than any other county in the segment or the River Corridor, 18% compared to 8%, while Prairie County has the highest ratio of both retirement and disability benefits as well as medical benefits, 13% and 12%, respectively (Table 7) (Bureau of Economic Analysis, 2010). In Prairie County, this is likely due to the aging population.

Figure 1. Personal Income (in Thousand $)



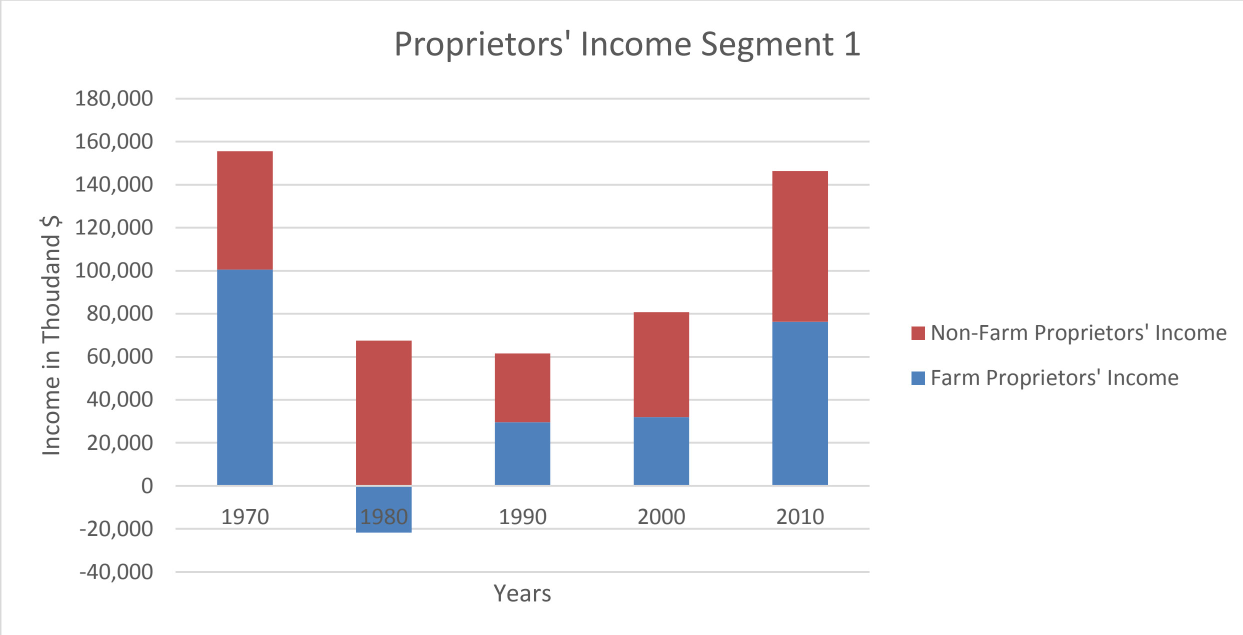
Source: Bureau of Economic Analysis, 2010

Figure 2. Other Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 3. Proprietors' Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 7. 2010 Income (in Thousand $)

	McKenzie	Percent Total	**Richland**	Percent Total	**Dawson**	Percent Total	**Prairie**	Percent Total	**River Corridor**	Percent Total
Personal income	356,659		454,434		287,724		36,563		8,774,733	
Per capita personal income	56		47		32		31		38	
Net earnings by place of residence	248,186	70%	296,053	65%	170,541	59%	13,751	38%	5,433,877	62%
Proprietors' income	63,534	18%	61,236	13%	21,022	7%	588	2%	660,096	8%
Farm proprietors' income	40,227	11%	24,720	5%	11,165	4%	151	0%	63,889	1%
Nonfarm proprietors' income	23,307	7%	36,516	8%	9,857	3%	437	1%	596,207	7%
Dividends, interest, and rent	68,645	19%	98,714	22%	53,276	19%	12,088	33%	1,766,656	20%
Personal current transfer receipts	39,828	11%	59,667	13%	63,907	22%	10,724	29%	1,574,200	18%
Retirement and disability insurance benefits	14,916	4%	25,500	6%	28,844	10%	4,644	13%	634,042	7%
Medical benefits	16,653	5%	23,570	5%	24,017	8%	4,481	12%	597,035	7%
Income maintenance benefits	4,149	1%	3,785	1%	3,634	1%	496	1%	132,357	2%
Other	4,110	1%	6,812	1%	7,412	3%	1,103	3%	210,766	2%

Source: Bureau of Economic Analysis, 2010

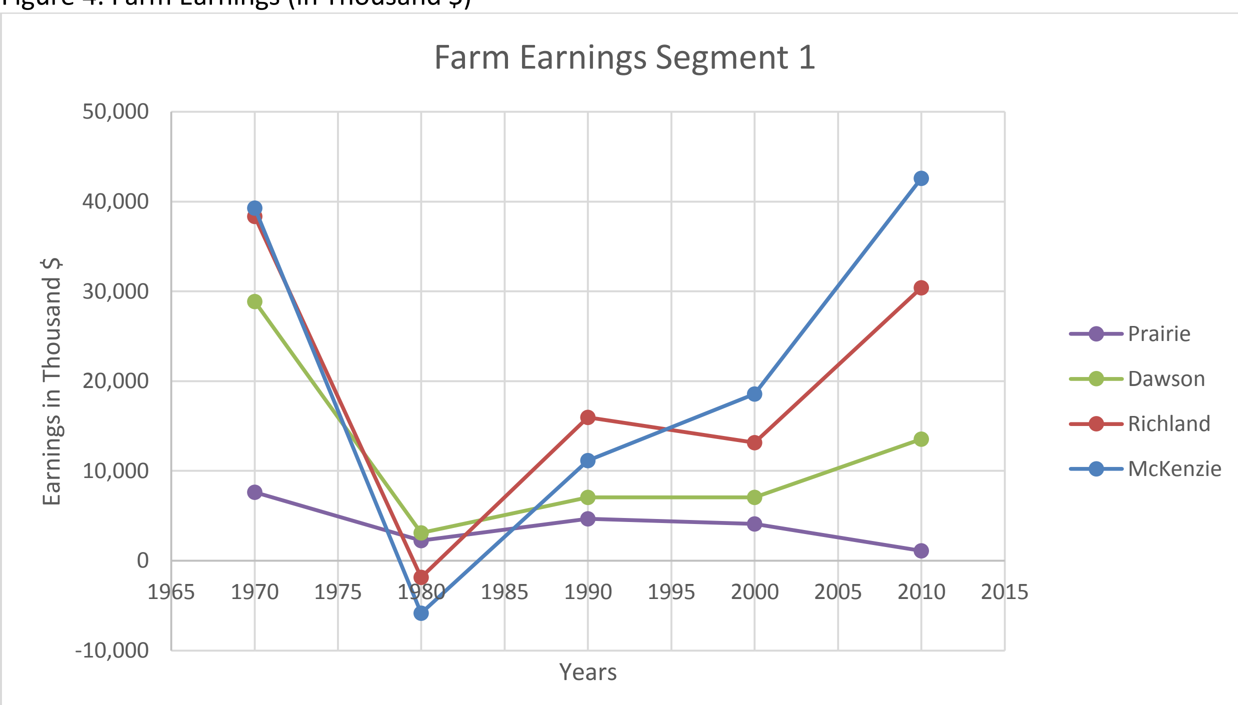
Earnings

Earnings in Segment 1 vary by industry. In some years, earnings data are suppressed and therefore not represented in the figures or tables provided in this report. Data suppression due to confidentiality reasons are marked with (D) while data suppressions resulting from a lack of confidence in the data are marked with (L). Confidentiality issues may result from only one company representing an industry within the county, while confidence issues may be due to a particularly low and therefore, uncertain estimates. All suppressed data are included in total earnings (Bureau of Economic Analysis, 2010).

Farm earnings, as shown in Figure 4, saw a dramatic decline across all counties within Segment 1 in 1980 and are currently experiencing an increase of varying degrees by county, with the exception of Prairie County, where farm earnings have once again declined (Bureau of Economic Analysis, 2010). As farm earnings declined in the 1980's, mining, construction, transportation and wholesale trade earnings began to increase across counties within Segment 1 (Figures 5, 6, 7, and 8). Again, this is most likely due to the boom of the gas and oil industry during the time period. A similar increase in mining, construction and wholesale trade earnings is seen again in 2010, likely correlated to the recent oil and gas industry development. With fewer fluctuations, earnings from services and government enterprises have increased since 1970, contributing consistently to total earnings in Segment 1 (Figures 12 and 13) (Bureau of Economic Analysis, 2010).

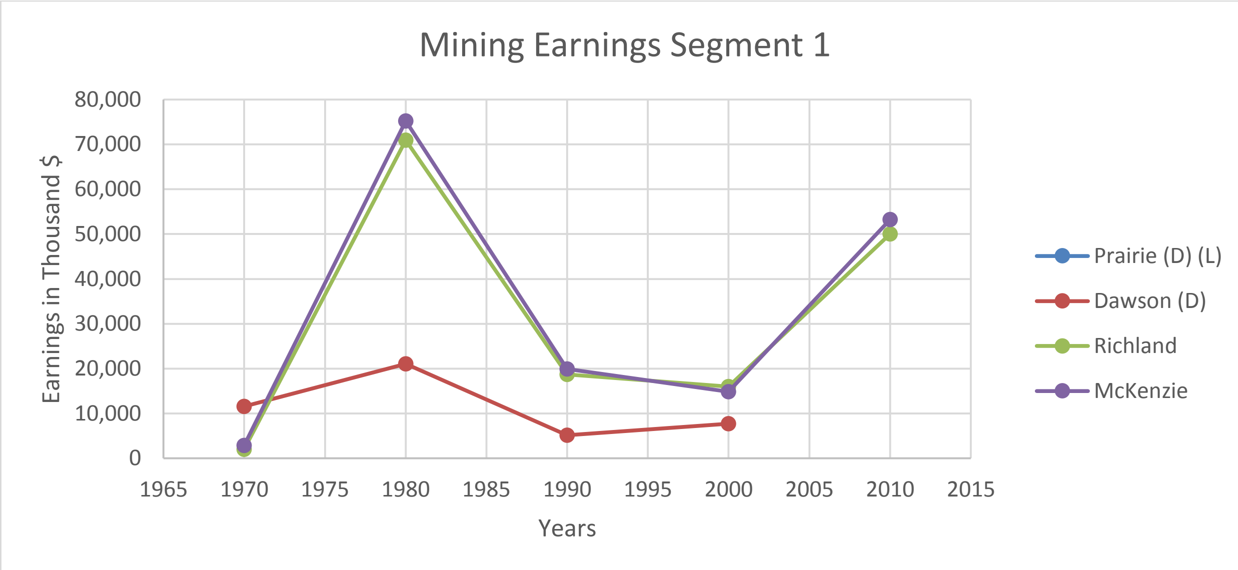
In 2010, McKenzie and Richland counties had the highest earnings by work place (Table 8) (Bureau of Economic Analysis, 2010). Percent of farm earnings in Segment 1 is much higher than seen across the River Corridor, ranging from 7-14%, compared to 2% at the River Corridor. Government enterprises make up 62% of earnings by place of work in Prairie County compared to only 16% at the corridor level. About 28% of the earnings in Dawson County are suppressed in 2010 for confidentiality reasons (Table 8) (Bureau of Economic Analysis, 2010).

Figure 4. Farm Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 5. Mining Earnings (in Thousand $)

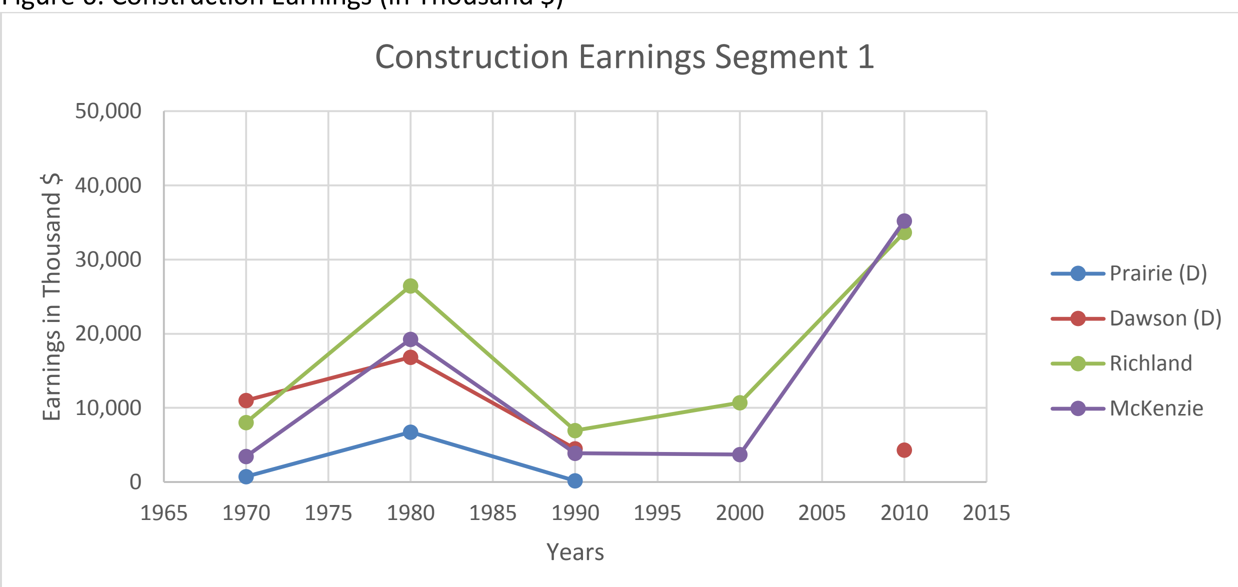


Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

* (L) Less than $50,000, but the estimates for this item are included in the totals.

Figure 6. Construction Earnings (in Thousand $)



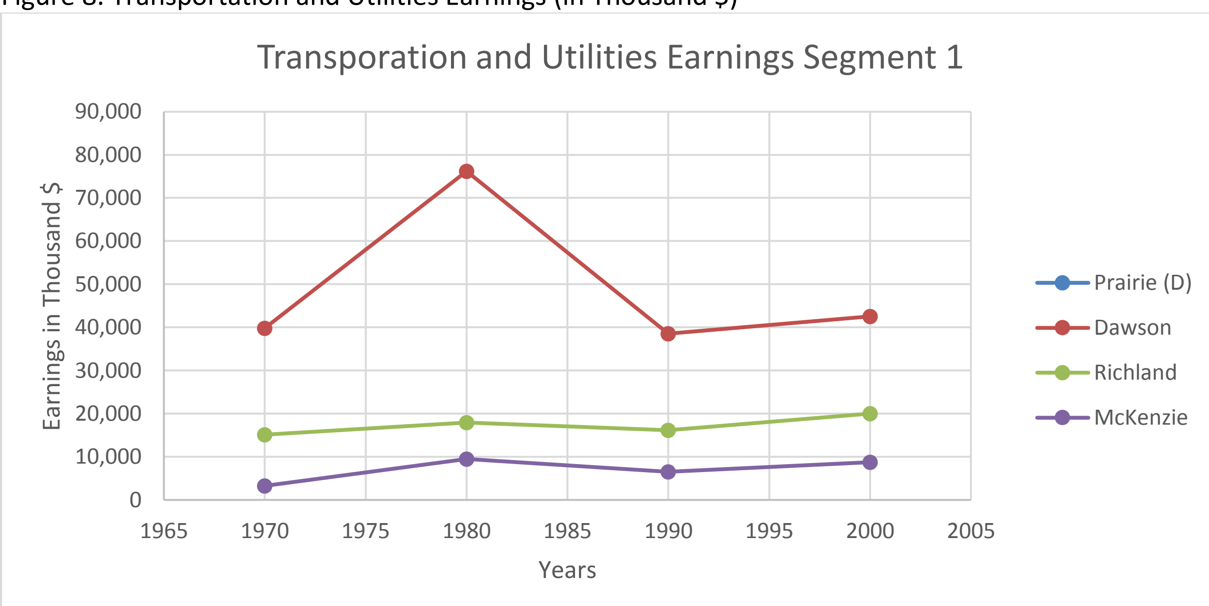
Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 7. Manufacturing Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 8. Transportation and Utilities Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

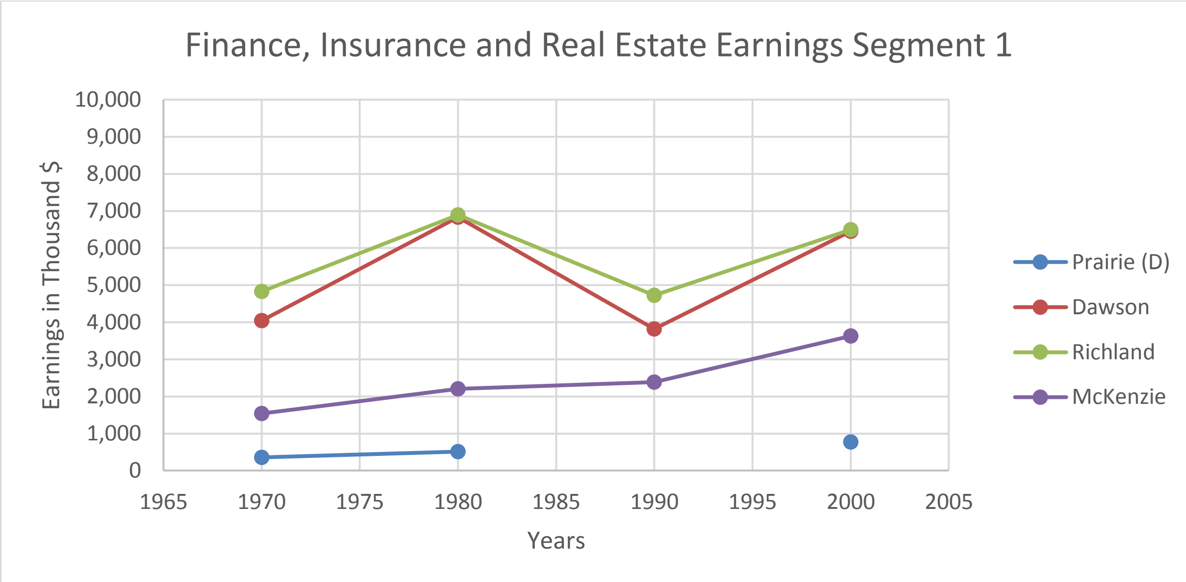
Figure 9. Wholesale Trade Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 10. Retail Trade Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

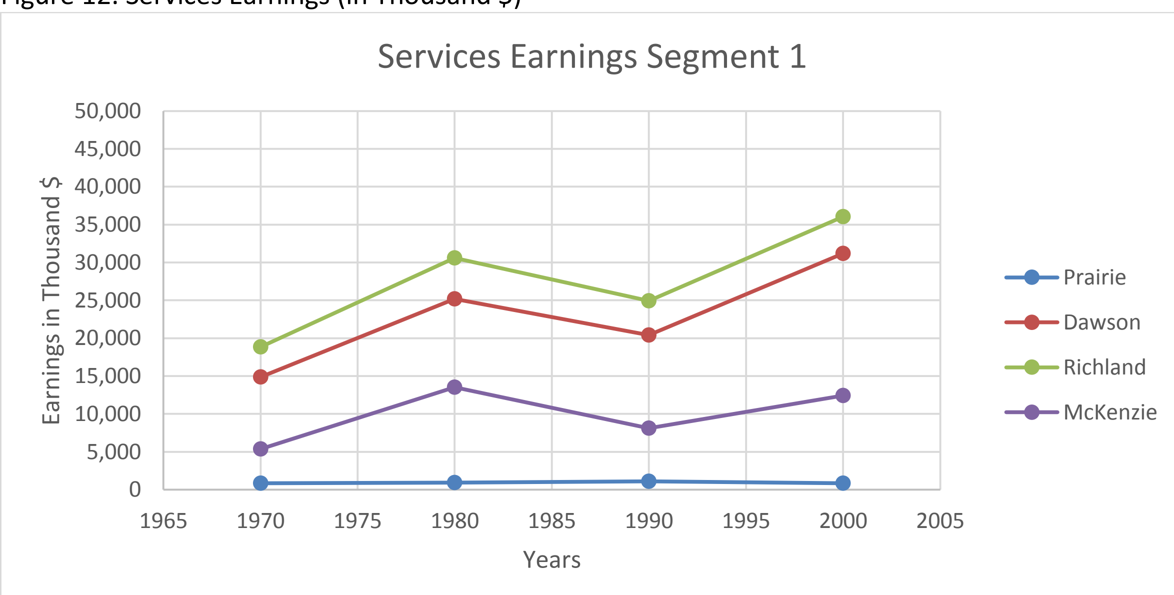
Figure 11. Finance, Insurance and Real Estate (in Thousand $)



Source: Bureau of Economic Analysis, 2010

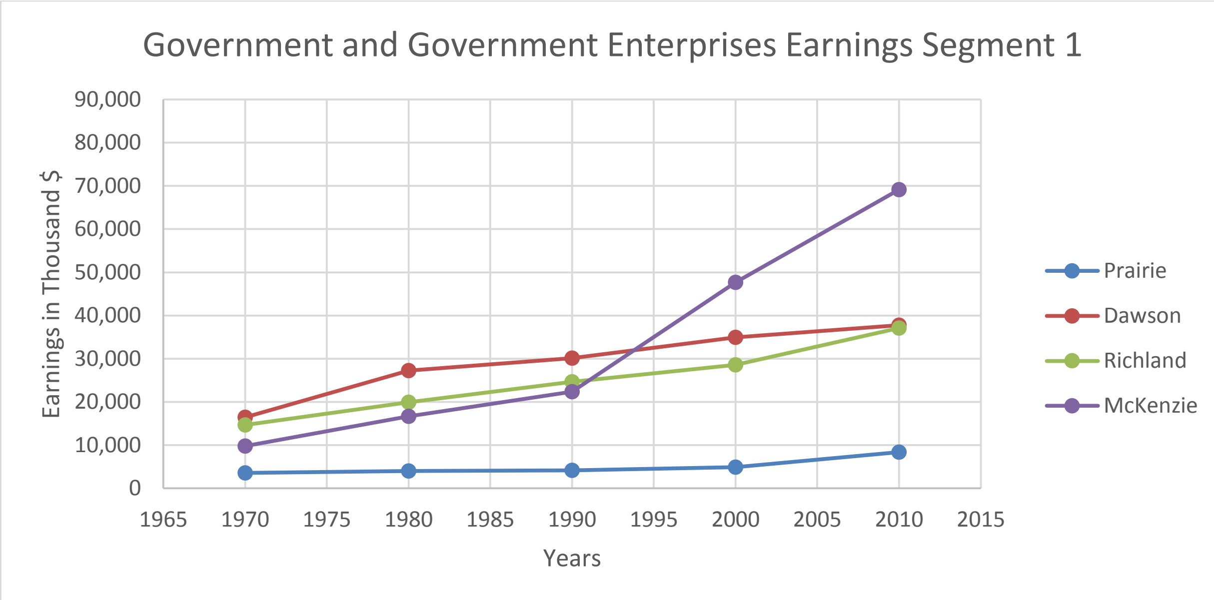
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 12. Services Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 13. Government and Government Enterprises Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 8. Earnings by Industry 2010 (in Thousand $)

	Segment 1								River Corridor	
Earnings by Industry 2010	**McKenzie**	Percent Total	**Richland**	Percent Total	**Dawson**	Percent Total	**Prairie**	Percent Total	**River Corridor**	Percent Total
Farm earnings	42,607	14%	30,390	9%	13,538	7%	1,119	8%	111,114	2%
Forestry, fishing, and related activities	(D)	-	(D)	-	(D)	-	(D)	-	8,501	0%
Mining	53,235	17%	50,059	15%	(D)	-	(D)	-	227,003	4%
Utilities	(D)	-	7,131	2%	(D)	-	(D)	-	53,712	1%
Construction	35,203	11%	33,673	10%	4,319	2%	(D)	-	474,975	8%
Manufacturing	2,299	1%	14,887	4%	1,671	1%	(D)	-	310,939	5%
Wholesale trade	15,901	5%	14,173	4%	8,594	4%	(D)	-	404,674	6%
Retail trade	(D)	-	17,032	5%	15,131	8%	236	2%	470,257	8%
Transportation and warehousing	43,259	14%	33,072	10%	(D)	-	480	4%	308,590	5%
Information	690	0%	1,581	0%	4,884	3%	184	1%	102,368	2%
Finance and insurance	5,279	2%	8,096	2%	4,436	2%	0	0%	278,587	4%
Real estate and rental and leasing	7,639	2%	6,788	2%	2,507	1%	0	0%	81,605	1%
Professional, scientific, and technical services	7,283	2%	12,785	4%	3,315	2%	770	6%	371,658	6%
Management of companies and enterprises	(D)	-	(D)	-	(D)	-	(D)	-	32,148	1%
Administrative and waste management services	(D)	-	(D)	-	(D)	-	(L)	-	166,574	3%
Educational services	755	0%	(D)	-	63	0%	(L)	-	31,762	1%
Health care and social assistance	7,089	2%	(D)	-	28,832	15%	(L)	-	895,034	14%
Arts, entertainment, and recreation	1,027	0%	2,355	1%	2,145	1%	(L)	-	63,352	1%
Accommodation and food services	3,012	1%	7,661	2%	6,280	3%	143	1%	233,769	4%
Other services, except public administration	5,324	2%	10,049	3%	7,018	4%	492	4%	229,168	4%
Government and government enterprises	69,159	22%	37,119	11%	37,771	19%	8,376	62%	999,422	16%
Provided Data Total	299,761	96%	286,851	86%	140,504	72%	11,800	87%	5,855,212	94%
Suppressed Data Total	11,745	4%	48,557	14%	53,906	28%	1,815	13%	400,857	6%
Earning by place of work	311,506		335,408		194,410		13,615		6,256,069	

Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
* (L) Less than $50,000, but the estimates for this item are included in the totals.

Employment

Within Segment 1, total employment for full-time and part-time workers has been steadily increasing since the decline of the 1990s, following the economic growth in the area that occurred in the 1980s. Between 2000 and 2010, total employment grew 19% while the population in the segment grew only 2.3 % (Tables 9 and 10). In 1970, the majority of proprietary employment was attributed to farm proprietors' employment. Conversely, beginning in 1980, non-farm proprietors' employment has accounted for the majority of the employment share with almost 3 times as much proprietors' employment coming from non-farm-related sectors than farm-related sectors in 2010. The sectors with the highest earnings often have the highest employment numbers. Employment in mining, construction and wholesale trade sectors increased in 1980 and again in 2010 (Bureau of Economic Analysis, 2010). A decrease in farm employment has occurred since 1970 and although farm earnings have increased at various rates since the 1990s, with a significant increase in 2010, farm employment continues to decrease (Tables 9 and 10) (Bureau of Economic Analysis, 2010).

Table 11 shows the labor force in Segment 1 from 1990 to 2010. The number of individuals employed shown in Table 11 is lower than the numbers reported in Tables 9 and 10. The labor force data is produced by Bureau of Labor Statistics (BLS) while the previous data is reported by Bureau of Economic Analysis (BEA). The BEA estimates of employment differ from the BLS data as the BEA adjusts data to account for employment not covered, or not fully covered, by the state Unemployment Insurance (UI) and the Unemployment for Federal Employees (UCFE) programs. This may include nonprofit organizations not participating in the UI program, students and their spouses employed by public colleges or universities, elected officials and members of state and local judiciary, interns employed by hospitals and by social service agencies, and insurance agents classified as statutory employees. More information is provided in the Methods and Definitions section of the report. Table 11 also shows that the unemployment rate has been decreasing in the segment since 1990 and has historically remained lower than the unemployment rate of the River Corridor (Bureau of Labor Statistics, 2010).Employment by Industry data from BEA and Labor Force data from BLS at the county level can be found in the appendix of this report.

Table 9. Employment by Industry 1970-2000

	Segment 1					The River Corridor	
	1970	**1980**	**1990**	**2000**	Percent Total	**2000**	Percent Total
Total full-time and part-time employment	13,329	19,305	14,534	16,369		138,767	
Proprietors employment	4,545	4,420	4,286	4,825	29%	32,826	24%
Farm proprietors employment	2,649	2,105	1,999	1,832		6,016	
Nonfarm proprietors employment	1,896	2,315	2,287	2,993		26,810	
Farm employment	3,309	2,692	2,399	2,304	14%	7,556	5%
Agricultural services, forestry, and fishing	227	206	237	180	1%	1,607	1%
Mining	426	2,987	932	765	5%	2,053	1%
Construction	610	1,330	490	488	3%	7,698	6%
Manufacturing	528	502	443	537	3%	5,526	4%
Transportation and public utilities	1,256	1,779	1,077	1,119	7%	8,618	6%
Wholesale trade	337	857	518	486	3%	7,720	6%
Retail trade	2,067	2,757	2,202	2,466	15%	26,278	19%
Finance, insurance, and real estate	696	736	669	702	4%	8,884	6%
Services	1,989	3,066	2,987	3,828	23%	43,052	31%
Government and government enterprises	1,846	2,298	2,515	3,190	19%	17,590	13%

Source: Bureau of Economic Analysis, 2010

Table 10. Employment by Industry 2010

	Segment 1		The River Corridor	
	2010	Percent Total	**2010**	Percent Total
Total employment	19,431		154,335	
Wage and salary employment	14,141	72.8%	117,792	76.3%
Proprietors employment	5,290	27.2%	38,388	24.9%
Farm proprietors employment	1,427		5,286	
Nonfarm proprietors employment	3,863		33,102	
Farm employment	1,738	8.9%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	1,372	7.1%	3,146	2.0%
Utilities	60	0.3%	483	0.3%
Construction	1,360	7.0%	9,952	6.4%
Manufacturing	461	2.4%	4,687	3.0%
Wholesale trade	680	3.5%	6,883	4.5%
Retail trade	1,381	7.1%	17,670	11.4%
Transportation and warehousing	988	5.1%	5,371	3.5%
Information	188	1.0%	2,159	1.4%
Finance and insurance	490	2.5%	6,338	4.1%
Real estate and rental and leasing	540	2.8%	6,441	4.2%
Professional, scientific, and technical services	587	3.0%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	34	0.2%	6,480	4.2%
Educational services	96	0.5%	1,681	1.1%
Health care and social assistance	1,001	5.2%	17,163	11.1%
Arts, entertainment, and recreation	373	1.9%	4,272	2.8%
Accommodation and food services	1,168	6.0%	12,769	8.3%
Other services, except public administration	982	5.1%	9,141	5.9%
Government and government enterprises	4,093	21.1%	19,405	12.6%

Source: Bureau of Economic Analysis, 2010

Table 11. Labor Force

	Segment 1			The River Corridor
	1990	**2000**	**2010**	**2010**
Labor Force	13,991	13,070	14,099	125,613
Employed	13,366	12,500	13,620	119,142
Unemployed	625	570	479	6,471
Unemployment Rate	4.5%	4.4%	3.4%	5.2%

Source: Bureau of Labor Statistics, 2010

Segment 2 – Treasure, Rosebud, and Custer Counties, MT

Introduction

Segment 2 of the River Corridor encompasses a three-county area: Treasure, Rosebud, and Custer Counties, MT. This area was extensively explored by trappers and fur traders, including Lewis and Clark, and later served as a camp for Lt. Col. George Armstrong Custer, just prior to his defeat at the Battle of the Little Bighorn. Today, this area is home to the Northern Cheyenne Tribe and Reservation (Rosebud County, 2008).

Similar to Segment 1, the three-county area of Segment 2 is sparsely populated, with an economy highly dependent on agriculture and energy development. The area is rich in energy sources, including coal, methane gas, oil and timber (Southeastern Montana Development Corporation, 2010). Located in Rosebud County, the city of Colstrip, MT, houses one of the largest coal mines in the state of Montana. Also located in Colstrip is the nation's second largest coal-fired power plant (Southeastern Montana Development Corporation, 2010). Miles City, the largest city in Segment 2, sits at the confluence of the Tongue and Yellowstone Rivers. Once an important military camp and hub for the early cattle economy, Miles City is the seat of Custer County, offering public services to rural southeastern Montana (Miles City Chamber of Commerce, 2014).

Additionally, Segment 2 is the Northern Cheyenne Reservation, located in the southern portion of Rosebud County, MT. The reservation is over 444 thousand acres and is home to nearly 5 thousand of the 10 thousand enrolled tribal members (Northern Cheyenne Tribe, 2013). There are five districts within the reservation, with the majority of residents living in the Lame Deer district (Chief Dull Knife College, 2013). The reservation offers several services to enrolled tribal members including two schools: St. Labre School, an on-site school for students from pre-kindergarten through twelfth grade and Chief Dull Knife College, a small land grant college offering students certificate and two-year degree programs (Chief Dull Knife College, 2013). Despite services offered on the reservation, in 2000, the poverty rate among reservation residents was above 46% with 1 in 4 residents over the age of 25 not having earned at least a high school diploma; in 2005, nearly 60% of residents of the reservation were unemployed (Montana State University Extension, 2011b).

Demographic Trends

Population

Since 1950, Treasure and Custer Counties have experienced negative population growth, with the population of Treasure County declining by nearly 50%. Conversely, the population of Rosebud County has increased by over 120% from 1950 to 2010, leading to an 18.8% increase in population for the segment as a whole. Even given the significant increase in population within Rosebud County, the percent increase in population for Segment 2 remains below that of the River Corridor, 18.8% as compared to 74.5% (see Table 12 below) (United States Census Bureau, 2010).

Segment 2 continues to be considered a rural part of the State of Montana, with only five towns/reservations having a population of over 1 thousand residents: Miles City (Custer), Forsyth

(Rosebud), Northern Cheyenne Reservation (Rosebud), Lame Deer (Rosebud), and Colstrip (Rosebud) (United States Census Bureau, 2010).

Table 12. Population Total 1950-2010

Segment 2	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Treasure County, MT	1,402	1,345	1,069	981	874	861	718	-48.8%
Rosebud County, MT	4,155	6,187	6,032	9,899	10,505	9,383	9,233	122.2%
Custer County, MT	12,661	13,227	12,174	13,109	11,697	11,696	11,699	-7.6%
Segment 2 Total	18,218	20,759	19,275	23,989	23,076	21,940	21,650	18.8%
River Corridor Total	133,723	162,839	161,516	194,822	196,814	214,004	233,355	74.5%

Source: United States Census Bureau, 2010

As can be seen in Table 12, Treasure County has experienced a steady decline in population while Custer County has experienced both growth and decline over time (United States Census Bureau, 2010). In direct contrast to Treasure County, Rosebud County has seen steady positive growth in its population. This may be related to the increasing demand for energy and related increase in employment opportunities, given Rosebud County's abundance of energy-related resources (Rosebud County, 2008).

Although Segment 2 has experienced positive population growth, the median age of the population continues to increase across each county. Table 13 shows the median age of the population from 1950 to 2010.

Table 13. Median Age 1950-2010

Segment 2	1950	1960	1970	1980	1990	2000	2010
Treasure County, MT	26.2	24.5	29.2	32.8	36.3	41.8	51.5
Rosebud County, MT	27.8	26.5	26.2	25.2	29.5	34.5	36.5
Custer County, MT	29.8	28.8	29.2	30.4	35.5	39.3	42.1

Source: United States Census Bureau, 2010

Similar to Segment 1, the population in Segment 2 continues to age; this is especially true for the population of Treasure County. In 1950, the population of Custer County had the highest median age at nearly 30 years, while in 2010, the population of Treasure County has the highest median age of the three counties in Segment 2 at 51.5 years (United States Census Bureau, 2010). The median age of the population of Rosebud County, though increased over time, showed the smallest increase of slightly less than 9 years (see Table 13).

Table 14 provides additional detail related to the age distribution of the population within each county. As expected given an older median age, only 5% of the population of Treasure County and just over 6% of the population of Custer County is under 5 years of age. This highlights a concern for these two counties, not only is the population continuing to age, but the next generation of residents is shrinking. This may indicate a decline in future economic activity in these counties. In 2010, 8.0% of the population of Rosebud County was under 5 years of age and only 11.5% was 65 years old or older (Table 14) (United States Census Bureau, 2010a). This may be an indication of continued population growth within Rosebud County.

Table 14. Detailed Age Distribution, 2010

Segment 2	Median Age	Percent of Population Under 5 Years of Age	Percent of Population 18 and Over	Percent of Population 65 and Over
Treasure County, MT	51.5	5.0	81.3	23.8
Rosebud County, MT	36.5	8.0	70.4	11.5
Custer County, MT	42.1	6.2	77.3	17.5

Source: United States Census Bureau, 2010a

Table 15 shows the population density for each of the three counties, Segment 2 and the River Corridor in 2010. As mentioned previously, southeastern Montana remains relatively rural and this is shown within Segment 2. In 2010, Treasure County had the lowest population density, with less than one person per square mile while Custer County had the highest density, 3.1 persons per square mile (United States Census Bureau, 2012). The average population density of Segment 2 is the same as Segment 1, and well below that of the River Corridor, 2.2 persons per square mile compared to 7.6 personal per square mile (see Table 15) (United States Census Bureau, 2012). Segments 1 and 2 have the lowest population density across the five segments in the River Corridor.

Table 15. Population Density, 2010

Segment 2	Land (square miles)	Population (2010)	Population density
Treasure County, MT	977.4	718	0.7
Rosebud County, MT	5,010.4	9,233	1.8
Custer County, MT	3,783.4	11,699	3.1
Segment Total	9,771.2	21,650	2.2
River Corridor Total	29,859.9	226,995	7.6

Source: United States Census Bureau, 2012

Housing

Though the population of Segment 2 increased by 18.8% from 1950 to 2010, total housing units in the segment have increased by over 50% (see Table 16).

Table 16. Total Housing Units* 1950-2010

Segment 2	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Treasure County, MT	450	443	448	462	448	422	422	-6.2%
Rosebud County, MT	2,161	1,989	2,055	3,787	4,251	3,912	4,057	87.7%
Custer County, MT	4,037	4,665	4,356	5,473	5,405	5,360	5,560	37.7%
Segment 2 Total	6,648	7,097	6,859	9,722	10,104	9,694	10,039	51.0%
River Corridor Total	44,383	54,887	57,593	80,151	88,808	95,967	109,295	146.3%

*A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.
Source: United States Census Bureau, 2010

Rosebud County had the greatest increase in housing units, 87.7%, while housing units in Treasure County declined by 6% from 1950 to 2010 (United States Census Bureau, 2010). This is consistent with the population growth in Rosebud County and the population decline in Treasure County. The increase in housing units by 38% in Custer County is contrary to the population decline seen in the county during the same time period. The percent increase in housing units of the River Corridor as a whole outpaced all three counties in Segment 2 (see Table 16). Segment 2 has the second lowest increase in housing units among all segments in the corridor (United States Census Bureau, 2010).

Table 17 indicates the number of individuals that have moved within the county, or have moved into each county from another county within the same state, from a different state, or from a different country. This table helps illustrate the population migration that occurred from 2011 to 2012.

Table 17. Percent Individuals by Residence 1 Year Ago, 2012

			Different House			
Segment 2	Population 1 Year and Over	Same House	Same County	Same State/Different County	Different State	Abroad
Treasure County, MT	698	92.4%	4.3%	1.0%	2.3%	0.0%
Rosebud County, MT	9,116	88.4%	5.3%	2.9%	3.3%	0.1%
Custer County, MT	11,586	79.6%	11.1%	5.0%	4.2%	0.1%
Segment 2 Total	21,400	83.8%	8.4%	4.0%	3.7%	0.1%
River Corridor Total	236,143	83.4%	9.2%	3.6%	3.9%	0.1%

Source: United States Census Bureau, 2012a

Custer County had the highest percentage of migration both within the county as well as residents moving to the county from a different county in the state of Montana as well as a different state. From 2011 to 2012, 5.0% of Custer County residents moved to the county from another county in Montana while 4.2% of residents moved to the county from a different state (United States Census Bureau, 2012a). This exceeds the rates of migration for these two categories for the River Corridor. Treasure County experienced the lowest percentage of migration from 2011 to 2012, with 1% of the population moving into the county from the state of Montana, and 2.3% of the population moving to the county from a different state within the U.S. (United States Census Bureau, 2012a). This may indicate economic stagnation within Treasure County as net in-migration is limited. Residents moving into the counties from abroad represent less than 0.1% of the population for the three-county area as well as the River Corridor (United States Census Bureau, 2012a).

Economic Trends

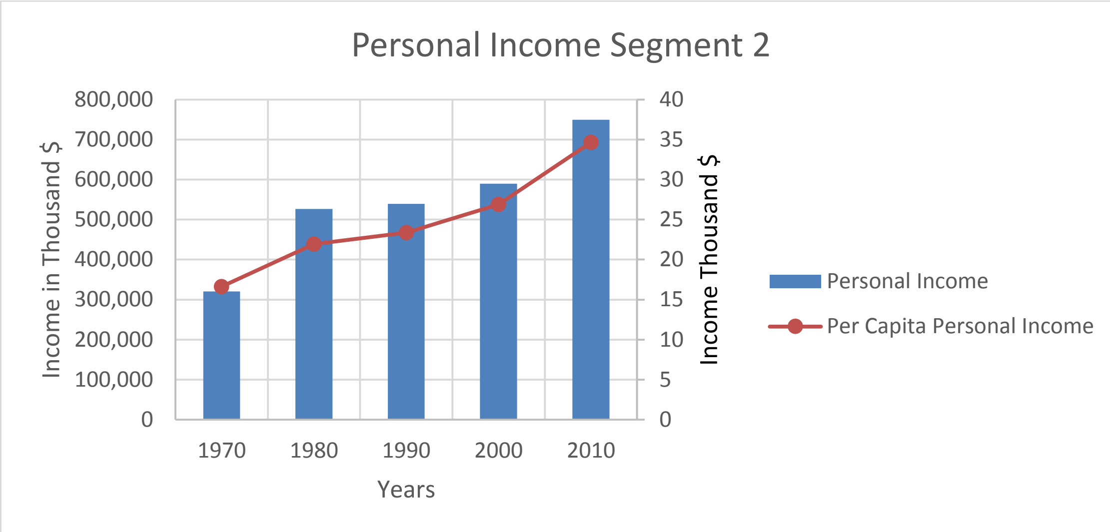
Segment 2 personal income is similar to that of Segment 4 at nearly $750 million, in 2010. The per capita income of Segment 2 is $35 thousand, which is below the average ($37 thousand) for the River Corridor, in 2010 (Bureau of Economic Analysis, 2010). This is the only segment in the River Corridor where the income from government payments exceeded the income from private property in 2010. The aging median population in the region may explain this. The largest share of earnings in this segment comes from government and government enterprises. Government is also one of the biggest employers, followed closely by services and retail trade industries (Bureau of Economic Analysis, 2010). The unemployment rate has fluctuated over time, and was 5.4% in 2010, 0.2% above the unemployment rate for the River Corridor (Bureau of Labor Statistics, 2010).

Income

Segment 2 has experienced consistent growth in both personal and per capita personal income since the 1970s (Figure 15). In 2010, the segment saw a particularly large growth in income compared to previous years, increasing 27% from 2000 (Bureau of Economic Analysis, 2010). Similarly, per capita personal income increased 28%, although the population decreased 1.3% from 2000 to 2010 (Bureau of Economic Analysis, 2010). The constant growth in the segment is attributed to the high income in Custer County, and continuously growing personal income in Rosebud County. Personal income in Treasure County has fluctuated over time, however, due to the county's small population, it does not affect the general trend of personal income in Segment 2. Since 1970, the three-county area has seen an increase in both dividend, interest and rent, and personal current transfer receipts income (Figure 15) (Bureau of Economic Analysis, 2010). Dividends, interests and rent typically represent investment income or property income while personal current transfer receipts capture government payments such as retirement and disability insurance benefits, Medicare and Medicaid. Most recently, dividends and interest income growth has slowed while government payments have increased, surpassing the amount that income dividends and interest contribute to the local economy, although both remain comparable contributors (Figure 15). Segment 2 has also experienced a decline in total proprietors' income since the 1970s, reaching its lowest of $46 million in 1990, after which it began a slight upward trend (Figure 16) (Bureau of Economic Analysis, 2010). In 2010 proprietors' income peaked at $51 million. Though there have been historical fluctuations in the total proprietor's income, the ratio between farm and non-farm income has been primarily dominated by non-farm income proprietors' income (Bureau of Economic Analysis, 2010).

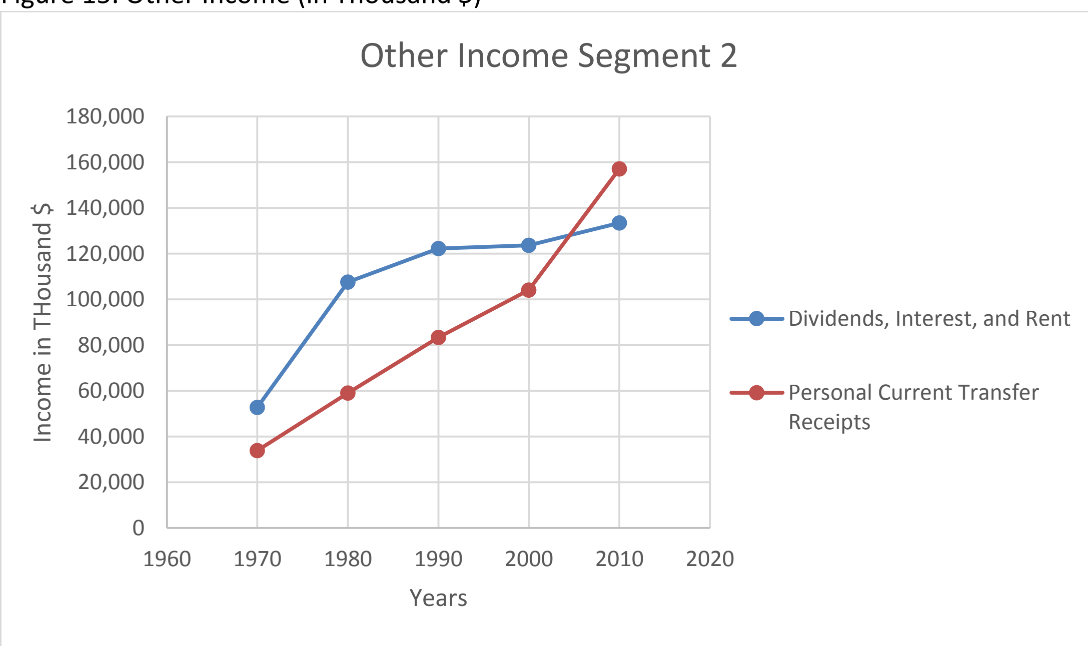
Table 18 provides income data for the three counties in Segment 2 for 2010. The table illustrates the extent to which Custer and Rosebud Counties act as the main drivers of the data in the segment. Though it has the lowest total personal income, Treasure County has the highest ratio of income from dividends, interest and rent, and retirement and disability insurance benefits compared to the other counties in the segment, 31% and 11%, respectively (Table 18) (Bureau of Economic Analysis, 2010). This is likely reflective of the aging population in Treasure County.

Figure 14. Personal Income (in Thousand $)



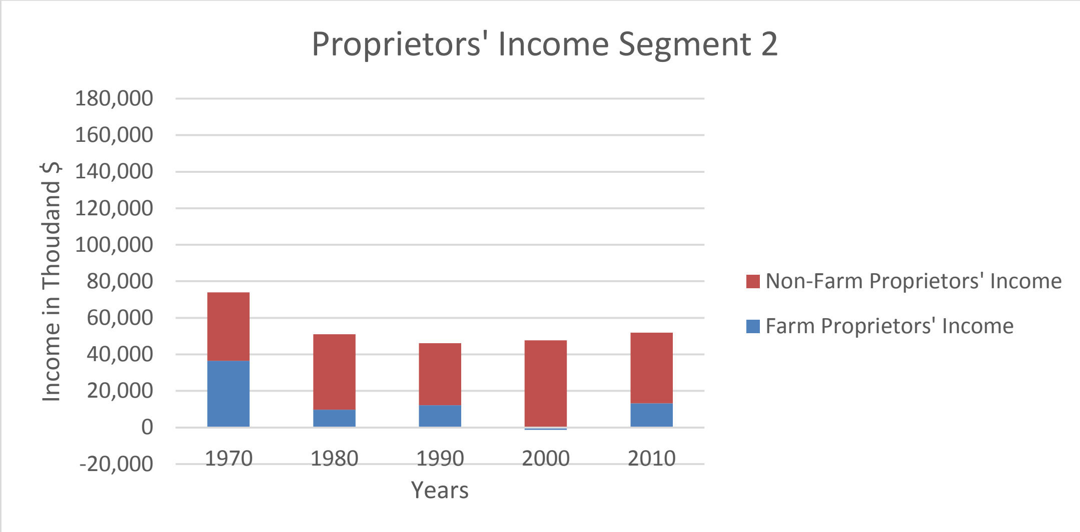
Source: Bureau of Economic Analysis, 2010

Figure 15. Other Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 16. Proprietors' Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 18. 2010 Income (in Thousand $)

	Segment 2						River Corridor	
	Custer	Percent Total	**Rosebud**	Percent Total	**Treasure**	Percent Total	**River Corridor**	Percent Total
Personal income	401,252		324,526		24,182		8,774,733	
Per capita personal income	34		35		34		38	
Net earnings by place of residence	237,800	59%	210,492	65%	11,168	46%	5,433,877	62%
Proprietors' income	29,393	7%	18,870	6%	3,606	15%	660,096	8%
Farm proprietors' income	4,018	1%	6,069	2%	3,208	13%	63,889	1%
Nonfarm proprietors' income	25,375	6%	12,801	4%	398	2%	596,207	7%
Dividends, interest, and rent	79,220	20%	46,659	14%	7,526	31%	1,766,656	20%
Personal current transfer receipts	84,232	21%	67,375	21%	5,488	23%	1,574,200	18%
Retirement and disability insurance benefits	33,011	8%	21,873	7%	2,713	11%	634,042	7%
Medical benefits	33,524	8%	25,453	8%	1,879	8%	597,035	7%
Income maintenance benefits	6,270	2%	10,719	3%	359	1%	132,357	2%
Other	11,427	3%	9,330	3%	537	2%	210,766	2%

Source: Bureau of Economic Analysis, 2010

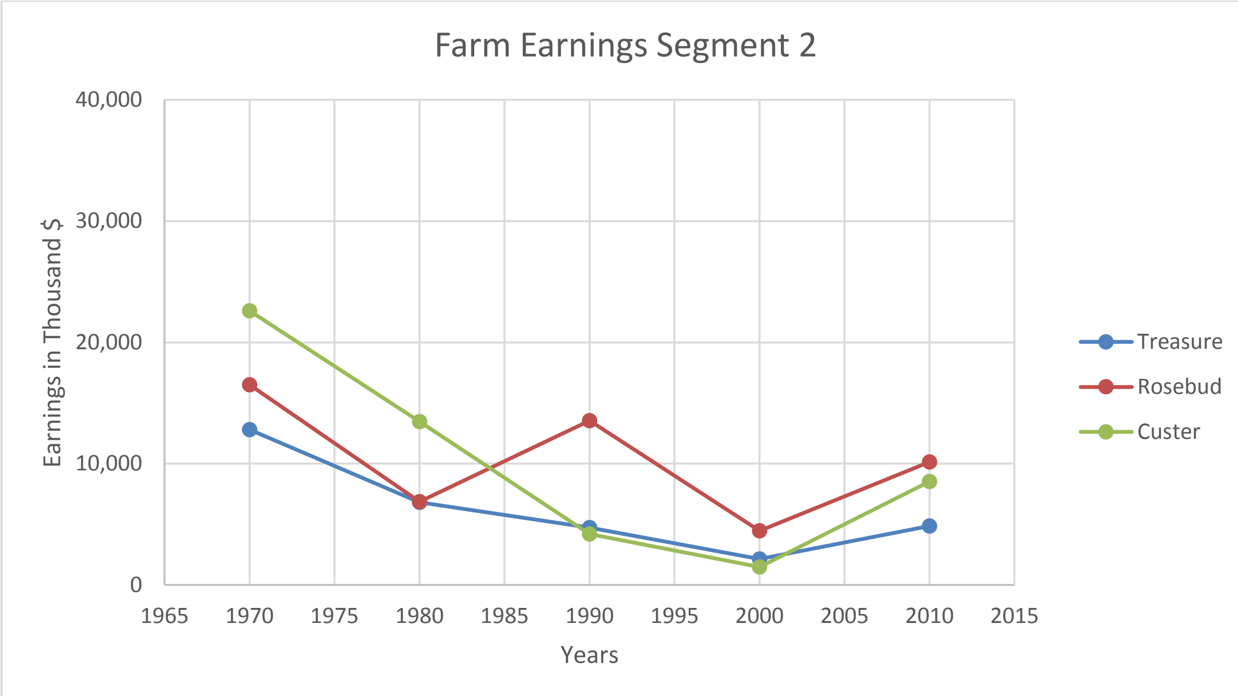
Earnings

Earnings in Segment 2 vary by industry. In some years, earnings data are suppressed and therefore not represented in the figures or tables provided in this report. Data suppression due to confidentiality reasons are marked with (D) while data suppressions resulting from a lack of confidence in the data is marked with (L). Confidentiality issues may result from only one company representing an industry within the county, while confidence issues may be due to a particularly low and therefore, uncertain estimate. All suppressed data are included in the total of all earnings (Bureau of Economic Analysis, 2010).

Farm earnings, displayed in Figure 17, show a decline across all counties from 1970 to 2000, with a slight increase in Rosebud County in 1990. Farm earnings in all three counties increased slightly in 2010. The majority of mining earnings is produced in Rosebud County, which have remained constant since the initial boom in the 1980s (Bureau of Economic Analysis, 2010). Construction earnings see a similar pattern as the one observed in Segment 1 with a spike in 1980 and 2010 (Figure 19). Earnings from the services sector increased in Custer County, while government and government enterprises earnings increase consistently in both Custer and Rosebud Counties since 1970 (Bureau of Economic Analysis, 2010).

Earnings by industry in 2010, displayed in Table 19, show Custer and Rosebud Counties have much higher earnings than Treasure County. While the highest percentage of earnings in Custer and Rosebud Counties comes from government and government services (23%), Treasure County relies much more heavily on farm earnings at 46% (Bureau of Economic Analysis, 2010). Segment 2 earnings are similar to the River Corridor earnings in most industries, with the exception of government and government services where the earnings in the segment range from 23-32% compared to 16% in the River Corridor. Note that 27% of the earnings data is suppressed within Rosebud County due to confidentiality reasons (Bureau of Economic Analysis, 2010).

Figure 17. Farm Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

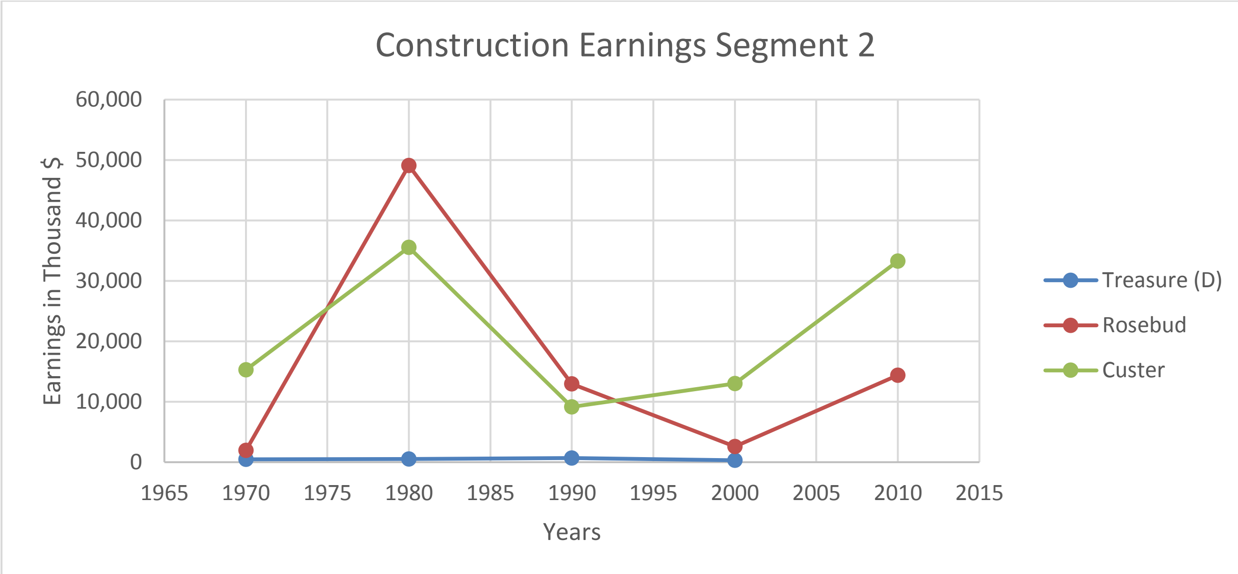
Figure 18. Mining Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

* (L) Less than $50,000, but the estimates for this item are included in the totals.

Figure 19. Construction Earnings (in Thousand $)

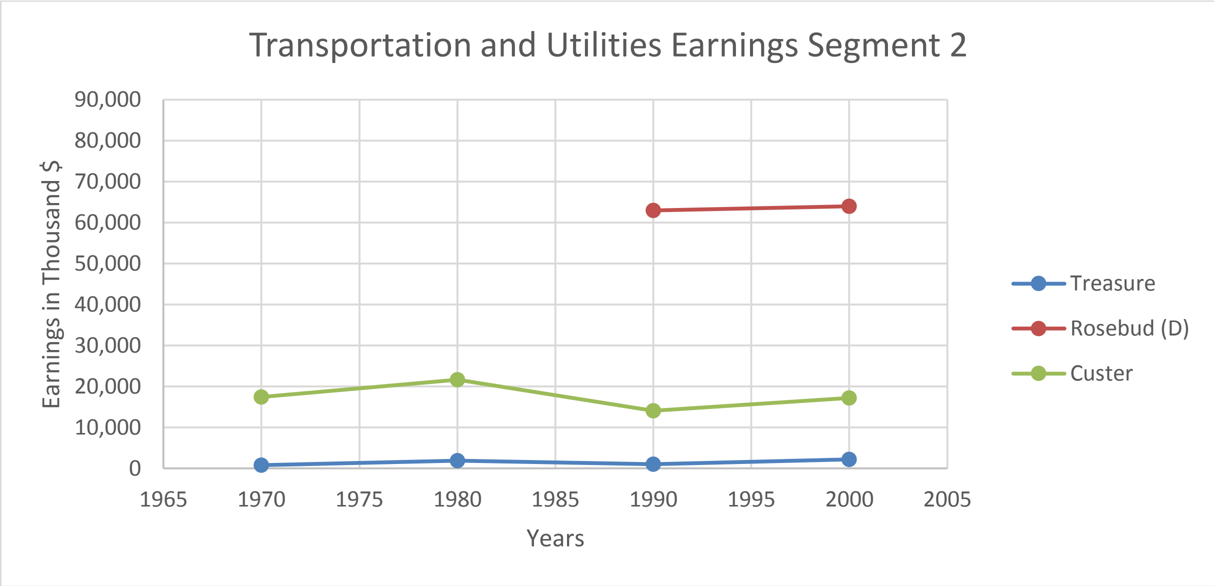


Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 20. Manufacturing Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
* (L) Less than $50,000, but the estimates for this item are included in the totals.

Figure 21. Transportation and Utilities Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

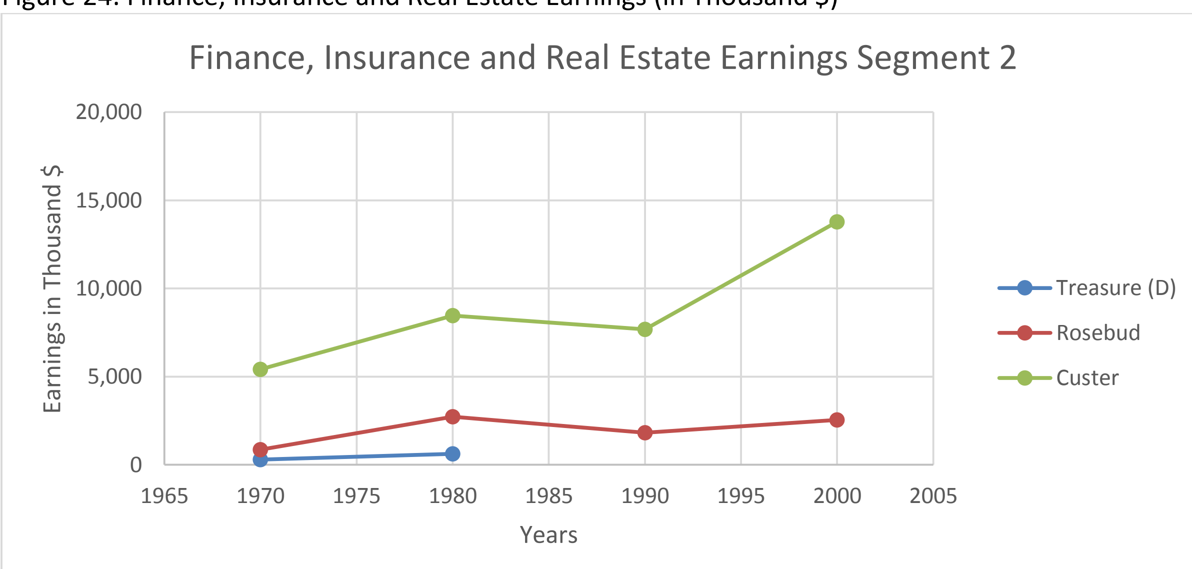
Figure 22. Wholesale Trade Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
* (L) Less than $50,000, but the estimates for this item are included in the totals.

Figure 23. Retail Trade Earnings (in Thousand $)

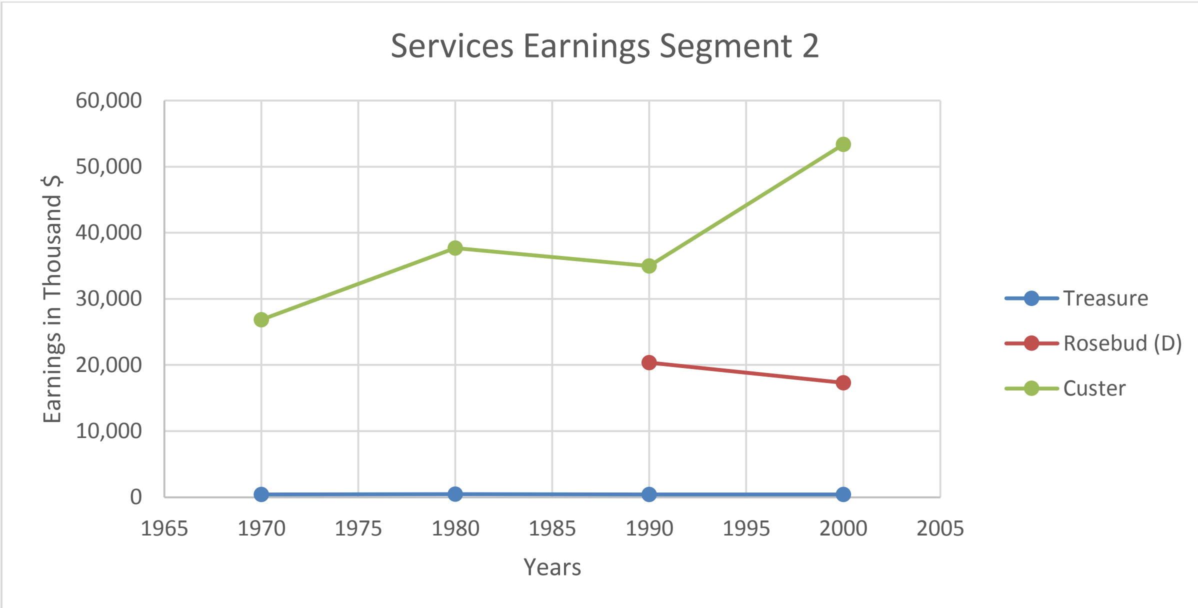
Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 24. Finance, Insurance and Real Estate Earnings (in Thousand $)



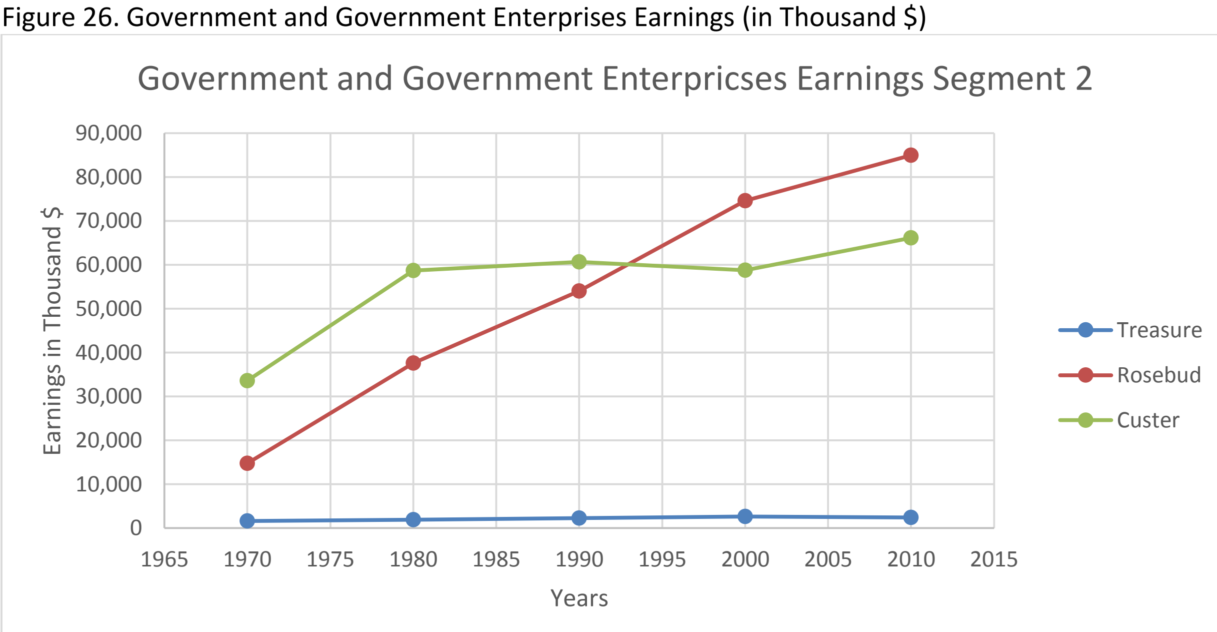
Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 25. Services Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 26. Government and Government Enterprises Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 19. Earnings by Industry 2010 (in Thousand $)

	Segment 2						River Corridor	
Earnings by Industry 2010	**Custer**	Percent Total	**Rosebud**	Percent Total	**Treasure**	Percent Total	**River Corridor**	Percent Total
Farm earnings	8,530	3%	10,146	4%	4,846	46%	111,114	2%
Forestry, fishing, and related activities	(D)	-	0	0%	120	1%	8,501	0%
Mining	(D)	-	44,873	17%	(D)	-	227,003	4%
Utilities	(D)	-	0	0%	(D)	-	53,712	1%
Construction	33,290	12%	14,369	5%	(D)	-	474,975	8%
Manufacturing	2,499	1%	498	0%	(D)	-	310,939	5%
Wholesale trade	7,299	3%	0	0%	894	8%	404,674	6%
Retail trade	26,938	10%	8,262	3%	(D)	-	470,257	8%
Transportation and warehousing	(D)	-	9,088	3%	(D)	-	308,590	5%
Information	3,214	1%	3,689	1%	(D)	-	102,368	2%
Finance and insurance	16,097	6%	2,753	1%	(D)	-	278,587	4%
Real estate and rental and leasing	1,258	0%	373	0%	(L)	-	81,605	1%
Professional, scientific, and technical services	8,777	3%	1,513	1%	(D)	-	371,658	6%
Management of companies and enterprises	3,042	1%	0	0%	(D)	-	32,148	1%
Administrative and waste management services	2,363	1%	1,598	1%	(D)	-	166,574	3%
Educational services	1,009	0%	(D)	-	(D)	-	31,762	1%
Health care and social assistance	41,092	15%	(D)	-	(D)	-	895,034	14%
Arts, entertainment, and recreation	2,124	1%	2,561	1%	(D)	-	63,352	1%
Accommodation and food services	11,108	4%	3,475	1%	(D)	-	233,769	4%
Other services, except public administration	8,828	3%	7,547	3%	225	2%	229,168	4%
Government and government enterprises	66,128	24%	84,917	32%	2,439	23%	999,422	16%
Provided Data Total	243,596	88%	195,662	73%	8,524	81%	5,855,212	94%
Suppressed Data Total	34,004	12%	70,730	27%	1,995	19%	400,857	6%
Earning by place of work	277,600		266,392		10,519		6,256,069	

Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

* (L) Less than $50,000, but the estimates for this item are included in the totals.

Employment

Employment in Segment 2 increased from 1970 to 2000 and decreased in 2010 (Tables 20 and 21). The government enterprises and services sectors accounted for the largest percentage of employment in 2000, 24% and 23%, respectively (Bureau of Economic Analysis, 2010). The retail trade sector followed closely behind with 17% of employment in 2000 and 11.5% in 2010. In 2010, the percentage of people employed by the government and government enterprises sectors in Segment 2 was double that of the River Corridor, 25.5% and 12.6%, respectively (Bureau of Economic Analysis, 2010).

Table 22 shows a decline in the labor force in Segment 2 since 1990. The number of individuals employed shown in Table 22 is lower than the numbers reported in Tables 20 and 21. The labor force data is produced by Bureau of Labor Statistics (BLS) while the previous data is reported by Bureau of Economic Analysis (BEA). The BEA estimates of employment differ from the BLS data as the BEA adjusts data to account for employment not covered, or not fully covered, by the state Unemployment Insurance (UI) and the Unemployment for Federal Employees (UCFE) programs. This may include nonprofit organizations not participating in the UI program, students and their spouses employed by public colleges or universities, elected officials and members of state and local judiciary, interns employed by hospitals and by social service agencies, and insurance agents classified as statutory employees. More information is provided in the Methods and Definitions section of the report. Table 22 also shows that the unemployment rate has fluctuated in the segment since 1990 and has either remained comparable or higher than the unemployment rate of the River Corridor (Bureau of Labor Statistics, 2010).

Employment by Industry data from BEA and Labor Force data from BLS at the county level can be found in the appendix of this report.

Table 20. Employment by Industry, 1970-2000

	Segment 2					The River Corridor	
	1970	**1980**	**1990**	**2000**	Percent Total	**2000**	Percent Total
Total full-time and part-time employment	8,647	12,659	12,640	13,221		138,767	
Proprietors employment	2,228	2,483	2,765	3,219	24%	32,826	24%
Farm proprietors employment	910	734	811	912		6,016	
Nonfarm proprietors employment	1,318	1,749	1,954	2,307		26,810	
Farm employment	1,596	1,193	1,269	1,224	9%	7,556	5%
Agricultural services, forestry, and fishing	124	135	171	110	1%	1,607	1%
Mining	132	472	539	511	4%	2,053	1%
Construction	451	1,566	556	444	3%	7,698	6%
Manufacturing	356	311	299	187	1%	5,526	4%
Transportation and public utilities	435	480	1,291	1,202	9%	8,618	6%
Wholesale trade	223	362	342	192	1%	7,720	6%
Retail trade	1,523	2,082	1,901	2,238	17%	26,278	19%
Finance, insurance, and real estate	375	495	453	619	5%	8,884	6%
Services	1,140	1,664	2,707	3,062	23%	43,052	31%
Government and government enterprises	1,737	2,844	3,080	3,143	24%	17,590	13%

Source: Bureau of Economic Analysis, 2010

Table 21. Employment by Industry, 2010

	Segment 2		The River Corridor	
	2010	**Percent Total**	**2010**	**Percent Total**
Total employment	14204		154,335	
Wage and salary employment	10,550	74.3%	117,792	76.3%
Proprietors employment	3,654	25.7%	38,388	24.9%
Farm proprietors employment	812	5.7%	5,286	
Nonfarm proprietors employment	2,842		33,102	
Farm employment	1,056	7.4%	6,393	4.1%
Forestry, fishing, and related activities	14	0.1%	429	0.3%
Mining	613	4.3%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	764	5.4%	9,952	6.4%
Manufacturing	133	0.9%	4,687	3.0%
Wholesale trade	251	1.8%	6,883	4.5%
Retail trade	1,422	10.0%	17,670	11.4%
Transportation and warehousing	134	0.9%	5,371	3.5%
Information	186	1.3%	2,159	1.4%
Finance and insurance	492	3.5%	6,338	4.1%
Real estate and rental and leasing	352	2.5%	6,441	4.2%
Professional, scientific, and technical services	386	2.7%	8,223	5.3%
Management of companies and enterprises	32	0.2%	481	0.3%
Administrative and waste management services	262	1.8%	6,480	4.2%
Educational services	85	0.6%	1,681	1.1%
Health care and social assistance	1,059	7.5%	17,163	11.1%
Arts, entertainment, and recreation	306	2.2%	4,272	2.8%
Accommodation and food services	1,027	7.2%	12,769	8.3%
Other services, except public administration	688	4.8%	9,141	5.9%
Government and government enterprises	3,153	22.2%	19,405	12.6%

Source: Bureau of Economic Analysis, 2010

Table 22. Labor Force, 1990-2010

	Segment 2			The River Corridor
	1990	**2000**	**2010**	**2010**
Labor Force	11,495	10,729	10,450	125,613
Employed	10,813	10,187	9,887	119,142
Unemployed	682	542	563	6,471
Unemployment Rate	5.9%	5.1%	5.4%	5.2%

Source: Bureau of Labor Statistics, 2010

Segment 3 – Yellowstone County, MT

Introduction

Segment 3 of the Yellowstone River Corridor encompasses only Yellowstone County, MT. Yellowstone County is known the historical landmark Pompey's Pillar, as well as its cultural importance to the Crow Nation. The city of Billings is also located in Yellowstone County and is the largest city in both the county as well as the state of Montana.

The Apsaalooké, or Crow, Reservation is located in Yellowstone, Big Horn, and Treasure Counties, MT, and is the largest reservation in Montana, encompassing over 2 million acres of land. Of the 10 thousand enrolled tribal members, about 7.5 thousand live on or near the reservation (Montana State Governor's Office of Indian Affairs, 2013). The tribal economy is dependent on both energy and agriculture. Currently, tribal members receive royalties from the operation of one coal mine on the reservation. Members also have a small dryland farming operations and use about 30% of their grazing lands to manage a small herd of about 300 buffalo (Montana State Governor's Office of Indian Affairs, 2013). The Crow Reservation has a lower unemployment rate as compared to other Montana tribal reservations. In 2005, the reservation had an unemployment rate of 46.5%, compared to a state reservation average of 51.6% (Montana State University Extension, 2011a). In 2000, the poverty rate on the reservation (30.5%) was almost the same as the average across all Montana tribal reservations (30.4%) (Montana State University Extension, 2011a).

Spurred on by the expansion of railroads, including the Great Northern Railroad, as well as the Enlarged Homestead Act, the city of Billings evolved as an economic hub in the early 20th Century (Jiusto, 2014). Today, Billings continues to serve as an important economic center for Yellowstone County and the state of Montana. In 2010, over 10% of the total population of Montana was located in Billings (United States Census Bureau, 2012). Additionally, as of 2007, over 10% of the firms in the state of Montana were located in Billings (United States Census Bureau, 2012). With the expansion of the Bakken Oilfields to the east, continued commercial growth and expansion is anticipated for both the city of Billings and Yellowstone County (Falstad, 2012).

Demographic Trends

Population

Since 1950, the population of Yellowstone County has been increasing, and has outpaced the growth of the River Corridor, increasing by nearly 165% (see Table 23).

Table 23. Population Total, 1950-2010

Segment 3	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Yellowstone County, MT	55,875	79,016	87,367	108,035	113,419	129,352	147,972	164.8%
River Corridor Total	133,723	162,839	161,516	194,822	196,814	214,004	233,355	74.5%

Source: United States Census Bureau, 2010

In 2010, the population of Yellowstone County accounted for about 15% of the statewide total. This growth in population is likely a reflection of the increasing professional opportunities found in the county, specifically located in the city of Billings, MT (Young and Zimmerman, 2013).

Though not as dramatically as other segments in the River Corridor, the population of Segment 3 has aged from 1950 to 2010. Though the population has increased within Yellowstone County, the median age has increased by nearly 10 years from 1950 to 2010, as seen in the table below (United States Census Bureau, 2010). Segment 3 has the youngest median age of all segments in the River Corridor.

Table 24. Median Age, 1950-2010

Segment 3	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**
Yellowstone County, MT	28.8	26.9	26.2	28.6	33.4	36.9	38.3

Source: United States Census Bureau, 2010

Table 25 provides additional detail regarding the age of the population of Yellowstone County. As seen below, less than 7% of the population is under the age of 5, while just over 14% of the population is over 65 years of age (United States Census Bureau, 2010a). The increasing median age may highlight the negative net migration occurring in the county in the 18-20 year old age bracket as many of these individuals move to Western Montana to attend university, as well as the positive net in-migration of slightly older residents seeking professional positions (Young and Zimmerman, 2013).

Table 25. Detailed Age Distribution, 2010

Segment 3	Median Age	Percent of Population Under 5 Years of Age	Percent of Population 18 and Over	Percent of Population 65 and Over
Yellowstone County, MT	38.3	6.8	76.3	14.1

Source: United States Census Bureau, 2010a

As home to the state's largest city, Yellowstone County had a significantly higher population density in 2010 as compared to the River Corridor, 56.2 and 7.6 people per square mile, respectively (United States Census Bureau, 2012) (see Table 26). While over 65% of the population of the River Corridor in 2010 was located in Yellowstone County, the county accounts for less than 9% of the total land mass.

Table 26. Population Density, 2010

Segment 3	Land (square miles)	Population (2010)	Population density
Yellowstone County, MT	2,633.3	147,972	56.2
River Corridor Total	29,859.9	226,995	7.6

Source: United States Census Bureau, 2012

Housing

Similar to the growth in population, Yellowstone County has experienced a significant increase in total housing units (Table 27).

Table 27. Total Housing Units*, 1950-2010

Segment 3	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Yellowstone County, MT	17,664	25,833	29,169	42,756	48,781	54,563	63,943	262%
River Corridor Total	44,383	54,887	57,593	80,151	88,808	95,967	109,295	146.3%

*A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.
Source: United States Census Bureau, 2010

From 1950 to 2010, total housing units in Yellowstone County increased 262%, and, as of 2010, Yellowstone County accounted for over half of the housing units found in the River Corridor (United States Census Bureau, 2010). Though the county has experienced negative net migration of its population of 18-20 year old residents, the county is one of the most important trade centers in the state and offers job opportunities for young professionals (Young and Zimmerman, 2013).

Table 28 indicates migration both within Yellowstone County as well as the River Corridor.

Table 28. Percent Individuals by Residence 1 Year Ago, 2012

			Different House			
Segment 3	Population 1 Year and Over	Same House	Same County	Same State/Different County	Different State	Abroad
Yellowstone County, MT	150,218	81.8%	10.7%	3.8%	3.7%	0.0%
River Corridor Total	236,143	83.4%	9.2%	3.6%	3.9%	0.1%

Source: United States Census Bureau, 2012a

Similar to the River Corridor, in 2012, over 80% of residents in Yellowstone County lived in the same house as they did in 2011 (United States Census Bureau, 2012a). Nearly 11% of residents of Yellowstone County moved to a different house, yet stayed within the county, while 3.8% of residents moved into Yellowstone County from a different county within the state of Montana. Finally, 3.7% of residents moved into Yellowstone County from another state (United States Census Bureau, 2012a).

Economic Trends

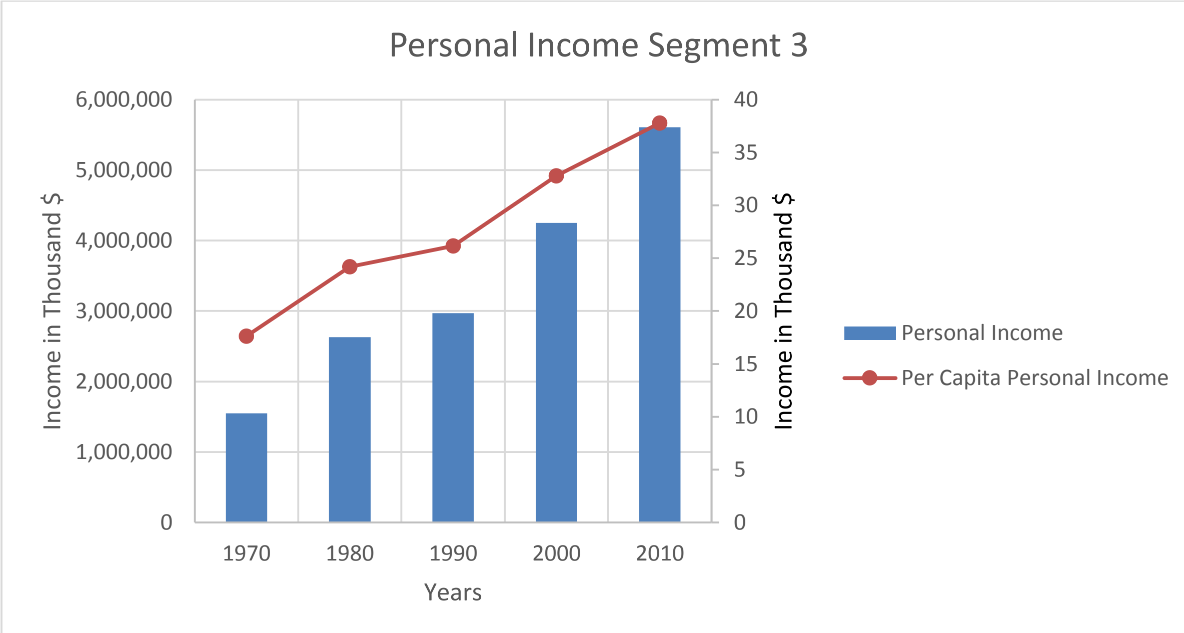
In 2010, the total personal income of the Yellowstone County, $5.6 billion, was the highest in the River Corridor. While Segment 1 has the second largest personal income of $1.1 billion in 2010, it is $4.5 billion lower than that of Segment 3 (Bureau of Economic Analysis, 2010). Per capita income in Yellowstone County is second highest in the River Corridor after Segment 1, $38 thousand and $43 thousand, respectively. A vast majority of the proprietors' income in this county comes from non-farm activity. Services, retail trade and government enterprises are the largest employment industries in this county (Bureau of Economic Analysis, 2010). Historically, the unemployment rate in the county has fluctuated above and below the rate of the River Corridor, with an unemployment rate of 5.4% in the county and 5.2% in the River Corridor in 2010 (Bureau of Labor Statistics, 2010).

Income

Personal income in Yellowstone County has been growing since the 1970 (Figure 27). Between 2000 and 2010, total personal income increased 32% (Bureau of Economic Analysis, 2010). During the same time, population and per capita income increased 15% each (Table 23 and Figure 27). Since 1970, the county has experienced a comparable growth of dividend, interest and rent income as well as personal current transfer receipts (Bureau of Economic Analysis, 2010). Dividends, interests and rent typically represent investment income or property income while personal current transfer receipts capture government payments such as retirement and disability insurance benefits, Medicare and Medicaid. As of 2010, property income was slightly above $1 billion while government payments in the county were slightly below $1 billion. Proprietors' income in Yellowstone County has fluctuated over the years, increasing in 1980 and again in 2000 (Figure 29) (Bureau of Economic Analysis, 2010). Proprietors' income decreased in 1990 and more recently in 2010. Historically, a vast majority of proprietors' income has come from non-farm income. In 2010, nearly $400 million came from non-farm income while -$8 million came from farm income (Bureau of Economic Analysis, 2010). In Yellowstone County, farm proprietor's income is negative, representing a loss due to production expenses exceeding gross output.

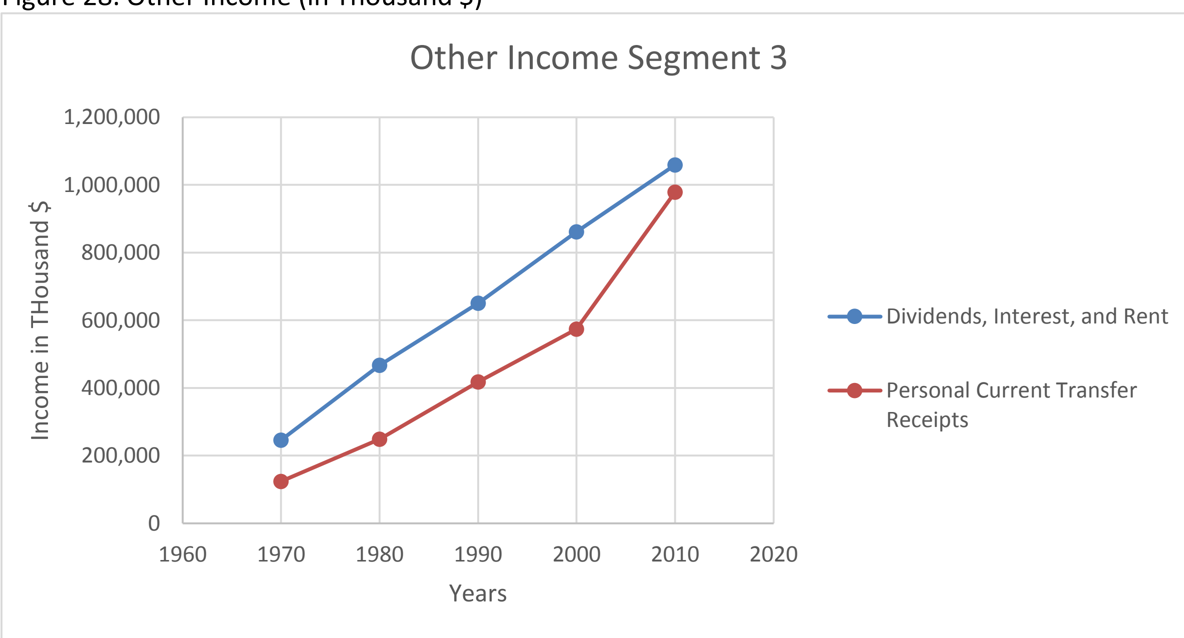
Table 23 shows income data for Yellowstone County for 2010. Overall, the income shares in the county are representative of the River Corridor. This is not surprising, since 64% of the income in the River Corridor is comprised of Yellowstone County personal income (Bureau of Economic Analysis, 2010).

Figure 27. Personal Income (in Thousand $)



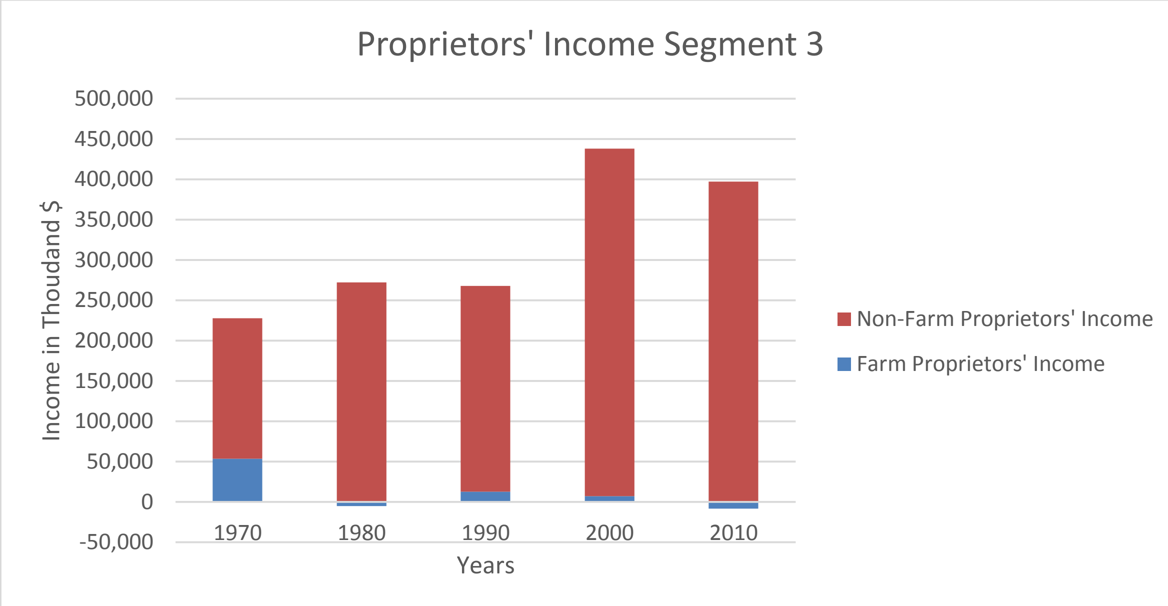
Source: Bureau of Economic Analysis, 2010

Figure 28. Other Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 29. Proprietors' Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 23. 2010 Income (in Thousand $)

	Segment 3		River Corridor	
	Yellowstone	Percent Total	**River Corridor**	Percent Total
Personal income	5,609,050		8,774,733	
Per capita personal income	38		38	
Net earnings by place of residence	3,571,236	64%	5,433,877	62%
Proprietors' income	388,957	7%	660,096	8%
Farm proprietors' income	-8,436	0%	63,889	1%
Nonfarm proprietors' income	397,393	7%	596,207	7%
Dividends, interest, and rent	1,058,792	19%	1,766,656	20%
Personal current transfer receipts	979,022	17%	1,574,200	18%
Retirement and disability insurance benefits	386,396	7%	634,042	7%
Medical benefits	372,616	7%	597,035	7%
Income maintenance benefits	85,576	2%	132,357	2%
Other	134,434	2%	210,766	2%

Source: Bureau of Economic Analysis, 2010

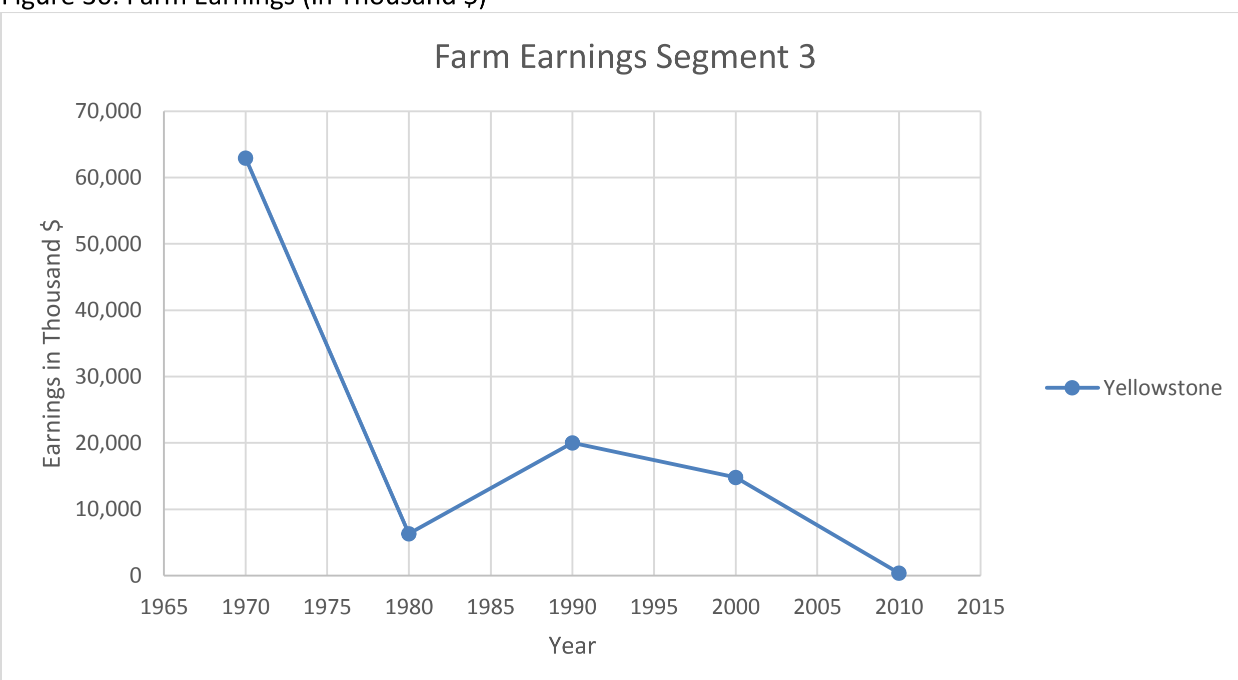
Earnings

Earnings in Segment 3 vary by industry. In some years, earnings data are suppressed and therefore not represented in the figures or tables provided in this report. Data suppression due to confidentiality reasons are marked with (D) while data suppressions resulting from a lack of confidence in the data is marked with (L). Confidentiality issues may result from only one company representing an industry within the county, while confidence issues may be due to a particularly low and therefore, uncertain estimate. All suppressed data are included in the total of all earnings (Bureau of Economic Analysis, 2010).

Earnings in every industry have been increasing in Yellowstone County, with the exception of farm earnings. Farm earnings plummeted after 1970, hitting an historic low in 2010 of $358 thousand (Figure 29) (Bureau of Economic Analysis, 2010). Although earnings from mining have increased, they make up about 2% of the total earning in the county. In 2000, earnings from the Services sector surpassed $1 billion, after historically consistent increases. Earnings from the finance, insurance and real-estate, government and government enterprises and services sectors have experienced uninterrupted upward trends in the region since 1970 (Bureau of Economic Analysis, 2010).

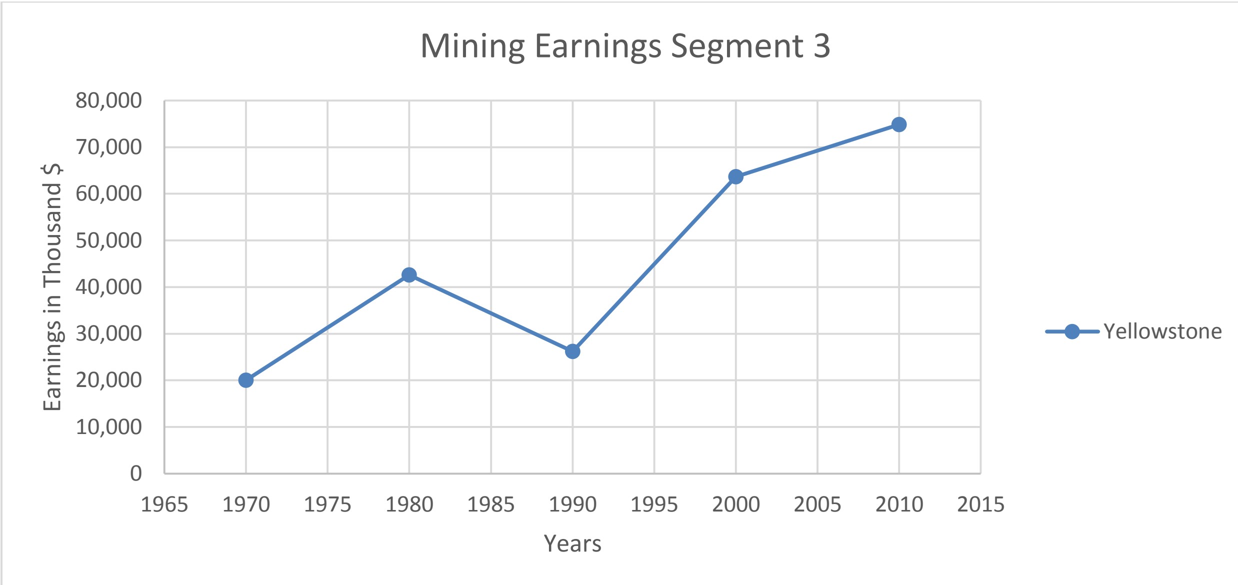
Earnings by industry for 2010 are shown in Table 24. In 2010, the health services and government and government enterprises sectors contributed the largest shares to the county earnings with nearly $770 and $600 million, respectively. Other industries that contribute substantially to earnings in the county are construction, wholesale trade, retail trade; all growing in recent decades with earnings above $300 thousand in 2010 (Bureau of Economic Analysis, 2010).

Figure 30. Farm Earnings (in Thousand $)



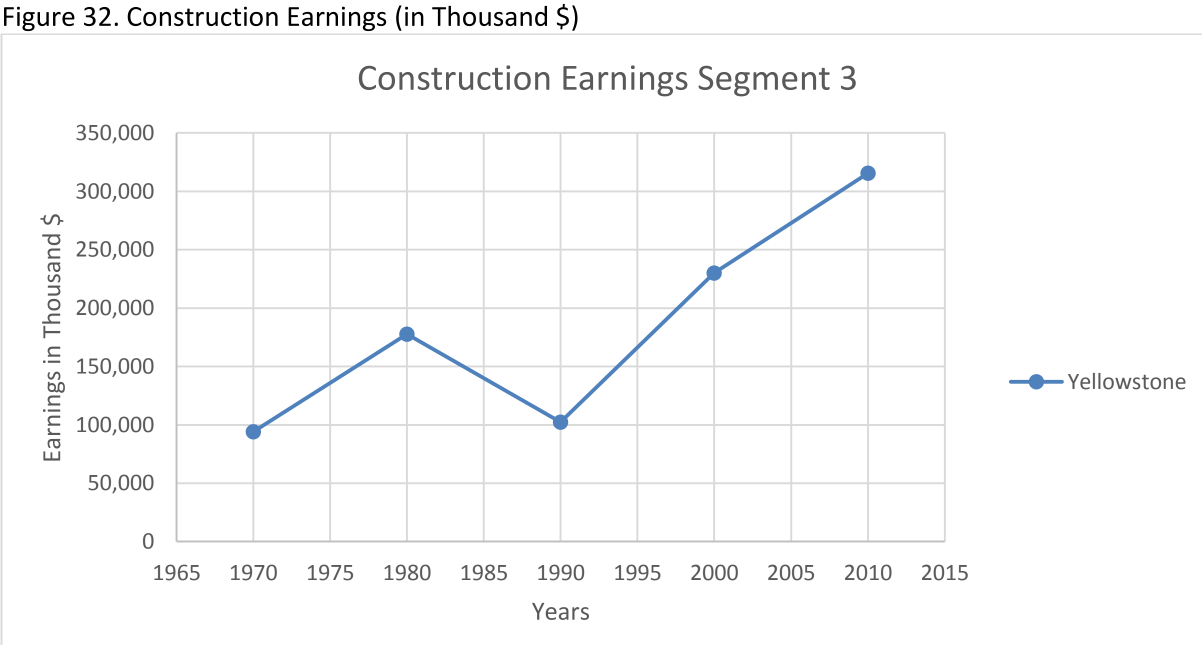
Source: Bureau of Economic Analysis, 2010

Figure 31. Mining Earnings (in Thousand $)



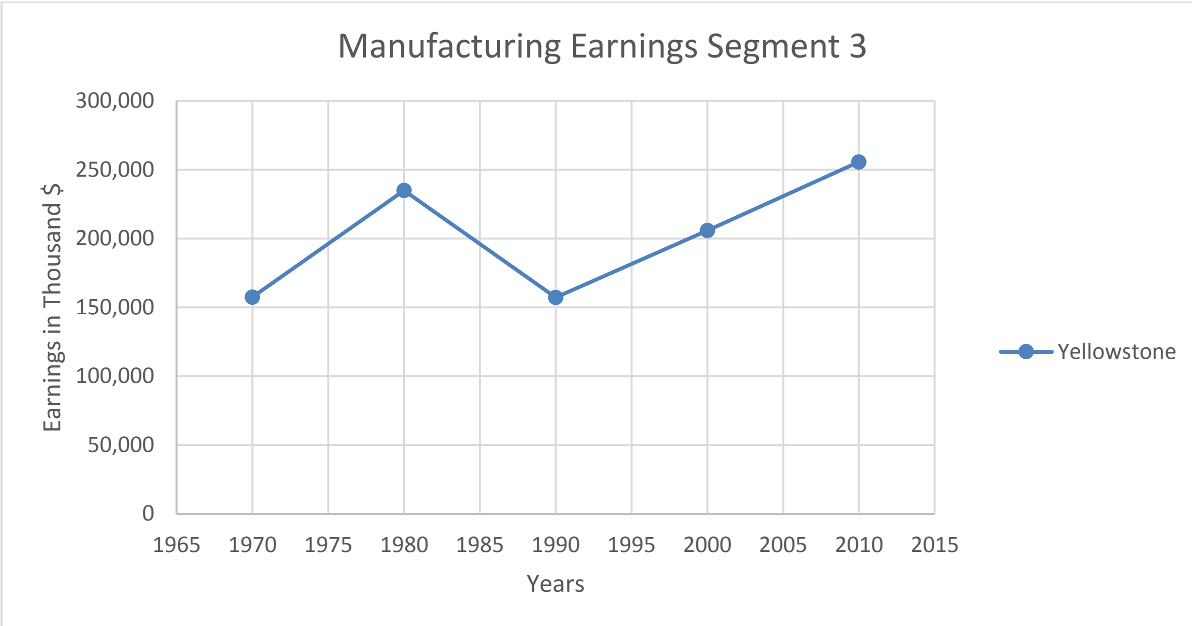
Source: Bureau of Economic Analysis, 2010

Figure 32. Construction Earnings (in Thousand $)



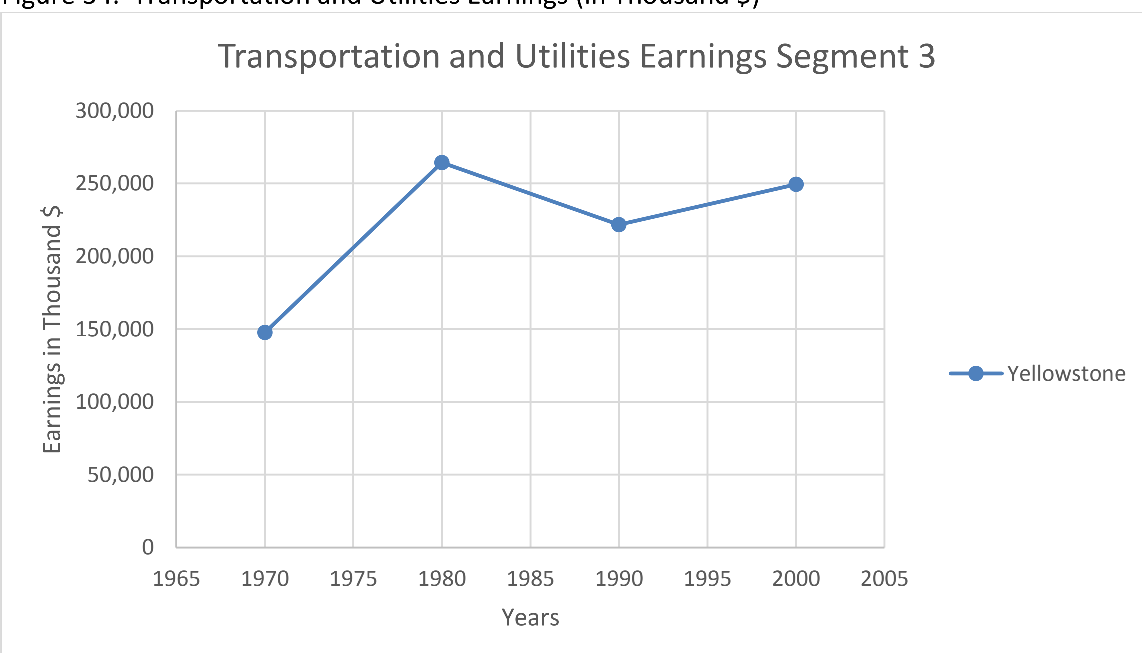
Source: Bureau of Economic Analysis, 2010

Figure 33. Manufacturing Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 34. Transportation and Utilities Earnings (in Thousand $)

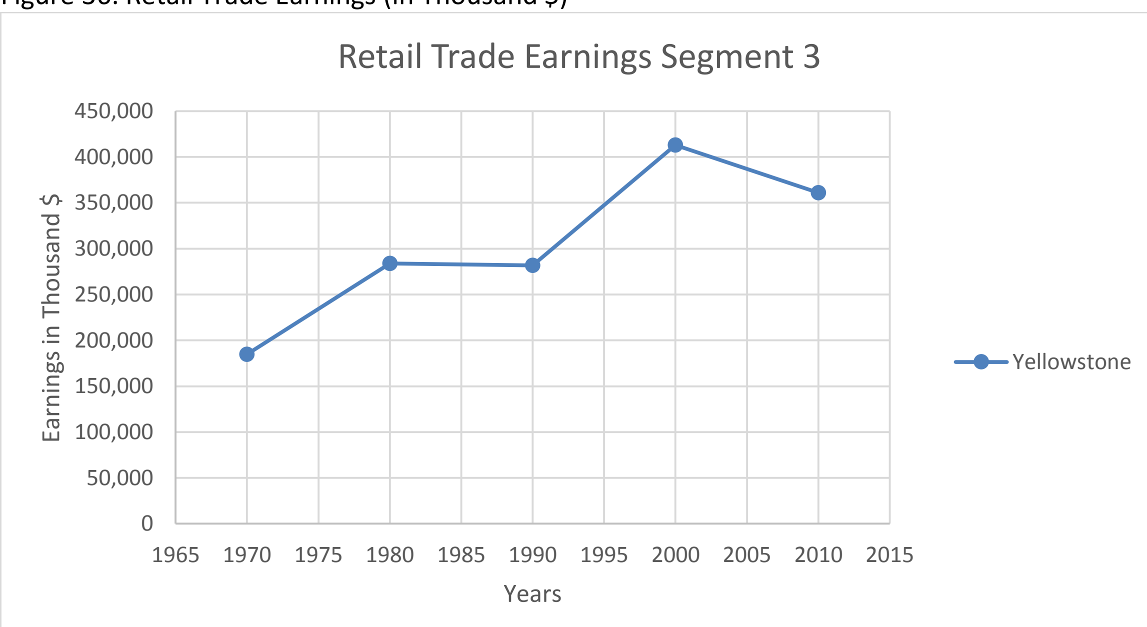


Source: Bureau of Economic Analysis, 2010

Figure 35. Wholesale Trade Earnings (in Thousand $)

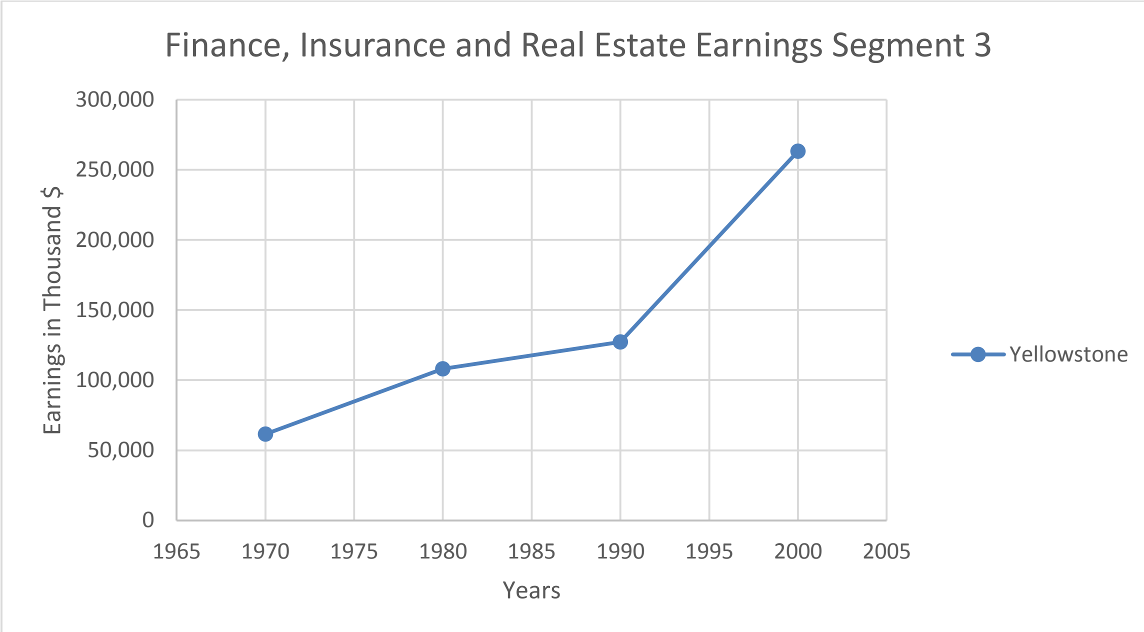
Source: Bureau of Economic Analysis, 2010

Figure 36. Retail Trade Earnings (in Thousand $)



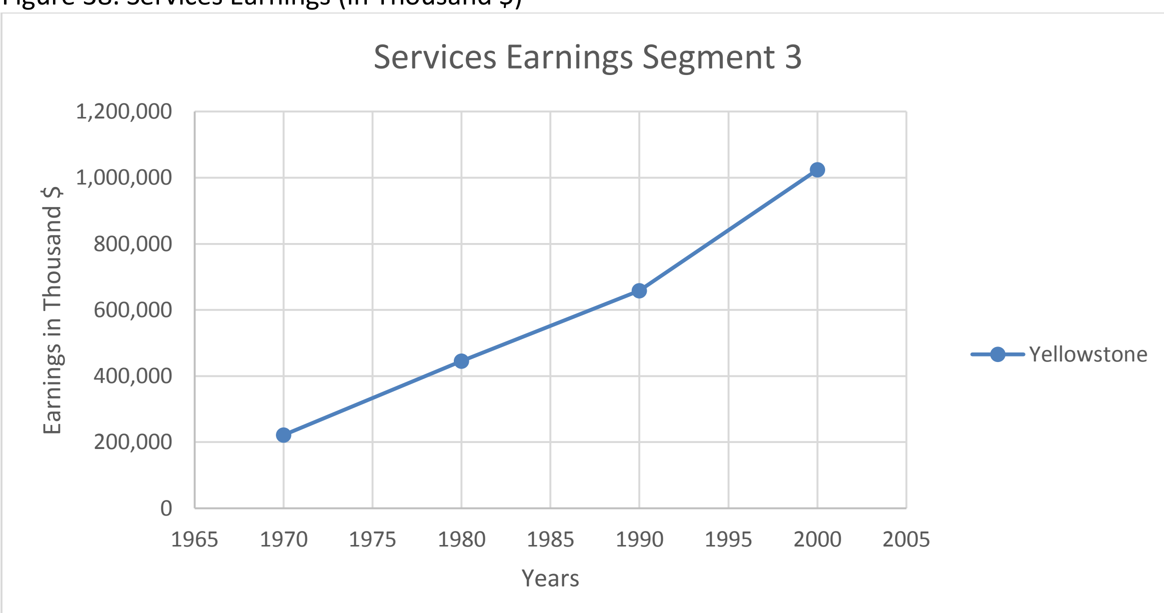
Source: Bureau of Economic Analysis, 2010

Figure 37. Finance, Insurance and Real Estate Earnings (in Thousand $)



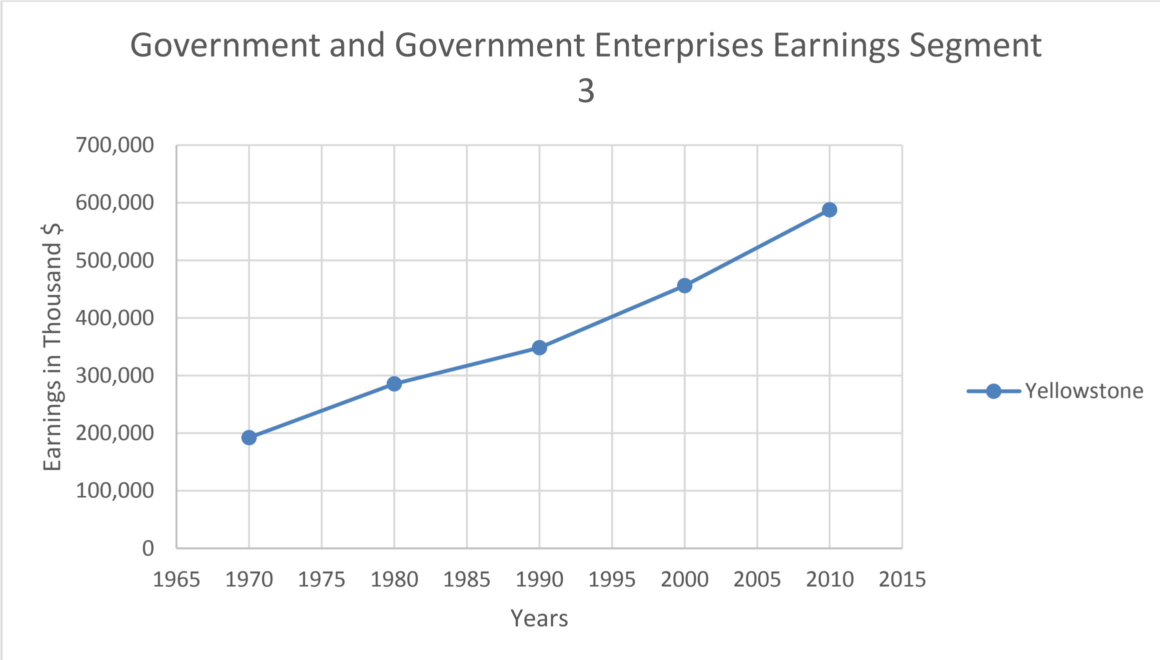
Source: Bureau of Economic Analysis, 2010

Figure 38. Services Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 39. Government and Government Enterprises Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 24. Earnings by Industry, 2010 (in Thousand $)

	Segment 3		River Corridor	
Earnings by Industry 2010	**Yellowstone**	Percent Total	**River Corridor**	Percent Total
Farm earnings	358	0%	111,114	2%
Forestry, fishing, and related activities	7,072	0%	8,501	0%
Mining	74,859	2%	227,003	4%
Utilities	36,072	1%	53,712	1%
Construction	315,580	7%	474,975	8%
Manufacturing	255,517	6%	310,939	5%
Wholesale trade	344,767	8%	404,674	6%
Retail trade	360,956	9%	470,257	8%
Transportation and warehousing	209,637	5%	308,590	5%
Information	82,050	2%	102,368	2%
Finance and insurance	223,395	5%	278,587	4%
Real estate and rental and leasing	55,103	1%	81,605	1%
Professional, scientific, and technical services	308,294	7%	371,658	6%
Management of companies and enterprises	29,106	1%	32,148	1%
Administrative and waste management services	162,613	4%	166,574	3%
Educational services	25,549	1%	31,762	1%
Health care and social assistance	769,834	18%	895,034	14%
Arts, entertainment, and recreation	43,232	1%	63,352	1%
Accommodation and food services	160,359	4%	233,769	4%
Other services, except public administration	160,038	4%	229,168	4%
Government and government enterprises	587,836	14%	999,422	16%
Provided Data Total	4,212,227	100%	5,855,212	94%
Suppressed Data Total	0	0%	400,857	6%
Earning by place of work	4,212,227		6,256,069	

Source: Bureau of Economic Analysis, 2010

Employment

Total full-time and part time employment has been increasing in Yellowstone County since 1970. As of 2000, the major sectors for employment in the county were services (35%) and retail trade (20%), followed by government and government enterprises (10%) and wholesale trade (8%) (Table 25) (Bureau of Economic Analysis, 2010). In 2010, employment in the services sector remained high, though the health care and social assistance and accommodation and food services sectors were the top employers (Table 26). Retail trade and government and government enterprises continue to employ a large share of Yellowstone County residents. Farm employment has declined in the county since 1970. In both 2000 and 2010, farm employment in Yellowstone County was below the farm employment of the River Corridor (Bureau of Economic Analysis, 2010).

Table 27 shows the labor force in Segment 3 from 1990 to 2010. The number of individuals employed shown in Table 27 is lower than the numbers reported in Tables 25 and 26. The labor force data is produced by Bureau of Labor Statistics (BLS) while the previous data is reported by Bureau of Economic Analysis (BEA). The BEA estimates of employment differ from the BLS data as the BEA adjusts data to account for employment not covered, or not fully covered, by the state Unemployment Insurance (UI) and the Unemployment for Federal Employees (UCFE) programs. This may include nonprofit organizations not participating in the UI program, students and their spouses employed by public colleges or universities, elected officials and members of state and local judiciary, interns employed by hospitals and by social service agencies, and insurance agents classified as statutory employees. More information is provided in the Methods and Definitions section of the report. Table 27 shows that unemployment rate in the county has fluctuated over the years, with a recent low of 4.1% in 2000. The unemployment rate in the county in 2010 was 5.2%. (Bureau of Labor Statistics, 2010).

Employment by Industry data from BEA and Labor Force data from BLS at the county level can be found in the appendix of this report.

Table 25. Employment by Industry, 1970-2000

	Segment 3					The River Corridor	
	1970	**1980**	**1990**	**2000**	**Percent Total**	**2000**	**Percent Total**
Total full-time and part-time employment	40,151	61,138	69,909	88,455		138,767	
Proprietors employment	7,450	10,717	14,442	16,992	19%	32,826	24%
Farm proprietors employment	1,014	998	1,028	1,227		6,016	
Nonfarm proprietors employment	6,436	9,719	13,414	15,765		26,810	
Farm employment	1,393	1,335	1,288	1,474	2%	7,556	5%
Agricultural services, forestry, and fishing	233	471	549	947	1%	1,607	1%
Mining	598	820	882	693	1%	2,053	1%
Construction	2,194	3,513	2,803	5,179	6%	7,698	6%
Manufacturing	3,525	4,450	3,539	3,759	4%	5,526	4%
Transportation and public utilities	3,213	4,890	4,564	5,725	6%	8,618	6%
Wholesale trade	3,369	5,797	5,781	6,671	8%	7,720	6%
Retail trade	7,406	12,171	13,867	17,905	20%	26,278	19%
Finance, insurance, and real estate	3,531	4,939	5,941	6,274	7%	8,884	6%
Services	8,481	14,918	21,935	30,822	35%	43,052	31%
Government and government enterprises	6,208	7,834	8,760	9,006	10%	17,590	13%

Source: Bureau of Economic Analysis, 2010

Table 26. Employment by Industry, 2010

	Segment 3		The River Corridor	
	2010	Percent Total	**2010**	Percent Total
Total employment	100,466		154,335	
Wage and salary employment	80,291	79.9%	117,792	76.3%
Proprietors employment	20,175	20.1%	38,388	24.9%
Farm proprietors employment	1,206		5,286	
Nonfarm proprietors employment	18,969		33,102	
Farm employment	1,384	1.4%	6,393	4.1%
Forestry, fishing, and related activities	320	0.3%	429	0.3%
Mining	1,078	1.1%	3,146	2.0%
Utilities	324	0.3%	483	0.3%
Construction	6,472	6.4%	9,952	6.4%
Manufacturing	3,300	3.3%	4,687	3.0%
Wholesale trade	5,696	5.7%	6,883	4.5%
Retail trade	12,921	12.9%	17,670	11.4%
Transportation and warehousing	3,888	3.9%	5,371	3.5%
Information	1,562	1.6%	2,159	1.4%
Finance and insurance	4,694	4.7%	6,338	4.1%
Real estate and rental and leasing	4,273	4.3%	6,441	4.2%
Professional, scientific, and technical services	6,189	6.2%	8,223	5.3%
Management of companies and enterprises	449	0.4%	481	0.3%
Administrative and waste management services	6,184	6.2%	6,480	4.2%
Educational services	1,253	1.2%	1,681	1.1%
Health care and social assistance	13,710	13.6%	17,163	11.1%
Arts, entertainment, and recreation	2,718	2.7%	4,272	2.8%
Accommodation and food services	8,291	8.3%	12,769	8.3%
Other services, except public administration	5,971	5.9%	9,141	5.9%
Government and government enterprises	9,789	9.7%	19,405	12.6%

Source: Bureau of Economic Analysis, 2010

Table 27. Labor Force, 1990-2010

	Segment 3			The River Corridor
	1990	**2000**	**2010**	**2010**
Labor Force	62,741	71,487	80,992	125,613
Employed	59,567	68,572	76,820	119,142
Unemployed	3,174	2,915	4,172	6,471
Unemployment Rate	5.3%	4.1%	5.2%	5.2%

Source: Bureau of Labor Statistics, 2010

Segment 4 – Sweet Grass, Stillwater, and Carbon Counties, MT

Introduction

Segment 4 of the Yellowstone River Corridor consists of Sweet Grass, Stillwater, and Carbon Counties, located in south central Montana. The geography of the area is diverse and includes several mountain ranges, prairies and grasslands, as well as two blue ribbon trout streams, the Boulder River and Yellowstone River. The economy of these three counties is currently changing, shifting from a primary focus on extractive natural resource activities, including mining and agriculture, to include recreation and tourism-based activities (Montana Department of Labor and Industry, 2012a).

All three counties found in Segment 4 have a rich history associated with natural resource extraction. Carbon County, formed from land in Yellowstone and Park County, was given its name due to the substantial coal deposits found in the area and, until recently, mining was the primary industry of the county (Montana Department of Labor and Industry, 2012a; Carbon County, 2014). Mining was, and is, still an important industry in both Stillwater and Sweet Grass Counties. The Stillwater Mining Company remains operational and is one of the world's largest producers of platinum and has the advantage of being the only mine in the United States to produce a significant amount of palladium (Montana Department of Labor and Industry, 2012b). Though not headquartered in Sweet Grass County, the Stillwater Mining Company is a one of the largest private employers in Sweet Grass County, contributing substantially to the county's economy (Montana Department of Labor and Industry, 2012c).

In 2010, agriculture, forestry, fishing and hunting accounted for 16% of total average employment across the three counties (Bureau of Economic Analysis, 2010). According to the 2012 Census of Agriculture, over 67% of total land in the three counties is under agricultural production (United States Department of Agriculture, 2012). The county seat of Stillwater County, Columbus, is an important distribution point for farms and ranches located within the county and surrounding areas (Montana Department of Labor and Industry, 2012b). Sweet Grass County is an important producer of livestock, including cattle and sheep, and dryland crops such as hay, wheat, barley and oats (Montana Department of Labor and Industry, 2012c).

Given the abundant natural resources located in Segment 4, recreation and tourism is an important element in the local economy of the three counties. In Carbon County, the Red Lodge Mountain Resort, Rock Creek Resort and Pollard Hotel are among the top private employers in the county (Montana Department of Labor and Industry, 2012a). Stillwater County is home to Halfbreed Lake and Hailstone Nation Wildlife Refuges (NWR). Though Halfbreed Lake is closed to the public, Hailstone NWR offers visitors hunting, hiking, and wildlife observation opportunities (U.S. Fish and Wildlife Service, 2014). Additionally, Red Lodge offers trout streams, hiking, mountaineering, cross-country and alpine skiing and serves as a gateway to Yellowstone National Park. The tourism industry is gaining importance in the economies of all three counties in Segment 4.

Demographic Trends

Population

From 1950 to 2010, the total population of the three counties in Segment 4 increased by 15.3%, though of the three counties, only Stillwater County experienced population growth (United States Census Bureau, 2010). Table 28 shows the population over time for each of the three counties.

Table 28. Population Total, 1950-2010

Segment 4	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Sweet Grass County, MT	3,290	3,621	2,980	3,216	3,154	3,609	2,651	-19.4%
Stillwater County, MT	5,416	5,526	4,632	5,598	6,536	8,195	9,117	68.3%
Carbon County, MT	10,241	8,317	7,080	8,099	8,080	9,552	10,078	-1.6%
Segment 4 Total	18,947	17,464	14,692	16,913	17,770	21,356	21,846	15.3%
River Corridor Total	133,723	162,839	161,516	194,822	196,814	214,004	233,355	74.5%

Source: United States Census Bureau, 2010

From 1950 to 2010, the population of Sweet Grass County declined by nearly 20%. During the same time period, the population of Carbon County also declined, though not nearly as substantially as Sweet Grass County, with a decline in population of only 1.6% (United States Census Bureau, 2010). Stillwater County experienced a change in population similar to that of the River Corridor, increasing by 68.3% from 1950 to 2010 (see Table 28). This increase in population may be a reflection of the job opportunities, possibly associated with the mining and tourism-based industries, and the above state average wages workers in Stillwater County receive (Montana Department of Labor and Industry, 2012b).

Similar to the majority of the counties in the River Corridor, the median age in all three counties in Segment 4 has increased from 1950-2010 (see Table 29, below). In 1950, the population of Sweet Grass County had the highest median age (32.2 years), while in 2010, the population of Carbon County had the highest median age (48.1 years) (United States Census Bureau, 2010). Carbon County experienced the greatest increase in median age, with an increase of 16.6 years from 1950 to 2010. This may be related to the closure of coal mines in the area. Sweet Grass County had the smallest increase in median age, 14.4 years (Table 29).

Table 29. Median Age, 1950-2010

Segment 4	1950	1960	1970	1980	1990	2000	2010
Sweet Grass County, MT	32.2	34.0	37.1	35.9	39.1	41.2	46.6
Stillwater County, MT	30.4	31.3	35.5	33.3	36.5	40.8	45.7
Carbon County, MT	31.5	35.5	39.8	35.0	38.6	41.9	48.1

Source: United States Census Bureau, 2010

A more detailed overview of age distribution across the three counties is provided in Table 30. As mentioned previously, Carbon County has the highest median age and correspondingly, the lowest percent of the population under the age of 5 (United States Census Bureau, 2010a). However, in 2010, Sweet Grass County had the highest percent of population 65 years of age and older (see Table 30). Stillwater County had both the lowest percent of the population 65 years of age and older and the highest percent of population under 5 years of age (United States Census Bureau, 2010a).

Table 30. Detailed Age Distribution, 2010

Segment 4	Median Age	Percent of Population Under 5 Years of Age	Percent of Population 18 and Over	Percent of Population 65 and Over
Sweet Grass County, MT	46.6	5.5	77.0	20.7
Stillwater County, MT	45.7	6.0	77.0	16.4
Carbon County, MT	48.1	4.1	80.3	18.8

Source: United States Census Bureau, 2010a

South central Montana remains relatively rural and this can be seen in the population densities across the three counties, shown below in Table 31. In 2010, Sweet Grass County was the least densely populated county in Segment 4, with only 1.4 persons per square mile (United States Census Bureau, 2012). Though Carbon County had the largest population in 2010, Stillwater County is the most densely populated county in Segment 4, with 5.1 residents per square mile (see Table 31). Overall, Segment is slightly more densely populated than the River Corridor, with 3.8 compared to 2.7 persons per square mile (United States Census Bureau, 2012).

Table 31. Population Density, 2010

Segment 4	Land (square miles)	Population (2010)	Population density
Sweet Grass County, MT	1,855.20	2,651	1.4
Stillwater County, MT	1,795.35	9,117	5.1
Carbon County, MT	2,048.79	10,078	4.9
Segment 4 Total	5,699.34	21,846	3.8
River Corridor Total	11,566.51	30,767	2.7

Source: United States Census Bureau, 2012

Housing

Though the total population of Segment 4 increased by 15.3% from 1950 to 2010, total housing units in the Segment have increased by over 100% (see Table 32).

Table 32. Total Housing Units*, 1950-2010

Segment 4	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Sweet Grass County, MT	1,161	1,196	1,387	1,479	1,639	1,860	2,148	85.0%
Stillwater County, MT	1,994	2,039	1,959	2,681	3,291	3,947	4,803	140.9%
Carbon County, MT	3,447	3,321	3,369	4,360	4,828	5,494	6,441	86.9%
Segment 4 Total	6,602	6,556	6,715	8,520	9,758	11,301	13,392	102.8%
River Corridor Total	44,383	54,887	57,593	80,151	88,808	95,967	109,295	146.3%

Source: United States Census Bureau, 2010

*A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

Stillwater County, experiencing population growth of nearly 70%, also had the greatest increase in total housing units, increasing by over 140% from 1950 to 2010 (United States Census Bureau, 2010). The increase in total housing units in Stillwater County (140.9%) is similar to the average increase seen across the River Corridor (146.3%). Though the population of Sweet Grass County declined by nearly 20% from 1950 to 2010, total housing units increased by 85% during the same time period. Carbon County experienced only a slight decline in population, but total housing units increased by over 85% from 1950 to 2010 (United States Census Bureau, 2010).

Table 33 examines migration across counties from the year 2011 to 2012. The percent population living in the same house, living in a different house but within the same county, moving into the county from a different county in the state of Montana, moving into the county from another state and finally moving into the county from abroad in the previous year is provided.

Table 33. Percent Individuals by Residence 1 Year Ago, 2012

			Different House			
Segment 4	Population 1 Year and Over	Same House	Same County	Same State/Different County	Different State	Abroad
Sweet Grass County, MT	3,635	93.3%	1.0%	2.0%	3.7%	0.0%
Stillwater County, MT	9,035	88.2%	6.0%	4.4%	6.2%	0.1%
Carbon County, MT	9,960	84.1%	8.4%	3.6%	3.8%	0.2%
Segment 4 Total	22,630	87.2%	6.3%	3.7%	4.7%	0.1%
River Corridor Total	236,143	66.3%	7.7%	2.9%	3.0%	0.1%

Source: United States Census Bureau, 2012a

As a portion of the population age 1 year and older, Sweet Grass County had the highest percentage of residents living in the same house in 2012 as they were in 2011, 93.3% (United States Census Bureau, 2012a). Of the three counties in Segment 4, Carbon County had the highest percentage of residents move, but stay within the same county, 8.4%, while Stillwater County had the greatest number of Montana state residents move into the county, 4.4% (see Table 33). Stillwater County also had the highest in-migration of out of state residents in Segment 4 and the second highest in the River Corridor, with 6.2% of total residents' age 1 year and older moving into the county from a different state in the previous year. Residents moving into the counties from abroad accounted for less than 1 percent of the population 1 year and over for all counties within Segment 4 as well as the River Corridor as a whole (United States Census Bureau, 2012a).

Economic Trends

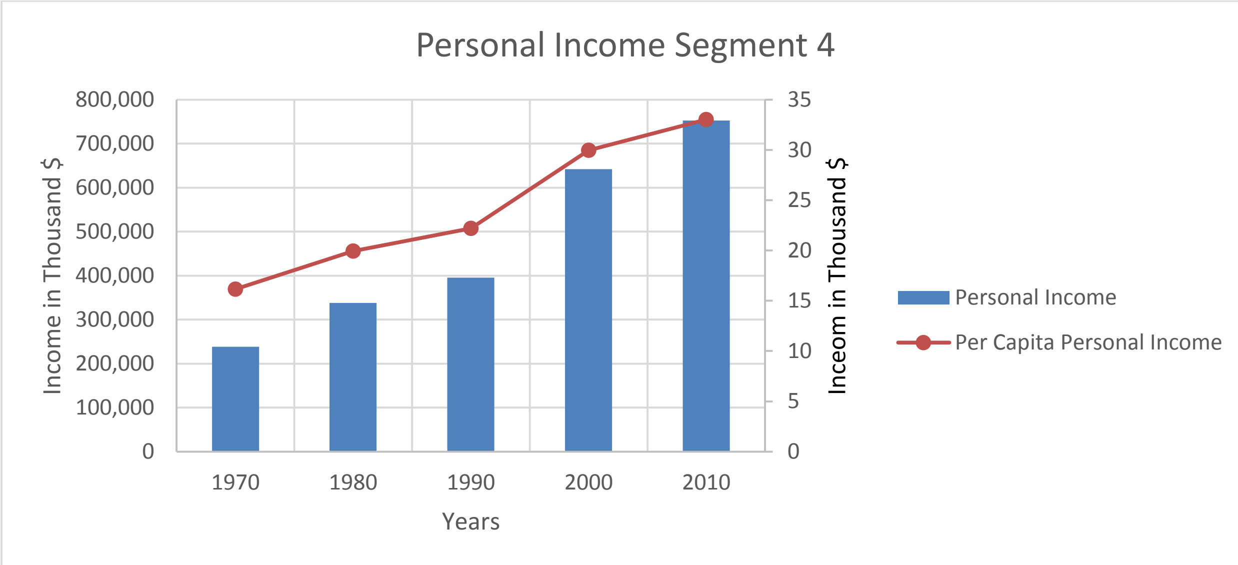
Similar to Segment 2, 2010 total personal income in Segment 4 was $750 million. Per capita income in Segment 4 is the lowest in the River Corridor, at $33 thousand (Bureau of Economic Analysis, 2010). Just as in other segments, property income and income from government payments have been increasing since 1970 and, as in most other segments, property income in Segment 4 remains higher than income from government payments. Proprietors' income in Segment 4 has fluctuated over time, initially relying heavily on farm proprietors' income to relying much more heavily on non-farm proprietors' income, beginning in 1980 (Bureau of Economic Analysis, 2010). The government and government enterprises and services sectors contribute to the largest share of earnings and employment by industry in this segment (Bureau of Economic Analysis, 2010). In 2010, the unemployment rate in Segment 4 was slightly above the unemployment rate of the River Corridor (Bureau of Labor Statistics, 2010).

Income

Personal income in Segment 4 has increased, although at a slower rate than in other segments in the River Corridor (Figure 40). Since 1970, per capita personal income grew more slowly than personal income in the segment (Bureau of Economic Analysis, 2010). In 2010, per capita income in Segment 4 was the lowest in the River Corridor at $33 thousand (Figure 38). Since 1970, the Segment has experienced comparable growth in dividend, interest and rent income as well as personal current transfer receipts (Bureau of Economic Analysis, 2010). Dividends, interests and rent typically represent investment income or property income while personal current transfer receipts capture government payments such as retirement and disability insurance benefits, Medicare and Medicaid. Between 2000 and 2010, property income in Segment 4 grew more slowly than income from government payments, which had the highest rate of increase in that time period (Figure 41). The increasing median age may explain this recent increase in the rate of change (Table 29). In 1970, proprietors' income relied heavily on farm enterprise, however, from 1980 forward, the majority of proprietary income has been non-farm (Bureau of Economic Analysis, 2010). Total proprietors' income has decreased most recently from 2000 to 2010 (Figure 42). Farm proprietors' income for 2010 was reported to be -$15 thousand, the lowest of all the segments in the River Corridor. Similarly to Segment 3, farm proprietor's income is negative in all three counties in Segment 4, representing a loss due to production expenses exceeding gross output (Bureau of Economic Analysis, 2010).

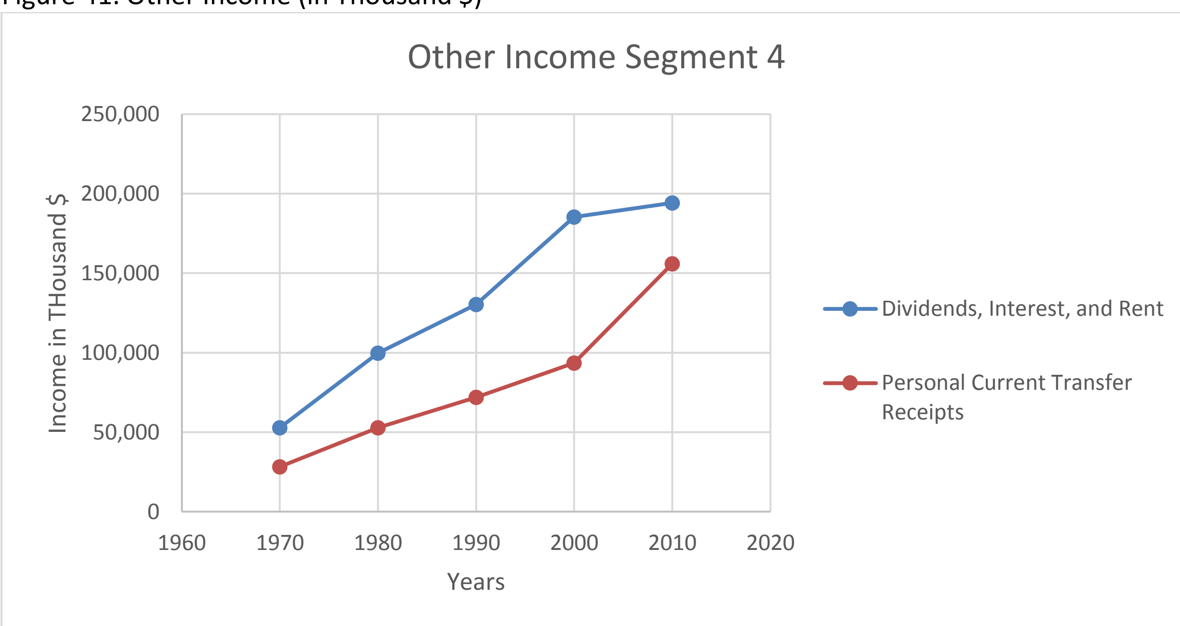
Table 34 provides 2010 personal income data for Segment 4. Carbon and Stillwater Counties account for the majority of personal income in Segment 4. In all three counties, per capita income is below that of the River Corridor. Income from personal transfer receipts in the segment exceeds that of the River Corridor, the portion of proprietors' income is below that of the River Corridor.

Figure 40. Personal Income (in Thousand $)



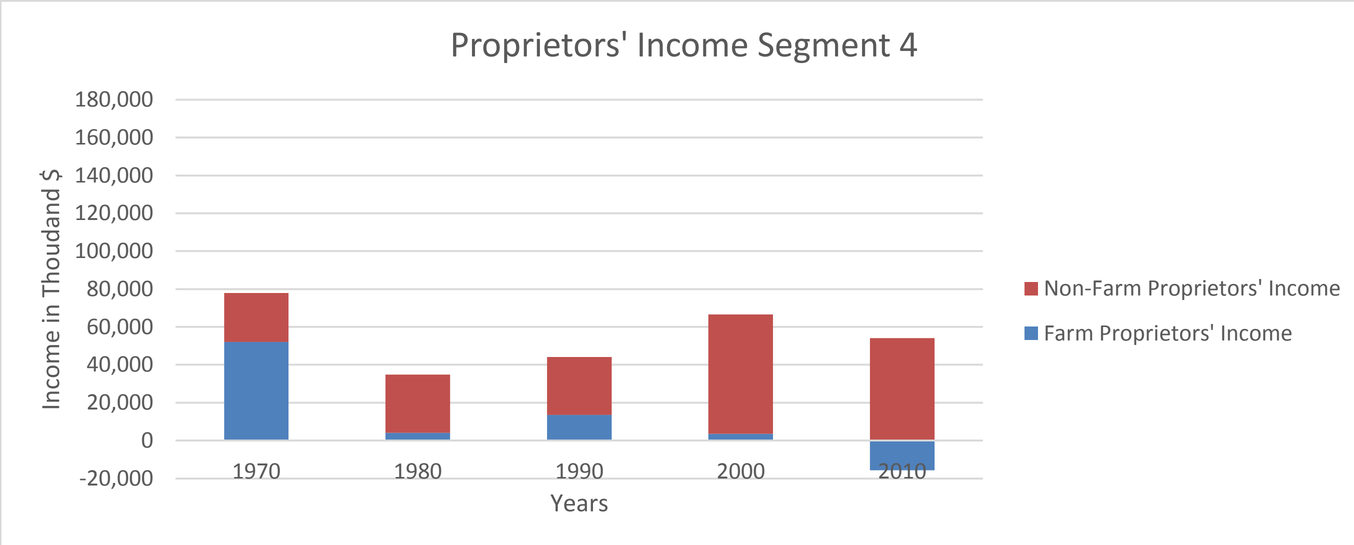
Source: Bureau of Economic Analysis, 2010

Figure 41. Other Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 42. Proprietors' Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 34. 2010 Income (in Thousand $)

	Segment 4						River Corridor	
	Carbon	Percent Total	**Stillwater**	Percent Total	**Sweet Grass**	Percent Total	**River Corridor**	Percent Total
Personal income	340,837		314,081		98,105		8,774,733	
Per capita personal income	34		34		27		38	
Net earnings by place of residence	177,657	52%	191,203	61%	33,939	35%	5,433,877	62%
Proprietors' income	20,793	6%	16,449	5%	1,331	1%	660,096	8%
Farm proprietors' income	-4,124	-1%	-4,127	-1%	-7,357	-7%	63,889	1%
Nonfarm proprietors' income	24,917	7%	20,576	7%	8,688	9%	596,207	7%
Dividends, interest, and rent	91,738	27%	63,193	20%	39,380	40%	1,766,656	20%
Personal current transfer receipts	71,442	21%	59,685	19%	24,786	25%	1,574,200	18%
Retirement and disability insurance benefits	31,626	9%	26,967	9%	10,368	11%	634,042	7%
Medical benefits	27,019	8%	21,426	7%	9,767	10%	597,035	7%
Income maintenance benefits	4,108	1%	3,353	1%	1,312	1%	132,357	2%
Other	8,689	3%	7,939	3%	3,339	3%	210,766	2%

Source: Bureau of Economic Analysis, 2010

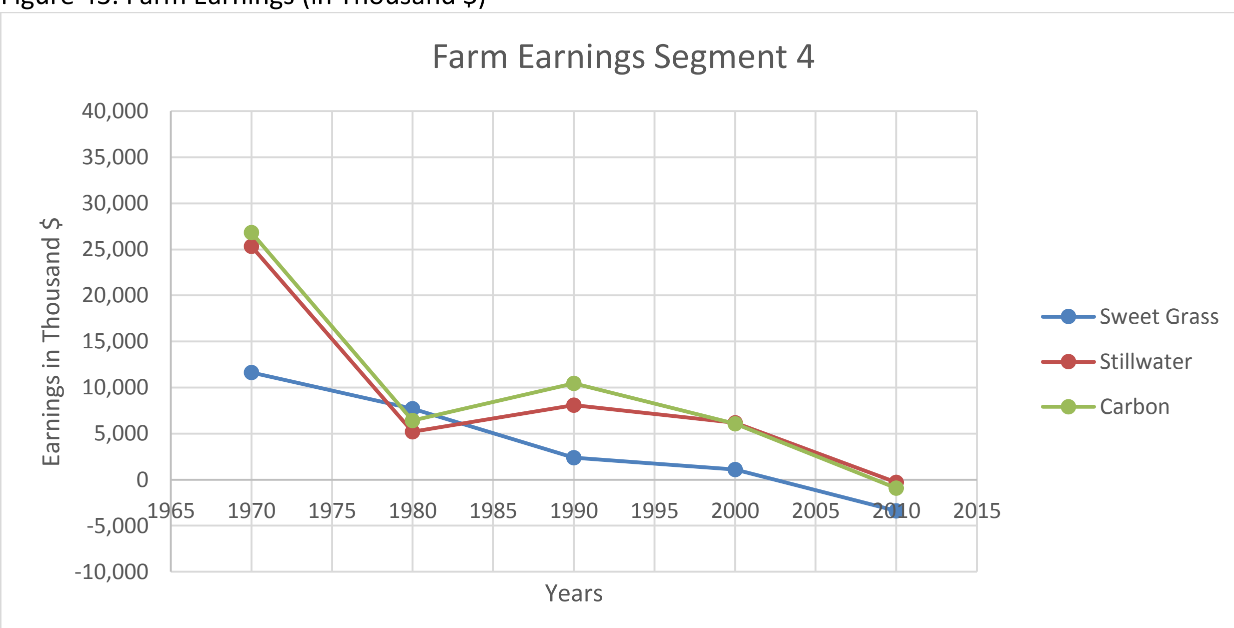
Earnings

Earnings in Segment 4 vary by industry. In some years, earnings data is suppressed and therefore not represented in the figures or tables provided in this report. Data suppression due to confidentiality reasons are marked with (D) while data suppressions resulting from a lack of confidence in the data is marked with (L). Confidentiality issues may result from only one company representing an industry within the county, while confidence issues may be due to a particularly low and therefore, uncertain estimate. All suppressed data are included in the total of all earnings (Bureau of Economic Analysis, 2010).

Since 1970, farm earnings in Segment 4 have been decreasing, with the exception of a slight increase in 1990, before a drastic decrease in 2010 (Figure 43) (Bureau of Economic Analysis, 2010). The government and government enterprises and services sectors contribute the largest share of earnings in the segment. The manufacturing, retail trade and financing sectors follow in their contribution to segment earnings, although earnings from the retail trade sector decreased between 2000 and 2010 (Figures 46, 49 and 50) (Bureau of Economic Analysis, 2010).

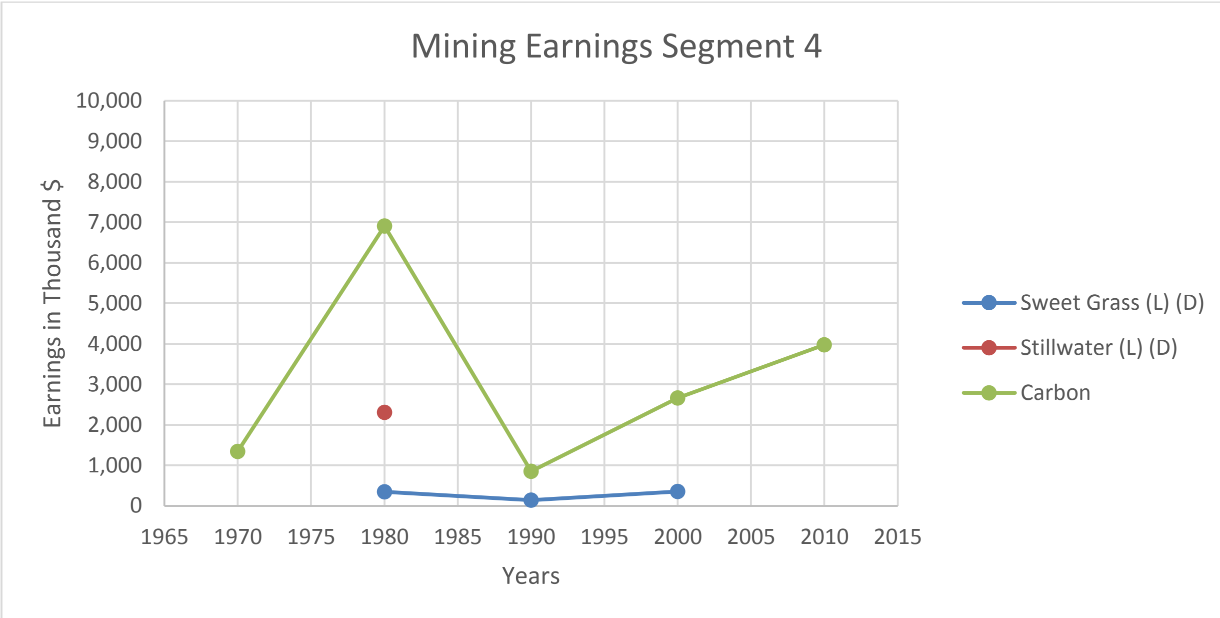
Earnings by industry for the year 2010 are shown in Table 35. Note that 62% of data related to earnings is suppressed for Stillwater County and 44% is suppressed for Sweet Grass County. The government and government enterprises sectors are responsible for the largest share of earnings in each county and exceed earnings in the River Corridor in these sectors in Carbon and Sweet Grass Counties.

Figure 43. Farm Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

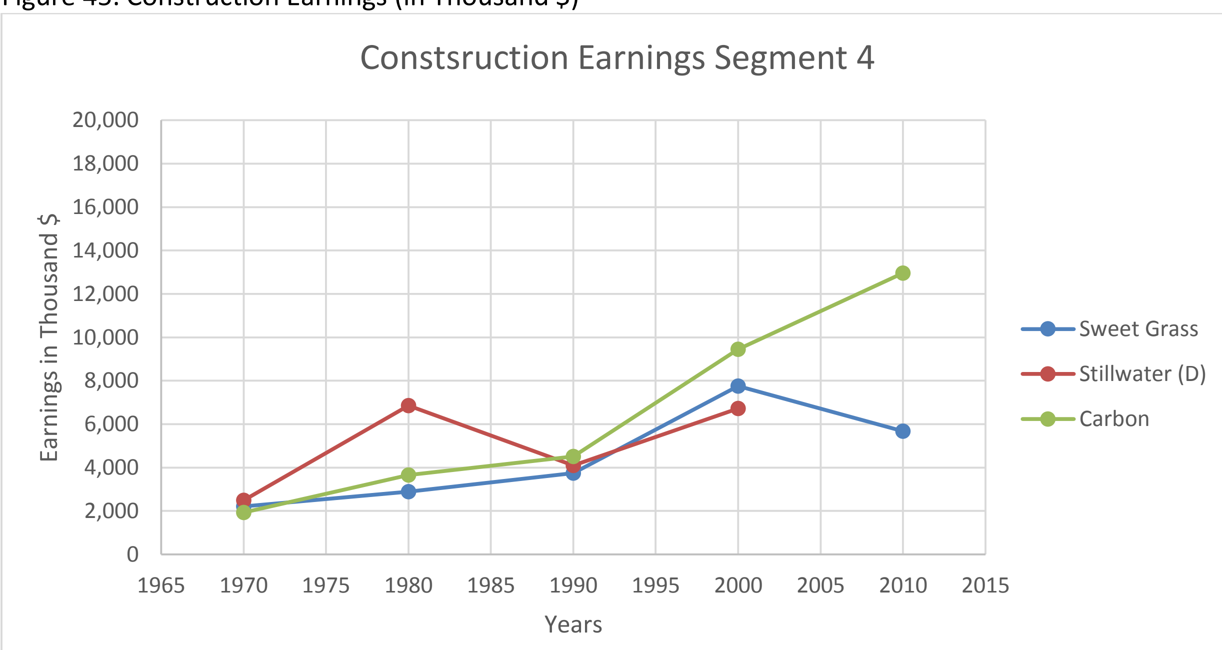
Figure 44. Mining Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
* (L) Less than $50,000, but the estimates for this item are included in the totals.

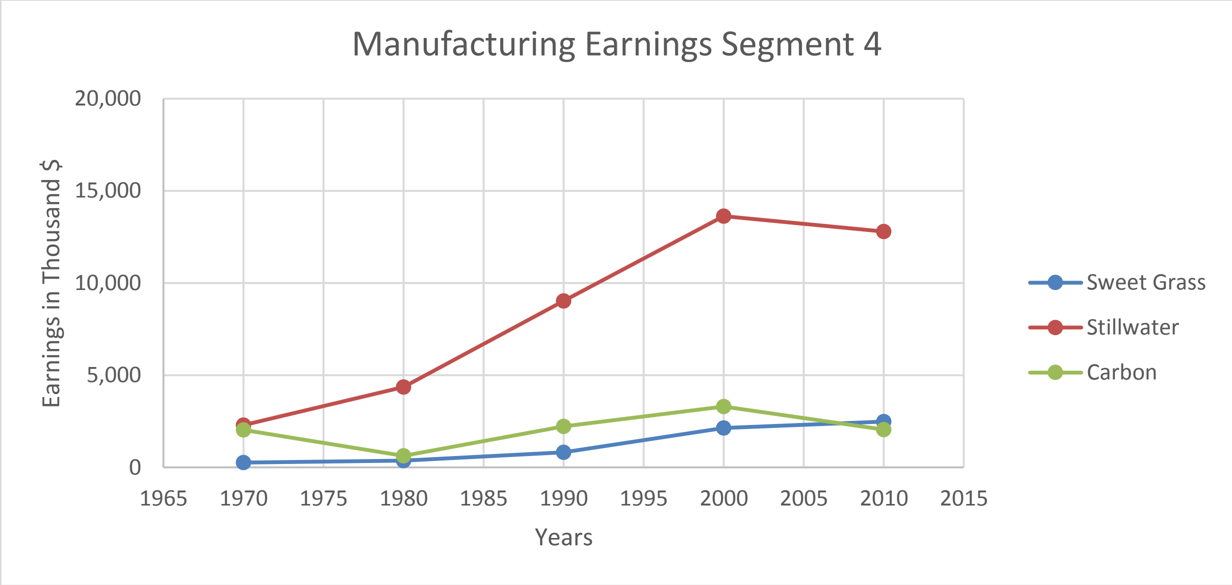
Figure 45. Construction Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

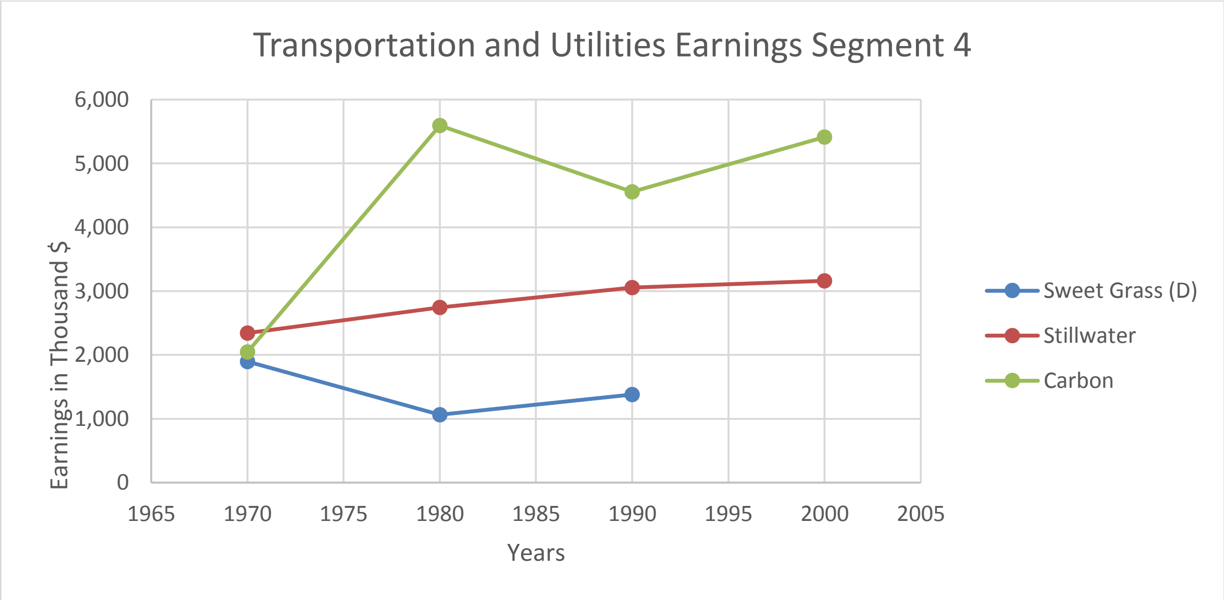
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 46. Manufacturing Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 47. Transportation and Utilities Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

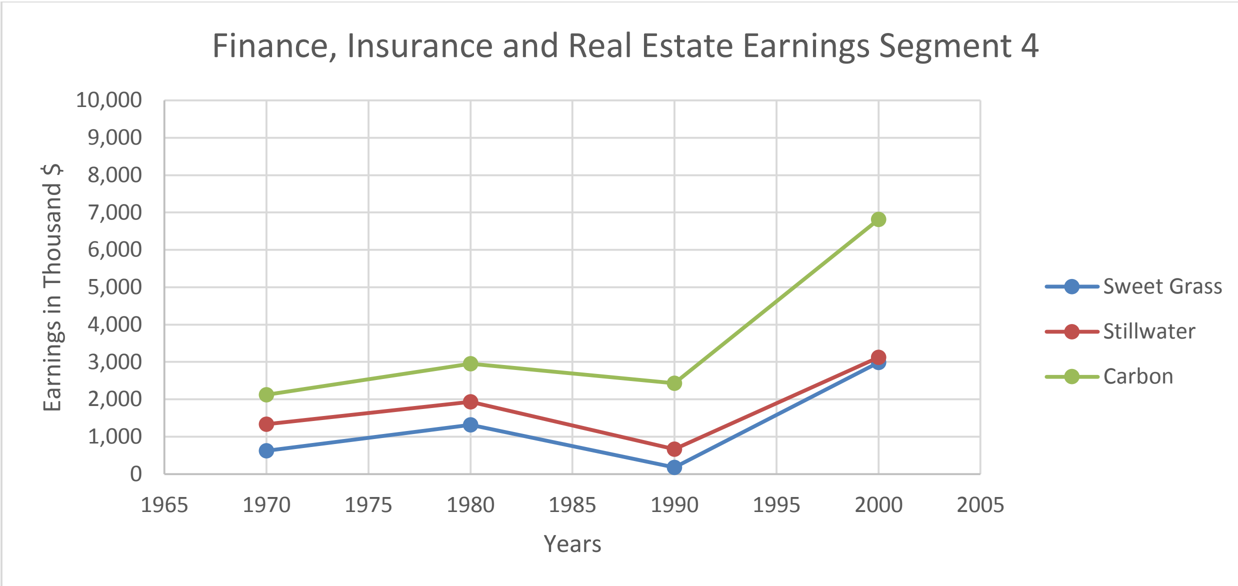
Figure 48. Wholesale Trade Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010
* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 49. Retail Trade Earnings (in Thousand $)

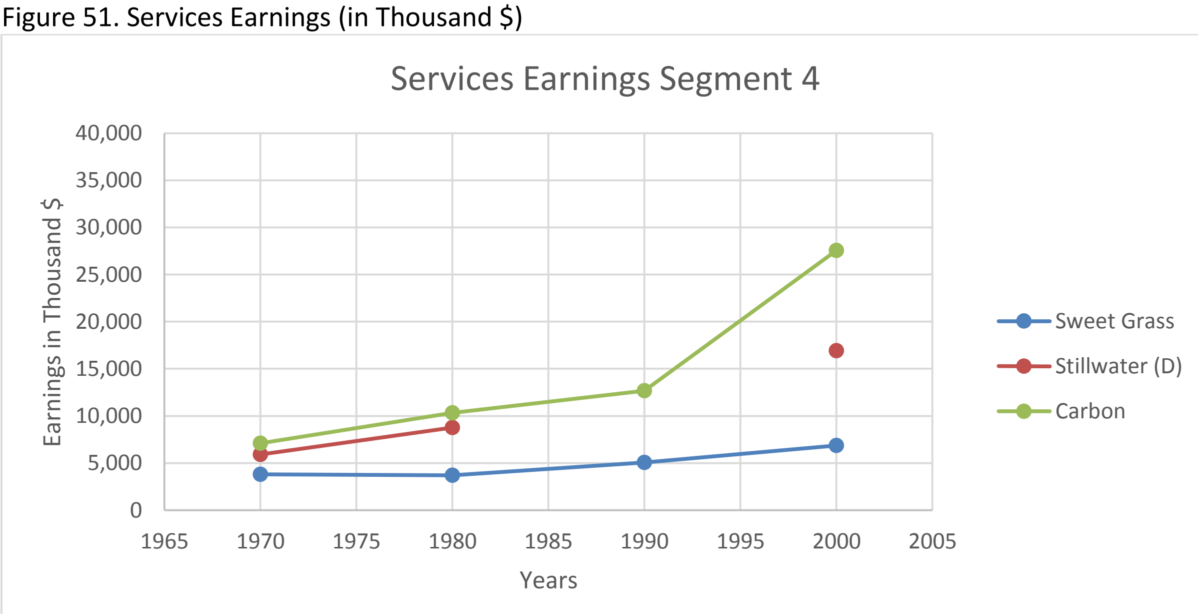
Source: Bureau of Economic Analysis, 2010

Figure 50. Finance, Insurance and Real Estate Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

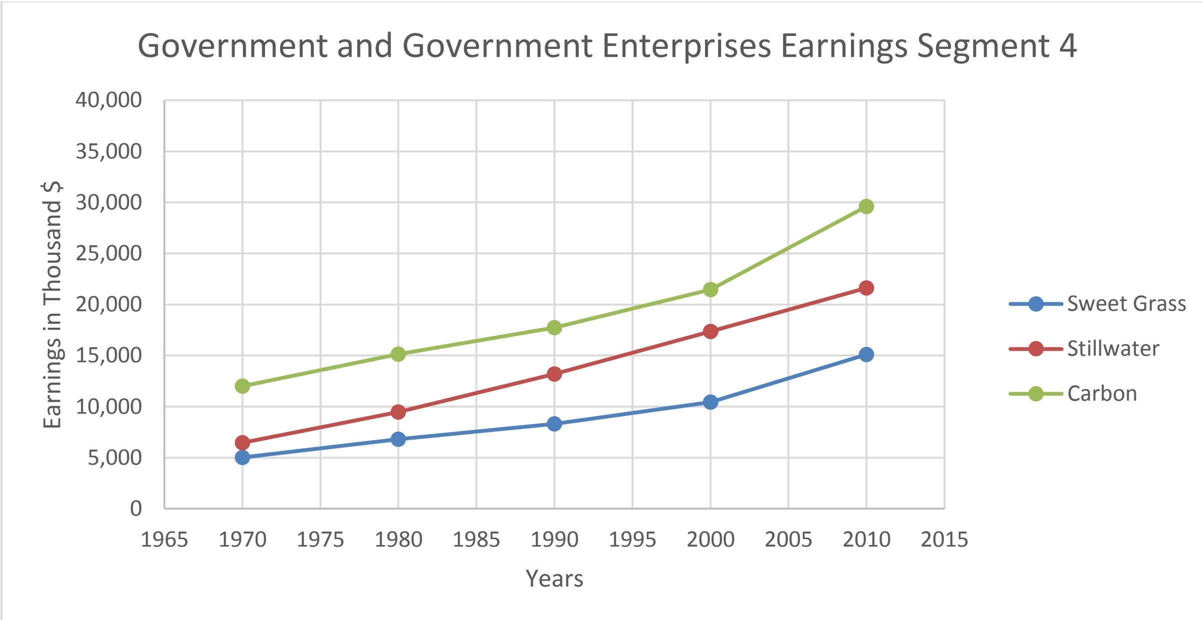
Figure 51. Services Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Figure 52. Government and Government Enterprises Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 35. Earnings by Industry, 2010 (in Thousand $)

	Segment 4						River Corridor	
Earnings by Industry 2010	**Carbon**	Percent Total	**Stillwater**	Percent Total	**Sweet Grass**	Percent Total	**River Corridor**	Percent Total
Farm earnings	-921	-1%	-301	0%	-3,372	-5%	111,114	2%
Forestry, fishing, and related activities	(D)	-	1,309	1%	(D)	-	8,501	0%
Mining	3,977	3%	(D)	-	(D)	-	227,003	4%
Utilities	3,729	3%	2,564	1%	(D)	-	53,712	1%
Construction	12,957	11%	(D)	-	5,675	9%	474,975	8%
Manufacturing	2,045	2%	12,793	6%	2,480	4%	310,939	5%
Wholesale trade	3,026	3%	4,239	2%	1,873	3%	404,674	6%
Retail trade	8,933	8%	7,981	4%	4,402	7%	470,257	8%
Transportation and warehousing	4,060	4%	1,450	1%	(D)	-	308,590	5%
Information	1,130	1%	813	0%	(D)	-	102,368	2%
Finance and insurance	3,656	3%	2,279	1%	2,263	3%	278,587	4%
Real estate and rental and leasing	2,758	2%	747	0%	1,012	2%	81,605	1%
Professional, scientific, and technical services	6,705	6%	9,722	5%	1,496	2%	371,658	6%
Management of companies and enterprises	(D)	-	(D)	-	(D)	-	32,148	1%
Administrative and waste management services	(D)	-	(D)	-	(D)	-	166,574	3%
Educational services	282	0%	176	0%	(D)	-	31,762	1%
Health care and social assistance	10,101	9%	6,997	3%	(D)	-	895,034	14%
Arts, entertainment, and recreation	3,789	3%	1,478	1%	553	1%	63,352	1%
Accommodation and food services	9,061	8%	3,514	2%	2,509	4%	233,769	4%
Other services, except public administration	5,420	5%	4,411	2%	2,856	4%	229,168	4%
Government and government enterprises	29,605	26%	21,604	10%	15,097	23%	999,422	16%
Provided Data Total	110,313	96%	81,776	38%	36,844	56%	5,855,212	94%
Suppressed Data Total	4,476	4%	131,082	62%	29,103	44%	400,857	6%
Earning by place of work	114,789		212,858		65,947		6,256,069	

Source: Bureau of Economic Analysis, 2010

*(D) suppressed data

Employment

Since 1970, total full-time and part-time employment in Segment 4 has grown. As of 2000, the services sector employed the highest percentage of the work force. Although farm earnings had dropped to an all-time low in 2000 and 2010 (Figure 43), in 2000, farm employment accounted for 16% of the total workforce and 13% in 2010 (Bureau of Economic Analysis, 2010). The retail sector employed 16% of the workforce in 2000, with high earnings that same year (Figure 49), while in 2010, employment had decreased to 7.9%, accompanying the decrease in earnings within the industry (Bureau of Economic Analysis, 2010). The government sector employed a consistent share of the workforce in 2000 and 2010, 12% (Bureau of Economic Analysis, 2010).

Table 38 shows the labor force in the segment since 1990. The number of individuals employed shown in Table 38 is lower than the numbers reported in Tables 36 and 37. The labor force data is produced by Bureau of Labor Statistics (BLS) while the previous data is reported by Bureau of Economic Analysis (BEA). The BEA estimates of employment differ from the BLS data as the BEA adjusts data to account for employment not covered, or not fully covered, by the state Unemployment Insurance (UI) and the Unemployment for Federal Employees (UCFE) programs. This may include nonprofit organizations not participating in the UI program, students and their spouses employed by public colleges or universities, elected officials and members of state and local judiciary, interns employed by hospitals and by social service agencies, and insurance agents classified as statutory employees. More information is provided in the Methods and Definitions section of the report. Table 38 shows that the unemployment rate in the segment has increased over time, with a recent high of 5.4% in 2010. The unemployment rate in 2010 was 5.4%, compared to the unemployment rate of the River Corridor, 5.2% (Bureau of Labor Statistics, 2010).

Employment by Industry data from BEA and Labor Force data from BLS at the county level can be found in the appendix of this report.

Table 36. Employment by Industry, 1970-2000

	Segment 4					The River Corridor	
	1970	**1980**	**1990**	**2000**	**Percent Total**	**2000**	**Percent Total**
Total full-time and part-time employment	6,003	6,839	8,527	11,898		138,767	
Proprietors employment	2,761	2,754	3,546	4,885	41%	32,826	24%
Farm proprietors employment	1,562	1,302	1,425	1,559		6,016	
Nonfarm proprietors employment	1,199	1,452	2,121	3,326		26,810	
Farm employment	2,072	1,776	1,789	1,923	16%	7,556	5%
Agricultural services, forestry, and fishing	56	150	255	119	1%	1,607	1%
Mining	36	171	34	54	0%	2,053	1%
Construction	207	356	411	853	7%	7,698	6%
Manufacturing	200	196	404	592	5%	5,526	4%
Transportation and public utilities	167	212	256	216	2%	8,618	6%
Wholesale trade	76	99	128	163	1%	7,720	6%
Retail trade	968	1,252	1,350	1,861	16%	26,278	19%
Finance, insurance, and real estate	350	325	369	691	6%	8,884	6%
Services	938	1,195	1,139	2,406	20%	43,052	31%
Government and government enterprises	921	1,107	1,241	1,428	12%	17,590	13%

Source: Bureau of Economic Analysis, 2010

Table 37. Employment by Industry, 2010

	Segment 4		The River Corridor	
	2010	**Percent Total**	**2010**	**Percent Total**
Total employment	12,835		154,335	
Wage and salary employment	7,327	57.1%	117,792	76.3%
Proprietors employment	5,508	42.9%	38,388	24.9%
Farm proprietors employment	1,420		5,286	
Nonfarm proprietors employment	4,088		33,102	
Farm employment	1,670	13.0%	6,393	4.1%
Forestry, fishing, and related activities	95	0.7%	429	0.3%
Mining	83	0.6%	3,146	2.0%
Utilities	53	0.4%	483	0.3%
Construction	653	5.1%	9,952	6.4%
Manufacturing	462	3.6%	4,687	3.0%
Wholesale trade	201	1.6%	6,883	4.5%
Retail trade	1,019	7.9%	17,670	11.4%
Transportation and warehousing	184	1.4%	5,371	3.5%
Information	81	0.6%	2,159	1.4%
Finance and insurance	257	2.0%	6,338	4.1%
Real estate and rental and leasing	740	5.8%	6,441	4.2%
Professional, scientific, and technical services	565	4.4%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	68	0.5%	1,681	1.1%
Health care and social assistance	610	4.8%	17,163	11.1%
Arts, entertainment, and recreation	459	3.6%	4,272	2.8%
Accommodation and food services	933	7.3%	12,769	8.3%
Other services, except public administration	740	5.8%	9,141	5.9%
Government and government enterprises	1,549	12.1%	19,405	12.6%

Source: Bureau of Economic Analysis, 2010

Table 38. Labor Force, 1990-2010

	Segment 4			The River Corridor
	1990	**2000**	**2010**	**2010**
Labor Force	8,702	11,407	11,740	125,613
Employed	8,368	10,924	11,105	119,142
Unemployed	334	483	635	6,471
Unemployment Rate	3.8%	4.2%	5.4%	5.2%

Source: Bureau of Labor Statistics, 2010

Segment 5 – Park County, MT

Introduction

Segment 5 of the River Corridor encompasses Park County, MT, so named for its proximity to Yellowstone National Park (Montana Department of Labor and Industry, 2012). Once an important stop for the Northern Pacific Railroad, the economy of Park County now includes agriculture, logging, and mining, as well as recreation and tourism related to Yellowstone National Park and the other surrounding natural resources (Park County Montana, 2013a).

Following the Lewis and Clark expedition, Park County became a popular destination for hunters and trappers with its abundant population of wildlife, specifically beavers (Park County Montana, 2013b). Late in the 19th Century, the Northern Pacific Railroad Company helped to establish the town of Livingston, MT, located in Park County. Livingston would serve as the company's repair and maintenance depot, and at one point employ over 1,100 residents at the peak of Livingston's population (City of Livingston Montana, 2008). Following the boom of the 1950s, the railroad industry began to decline as highways and cars became the chosen method of transportation.

With the railroad no longer playing such an active role in the economy of Park County, industries associated with recreation and tourism have begun to drive the local economy. The original, and only year round, road access to Yellowstone National Park is located in Park County. In addition to Yellowstone National Park, Park County is home to over 100 mountain peaks, the Yellowstone and Shields Rivers, and over 160 lakes and reservoirs (Park County Montana, 2013a). These natural resources are helping to attract local business that can cater to the growing tourism industry. In 2011, 4 of the top 10 industries in Park County were related to recreation and tourism (Montana Department of Labor and Industry, 2012). The recreation and tourism industry is viewed as an important element in the continued growth of the Park County economy. One of the goals of the Northern Rocky Mountain Economic District (encompassing both Park and Gallatin Counties) is to, "build on our unique natural assets to develop and enhance our tourist industries" (Northern Rocky Mountain Economic Development District, 2012). Tourism will likely continue to play an essential role in the growing economy of Park County.

Demographic Trends

Population

From 1950 to 2010, the population of Park County has increased by over 30%, making Segment 5 the second fastest growing segment in the River Corridor behind Segment 3 (United States Census Bureau, 2010). Table 39 shows total population for both Park County and the River Corridor as a whole from 1950 to 2010.

Table 39. Population Total, 1950-2010

Segment 5	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Park County, MT	11,999	13,168	11,197	12,869	14,562	15,694	15,636	30.3%
River Corridor Total	133,723	162,839	161,516	194,822	196,814	214,004	233,355	74.5%

Source: United States Census Bureau, 2010

As can be seen in Table 39, the population of Park County increased from 1950 to 1960, but then decreased from 1960 to 1970. The total population in the River Corridor also declined slightly during this time (United States Census Bureau, 2010). Though the population of Park County has grown since 1950, this increase has occurred at a lower rate compared to the average growth seen across the River Corridor, 30.3% compared to 74.5% (United States Census Bureau, 2010).

Table 40 shows the median age of the population of Park County from 1950 to 2010.

Table 40. Median Age, 1950-2010

Segment 5	1950	1960	1970	1980	1990	2000	2010
Park County, MT	32.9	31.9	35.7	32.7	37.1	40.6	45.4

Source: United States Census Bureau, 2010

Like other counties in the River Corridor, the population of Park County has aged over time. This may reflect an aging population and lower birth rates in the county, or an out migration of younger adults. From 1950 to 2010 the median age of residents of Park County increased by 12.5 years (United States Census Bureau, 2010). This is consistent with the other counties in the River Corridor.

As can be seen in Table 41, 5.2% of the population of Park County is under the age of 5, while nearly 17% is 65 years of age and older (United States Census Bureau, 2010a). This may indicate that the median age of the county will continue to increase as the younger population is not increasing as quickly as the aging population.

Table 41. Detailed Age Distribution, 2010

Segment 5	Median Age	Percent of Population Under 5 Years of Age	Percent of Population 18 and Over	Percent of Population 65 and Over
Park County, MT	45.4	5.2	80.3	16.6

Source: United States Census Bureau, 2010a

Park County is the second densest county within the River Corridor, with 5.6 persons per square mile. The average population density across the corridor is skewed due to the high population density of Yellowstone County (United States Census Bureau, 2012) (see Table 42, below).

Table 42. Population Density, 2010

Segment 5	Land (square miles)	Population (2010)	Population density
Park County, MT	2,803.06	15,636	5.6
River Corridor Total	29,859.91	226,995	7.6

Source: United States Census Bureau, 2012

In 2010, the population of Park County accounted for less than 7% of the total population of the River Corridor but nearly 10% of the total land within the corridor. Though it is considered a gateway to Yellowstone National Park and is neighbors with Gallatin County, which is home to the city of Bozeman, as well as Montana State University, Park County remains relatively rural with only two incorporated cities and a fairly low population density.

Housing

Table 43 shows the change in total housing units from 1950 to 2010. Though the population of Park County only increased by 30% during this time, total housing units increased by nearly 125% (United States Census Bureau, 2010). This increase in housing stock may be an indication of second home owners in the area, or a more seasonal workforce that requires housing but would not be considered residents of the county.

Table 43. Total Housing Units*, 1950-2010

Segment 5	1950	1960	1970	1980	1990	2000	2010	Percent Change 1950-2010
Park County, MT	4,194	4,597	4,648	6,074	6,926	8,247	9,375	123.5%
River Corridor Total	44,383	54,887	57,593	80,151	88,808	95,967	109,295	146.3%

Source: United States Census Bureau, 2010
*A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

Table 44 further examines the place of residence of the population for the previous year. This indicates the number of individuals that have moved within the county, or have moved into the county from another county within the same state, from a different state, or from a different country.

Table 44. Percent Individuals by Residence 1 Year Ago, 2012

			Different House			
Segment 5	Population 1 Year and Over	Same House	Same County	Same State/Different County	Different State	Abroad
Park County, MT	15,523	89.9%	4.0%	1.6%	3.6%	0.9%
River Corridor Total	236,143	83.4%	9.2%	3.6%	3.9%	0.1%

Source: United States Census Bureau, 2012a

As a portion of the population one year of age and older, nearly 90% of Park County residents lived in the same house in 2012 as they were living in 2011 (United States Census Bureau, 2012a). During this same timeframe, 4% of residents moved within Park County and just over 1.5% of residents moved into Park County from another county in the state of Montana. Combined, just over 4.5% of Park County residents moved into the county from another state or country from 2011 to 2012. Across the River Corridor, just over 83% of residents were living in the same house, 9.2% of residents moved within their same county, 3.6% of residents moved from another county within the same state and nearly 4% of residents moved from another state (United States Census Bureau, 2012a). Only 0.1% of residents of the River Corridor moved into the area from another country from 2011 to 2012.

Economic Trends

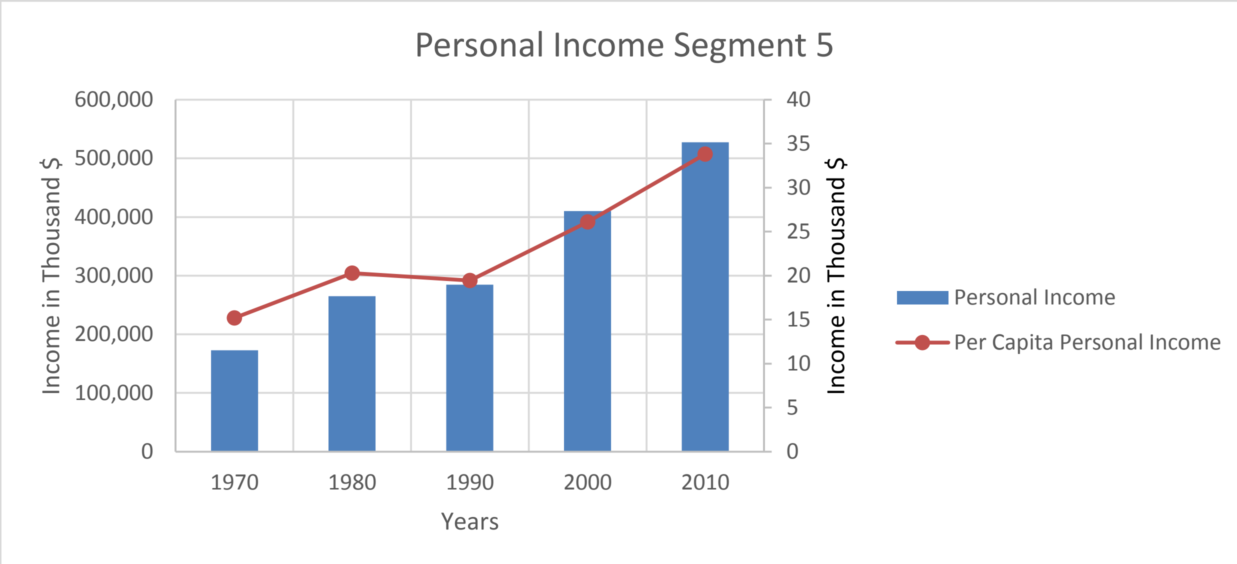
Segment 5, Park County, has the lowest total personal income and the second lowest per capita income of all other segments in the River Corridor. The county has seen constant growth in both property income and income from government payments since 1970 (Bureau of Economic Analysis, 2010). Consistent with most other segments, the majority of proprietors' income is derived from non-farm enterprises. Over time, earnings from the farming and transportation sectors declined, while earnings from the services, manufacturing, government and government enterprises and construction sectors have increased (Bureau of Economic Analysis, 2010). Since 1970, total employment in the county has increased consistently, with the accommodation and food services, retail trade, government and government enterprises, and health care and other services sectors providing the majority of employment (Bureau of Economic Analysis, 2010). The unemployment rate in Park County has consistently been above that of the River Corridor with a most recent rate of 7.5% compared to corridor's 5.2%, in 2010 (Bureau of Labor Statistics, 2010).

Income

Segment 5 has experienced steady growth in both personal income and per capita income since the 1970 (Figure 53). Yet as of 2010, Segment 5 had the lowest personal income and the second lowest per capita income as compared to the other segments in the River Corridor (Bureau of Economic Analysis, 2010). Since 1970, the segment has experienced comparable growth in income from dividends, interest and rent and personal current transfer receipts (Figure 54). Dividends, interest and rent typically represent investment income or property income while personal current transfer receipts capture government payments such as retirement and disability insurance benefits, Medicare and Medicaid. Between 2000 and 2010, property income and government payments grew at nearly identical rates (Bureau of Economic Analysis, 2010). Property income remains higher than government payments, consistent with most segments in the corridor. Proprietors' income has fluctuated over the years, decreasing in 1980 and then again in 2010 (see Figure 55). The large majority of the proprietors' income is from non-farm enterprises. In 2010, -$16. thousand came from farm income while nearly $36 thousand came from non-farm proprietors' income (Bureau of Economic Analysis, 2010). Like Segments 3 and 4, farm proprietors' income is negative in Segment 5, indicating that the cost of production exceed gross production.

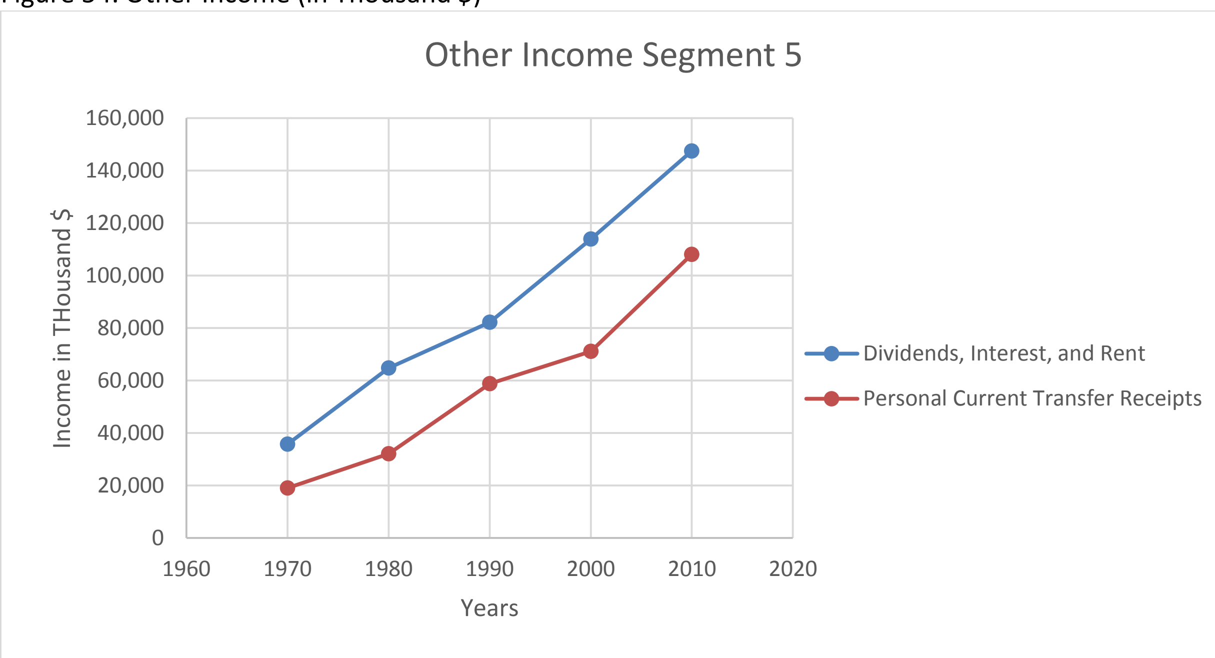
Table 45 shows personal income data for the segment in 2010. The share of income related to property ownership and income from government payments in the segment exceeds that of the River Corridor. The ratios of proprietors' income in the segment are comparable to the rest of the River Corridor (Bureau of Economic Analysis, 2010).

Figure 53. Personal Income (in Thousand $)



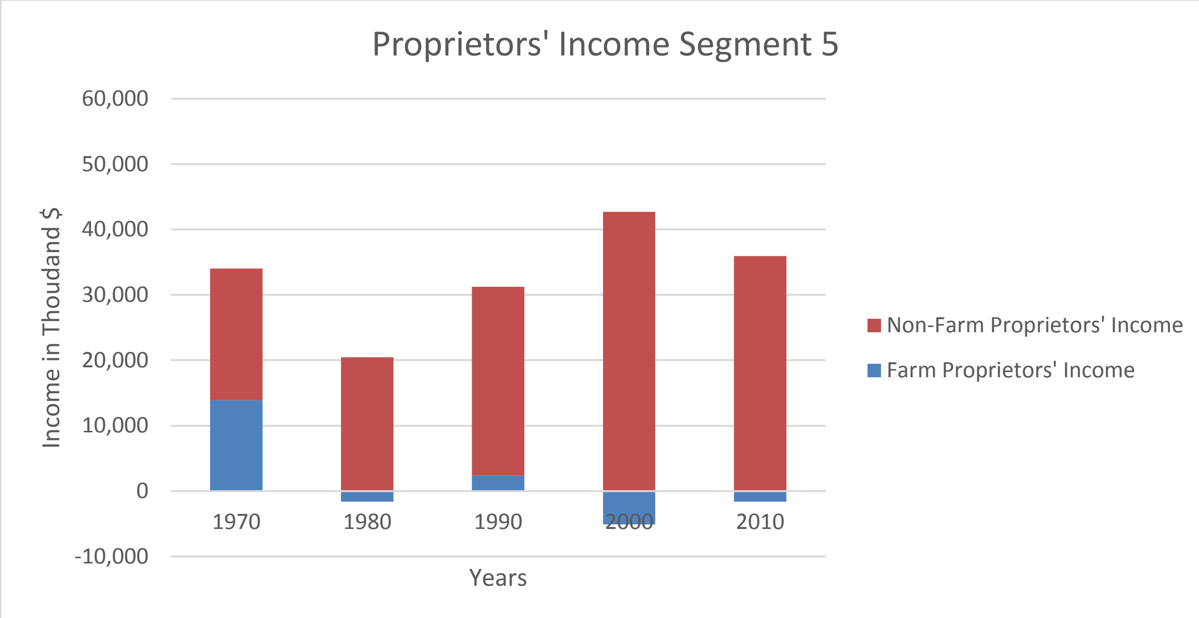
Source: Bureau of Economic Analysis, 2010

Figure 54. Other Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 55. Proprietors' Income (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 45. 2010 Income (in Thousand $)

	Segment 5		River Corridor	
	Park	Percent Total	**River Corridor**	Percent Total
Personal income	527,320		8,774,733	
Per capita personal income	34		38	
Net earnings by place of residence	271,851	52%	5,433,877	62%
Proprietors' income	34,317	7%	660,096	8%
Farm proprietors' income	-1,625	0%	63,889	1%
Nonfarm proprietors' income	35,942	7%	596,207	7%
Dividends, interest, and rent	147,425	28%	1,766,656	20%
Personal current transfer receipts	108,044	20%	1,574,200	18%
Retirement and disability insurance benefits	47,184	9%	634,042	7%
Medical benefits	36,630	7%	597,035	7%
Income maintenance benefits	8,596	2%	132,357	2%
Other	15,634	3%	210,766	2%

Source: Bureau of Economic Analysis, 2010

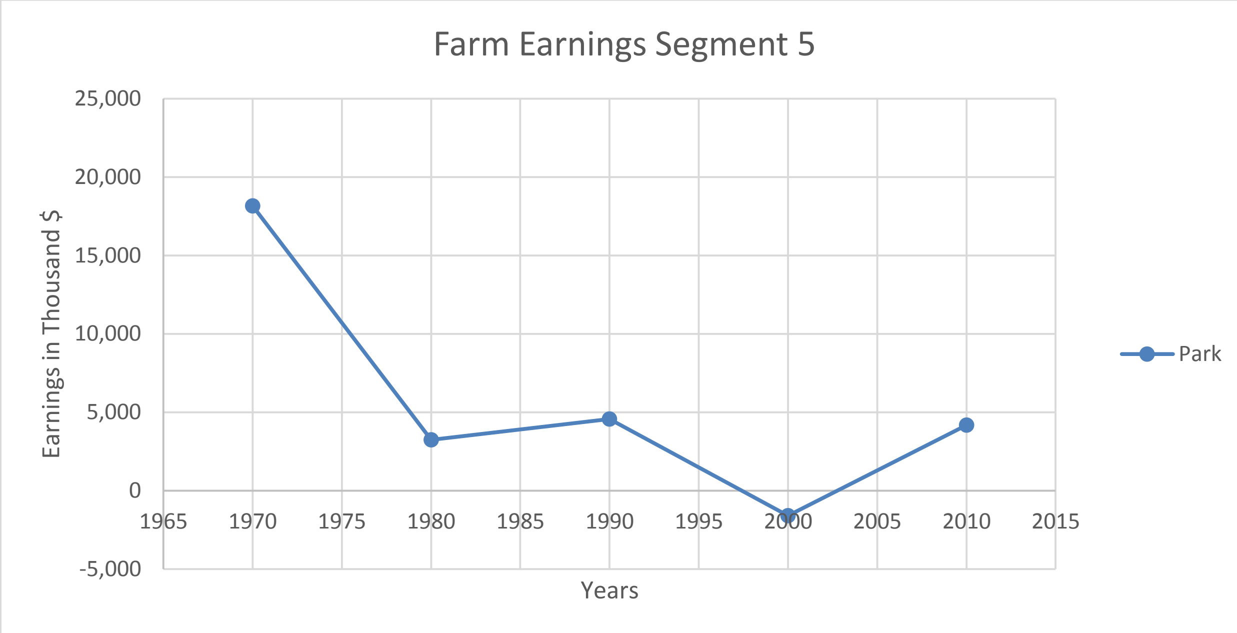
Earnings

Earnings in Segment 5 vary by industry (Figures 56-65). In some years, earnings data are suppressed and therefore not represented in the figures or tables provided in this report. Data suppression due to confidentiality reasons are marked with (D) while data suppressions resulting from a lack of confidence in the data is marked with (L). Confidentiality issues may result from only one company representing an industry within the county, while confidence issues may be due to a particularly low and therefore, uncertain estimate. All suppressed data are included in the total of all earnings (Bureau of Economic Analysis, 2010).

Since 1970, earnings from the farm and transportation sectors have fluctuated the most within Segment 5 (Figures 56 and 60). Transportation earnings saw a boom in 1980, followed by an extreme decline in 1990 (Bureau of Economic Analysis, 2010). Overall, farm earnings have decreased since 1970, however a slight increase occurred in 1990 and again in 2010. The greatest growth has been seen in earnings in the services sector in the county, contributing over 33% of the earnings in 2000 (Figure 64 and Table 46) (Bureau of Economic Analysis, 2010). Additionally, earnings from the government and government enterprises, manufacturing and construction sectors have experienced growth in recent decades (Figures 65, 59, and 58). Interestingly, wholesale and retail trade both took at downturn in 2010, after a historical high in 2000 (Figures 61 and 62) (Bureau of Economic Analysis, 2010).

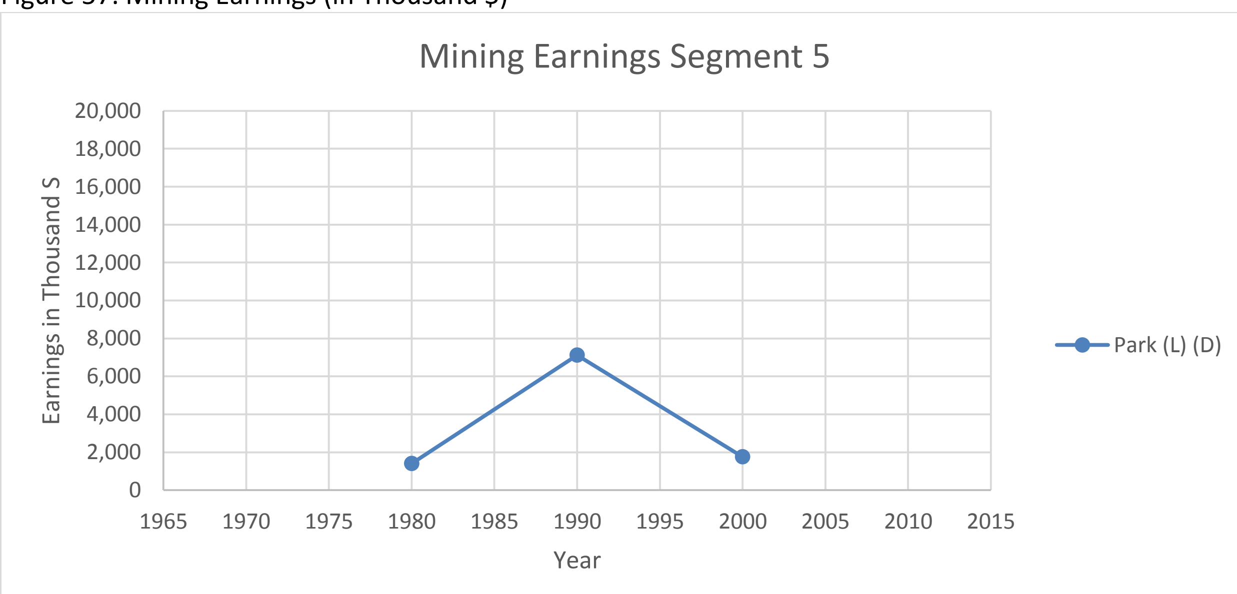
Table 46 shows the 2010 earnings by industry for Park County. The services sector continues to contribute the biggest share of earnings with Health Care and Social Assistance at 13%, accommodation and food services at 11% and other services at 7% (Bureau of Economic Analysis, 2010). Government and government enterprises contributed 16% to the total earnings share, while retail trade and construction each contributed 8% (Bureau of Economic Analysis, 2010). Only 6 % of the data in Park County is suppressed due to confidentiality reasons.

Figure 56. Farm Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

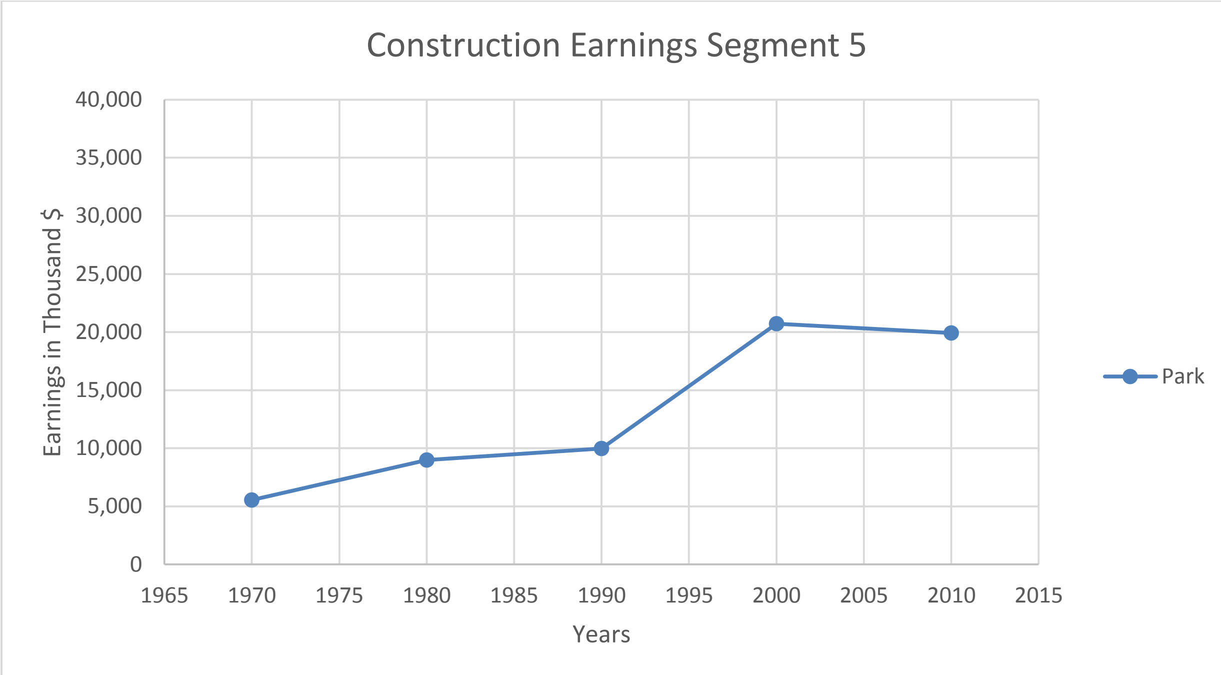
Figure 57. Mining Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

* (D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
* (L) Less than $50,000, but the estimates for this item are included in the totals.

Figure 58. Construction Earnings (in Thousand $)

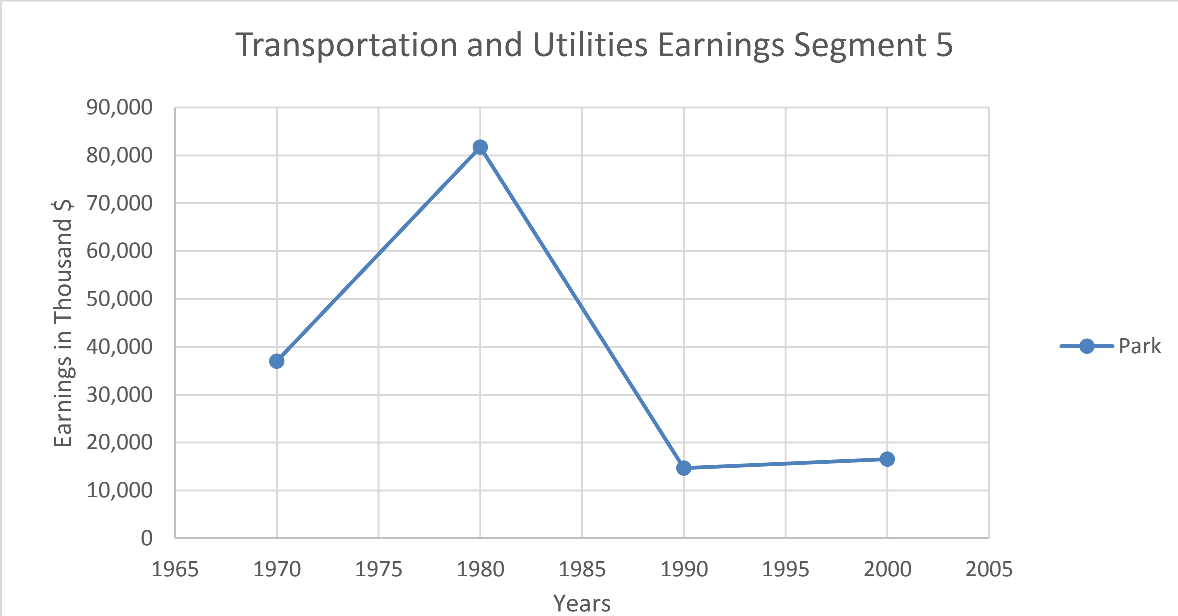


Source: Bureau of Economic Analysis, 2010

Figure 59. Manufacturing Earnings (in Thousand $)

Source: Bureau of Economic Analysis, 2010

Figure 60. Transportation and Utilities Earnings (in Thousand $)

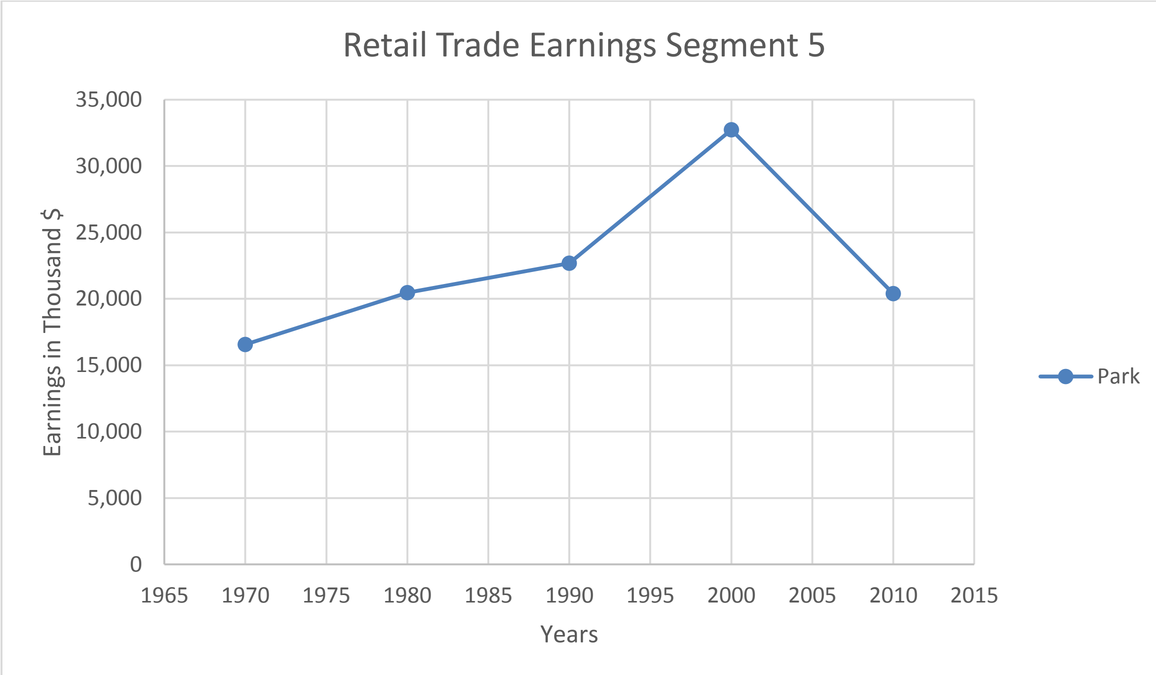


Source: Bureau of Economic Analysis, 2010

Figure 61. Wholesale Trade Earnings (in Thousand $)

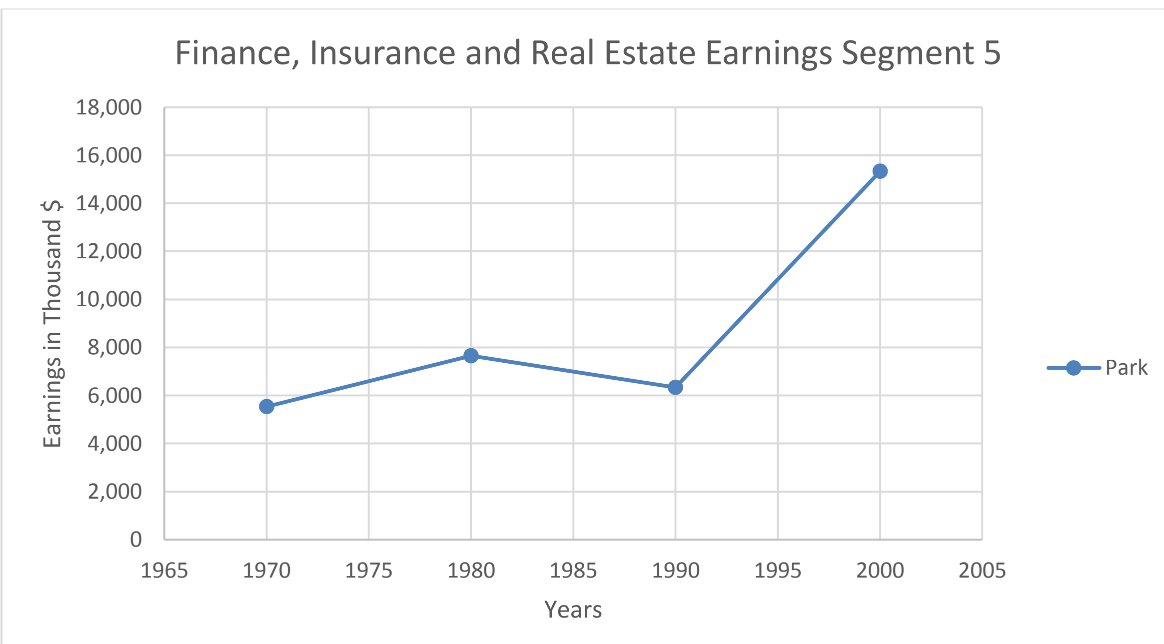
Source: Bureau of Economic Analysis, 2010

Figure 62. Retail Trade Earnings (in Thousand $)



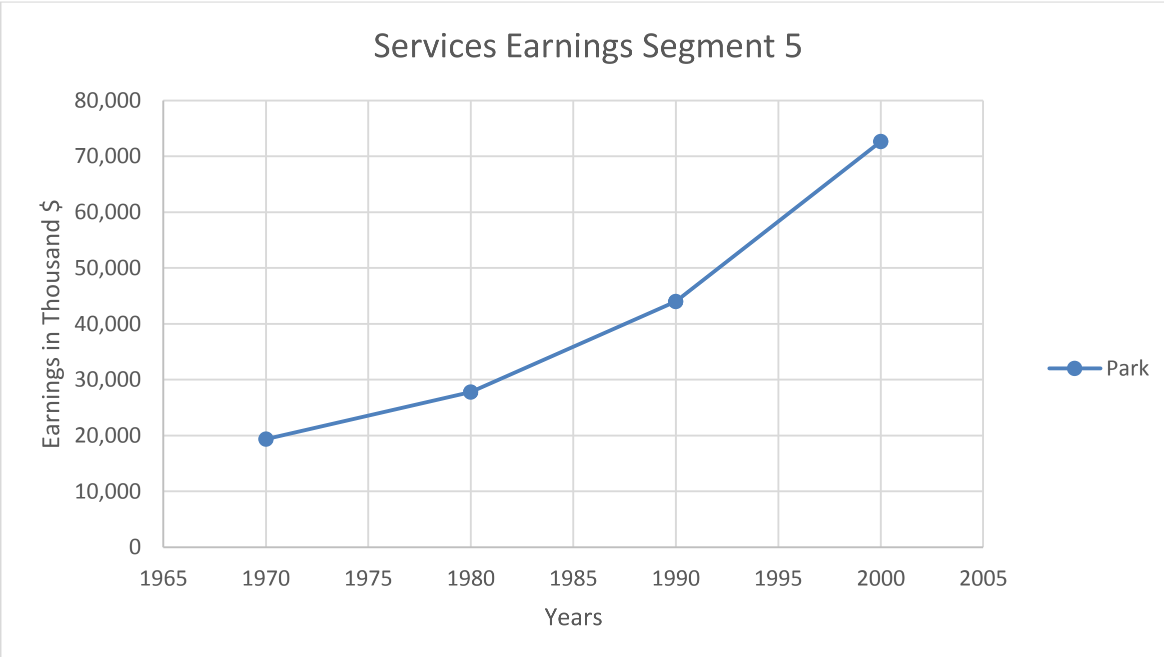
Source: Bureau of Economic Analysis, 2010

Figure 62. Finance, Insurance and Real Estate Earnings (in Thousand $)



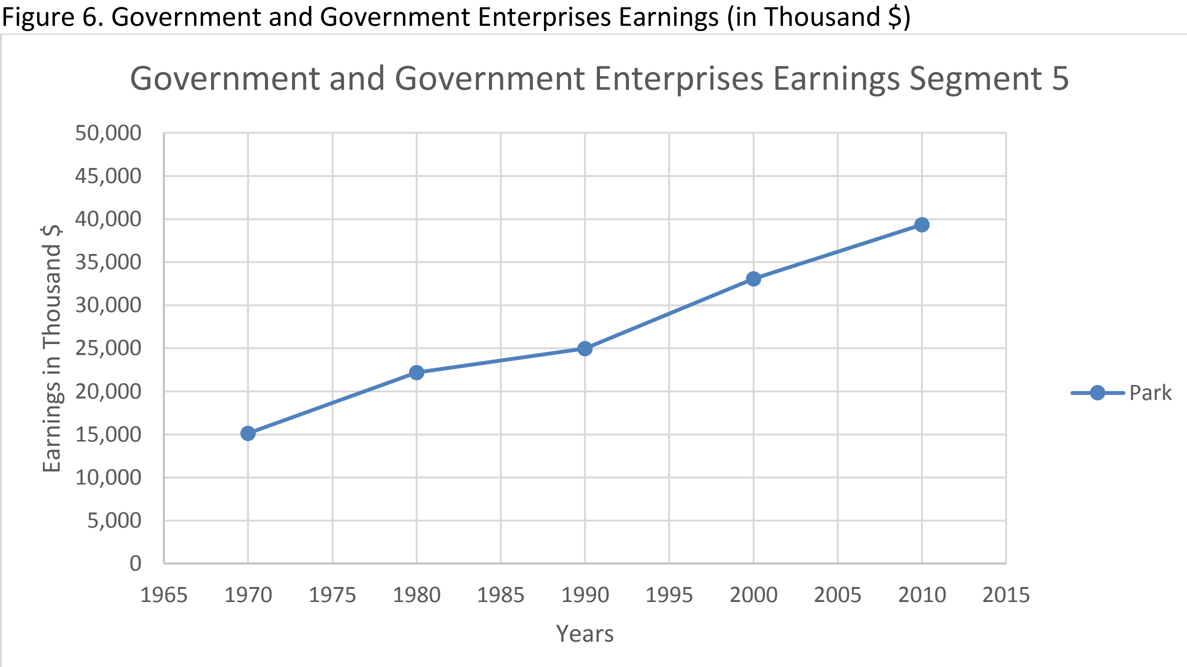
Source: Bureau of Economic Analysis, 2010

Figure 64. Services Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Figure 6. Government and Government Enterprises Earnings (in Thousand $)



Source: Bureau of Economic Analysis, 2010

Table 46. Earnings by Industry, 2010 (in Thousand $)

Earnings by Industry 2010	Segment 5 Park	Percent Total	River Corridor River Corridor	Percent Total
Farm earnings	4,174	2%	111,114	2%
Forestry, fishing, and related activities	(D)	-	8,501	0%
Mining	(D)	-	227,003	4%
Utilities	4,216	2%	53,712	1%
Construction	19,909	8%	474,975	8%
Manufacturing	16,250	7%	310,939	5%
Wholesale trade	3,908	2%	404,674	6%
Retail trade	20,386	8%	470,257	8%
Transportation and warehousing	7,544	3%	308,590	5%
Information	4,133	2%	102,368	2%
Finance and insurance	10,333	4%	278,587	4%
Real estate and rental and leasing	3,420	1%	81,605	1%
Professional, scientific, and technical services	10,998	5%	371,658	6%
Management of companies and enterprises	(D)	-	32,148	1%
Administrative and waste management services	(D)	-	166,574	3%
Educational services	3,928	2%	31,762	1%
Health care and social assistance	31,089	13%	895,034	14%
Arts, entertainment, and recreation	4,088	2%	63,352	1%
Accommodation and food services	26,647	11%	233,769	4%
Other services, except public administration	16,960	7%	229,168	4%
Government and government enterprises	39,371	16%	999,422	16%
Provided Data Total	227,354	94%	5,855,212	94%
Suppressed Data Total	13,444	6%	400,857	6%
Earning by place of work	240,798		6,256,069	

Source: Bureau of Economic Analysis, 2010
*(D) suppressed data

Employment

Total full-time and part-time employment has grown in Park County since 1970 (Tables 47 and 48). As of 2010, the industries with the highest percent of employment were accommodation and food services (14.6%), retail trade (10%), government and government enterprises (8.9%), health care and social assistance (8.5%) and other services(8.2%) (Bureau of Economic Analysis, 2010). Park County has the highest percent employed in accommodations and food services than any other segment in the River Corridor. This is not surprising and is most likely attributed to the entrance to the Yellowstone National Park, located in town of Gardiner within Park County.

Table 49 shows the labor force in the segment since 1990. The number of individuals employed shown in Table 49 is lower than the numbers reported in Tables 47 and 48. The labor force data is produced by Bureau of Labor Statistics (BLS) while the previous data is reported by Bureau of Economic Analysis (BEA). The BEA estimates of employment differ from the BLS data as the BEA adjusts data to account for employment not covered, or not fully covered, by the state Unemployment Insurance (UI) and the Unemployment for Federal Employees (UCFE) programs. This may include nonprofit organizations not participating in the UI program, students and their spouses employed by public colleges or universities, elected officials and members of state and local judiciary, interns employed by hospitals and by social service agencies, and insurance agents classified as statutory employees. More information is provided in the Methods and Definitions section of the report. Table 49 shows that unemployment rate in the county has fluctuated over the decades. The unemployment rate in 2010, the highest rate since 1990, was 7.5%, compared to the unemployment rate of the River Corridor, 5.2% (Bureau of Labor Statistics, 2010).

Employment by Industry data from BEA and Labor Force data from BLS at the county level can be found in the appendix of this report.

Table 47. Employment by Industry, 1970-2010

	Segment 5					The River Corridor	
	1970	**1980**	**1990**	**2000**	**Percent Total**	**2000**	**Percent Total**
Total full-time and part-time employment	4,692	6,287	6,598	8,824		138,767	
Proprietors employment	1,248	1,528	2,299	2,905	33%	32,826	24%
Farm proprietors employment	416	373	393	486		6,016	
Nonfarm proprietors employment	832	1,155	1,906	2,419		26,810	
Farm employment	630	523	505	631	7%	7,556	5%
Agricultural services, forestry, and fishing	47	71	125	251	3%	1,607	1%
Mining	0	14	128	30	0%	2,053	1%
Construction	156	294	379	734	8%	7,698	6%
Manufacturing	295	414	347	451	5%	5,526	4%
Transportation and public utilities	744	1,371	322	356	4%	8,618	6%
Wholesale trade	37	55	132	208	2%	7,720	6%
Retail trade	872	1,052	1,236	1,808	20%	26,278	19%
Finance, insurance, and real estate	357	409	461	598	7%	8,884	6%
Services	998	1,413	2,214	2,934	33%	43,052	31%
Government and government enterprises	555	671	749	823	9%	17,590	13%

Source: Bureau of Economic Analysis, 2010

Table 48. Employment by Industry, 2010

	Segment 5		The River Corridor	
	2010	Percent Total	**2010**	Percent Total
Total employment	9,244		154,335	
Wage and salary employment	5,483	59.3%	117,792	76.3%
Proprietors employment	3,761	40.7%	38,388	24.9%
Farm proprietors employment	421		5,286	
Nonfarm proprietors employment	3,340		33,102	
Farm employment	545	5.9%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	46	0.5%	483	0.3%
Construction	703	7.6%	9,952	6.4%
Manufacturing	331	3.6%	4,687	3.0%
Wholesale trade	55	0.6%	6,883	4.5%
Retail trade	927	10.0%	17,670	11.4%
Transportation and warehousing	177	1.9%	5,371	3.5%
Information	142	1.5%	2,159	1.4%
Finance and insurance	405	4.4%	6,338	4.1%
Real estate and rental and leasing	536	5.8%	6,441	4.2%
Professional, scientific, and technical services	496	5.4%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	179	1.9%	1,681	1.1%
Health care and social assistance	783	8.5%	17,163	11.1%
Arts, entertainment, and recreation	416	4.5%	4,272	2.8%
Accommodation and food services	1,350	14.6%	12,769	8.3%
Other services, except public administration	760	8.2%	9,141	5.9%
Government and government enterprises	821	8.9%	19,405	12.6%

Source: Bureau of Economic Analysis, 2010

Table 49. Labor Force, 1990-2010

	Segment 5			The River Corridor
	1990	**2000**	**2010**	**2010**
Labor Force	7,845	9,051	8,332	125,613
Employed	7,417	8,589	7,710	119,142
Unemployed	428	462	622	6,471
Unemployment Rate	5.5%	5.1%	7.5%	5.2%

Source: Bureau of Labor Statistics, 2010

Summary of Demographic Trends

Table 50 provides the total population, in 2010, for each segment in the River Corridor as well the percent change in population from 1950 to 2010. Segment 1 was the only segment in the River Corridor where the population declined from 1950 to 2010. Segment 3, Yellowstone County, had the greatest growth in population during this time period, 165% (United States Census Bureau, 2010). Segment 3 accounts for the largest portion of the total population of the River Corridor, with 63% of residents in the River Corridor living in the segment. Segment 5, Park County, though only accounting for 7% of the total River Corridor population, had an increase in population of 30%, the second highest increase across the River Corridor (United States Census Bureau, 2010).

Table 50. 2010 Total Population and Percent Change

	2010	Percent Change from 1950-2010
Segment 1	26,251	-8%
Segment 2	21,650	19%
Segment 3	147,972	165%
Segment 4	21,846	15%
Segment 5	15,636	30%
River Corridor Total	233,355	75%

Source: United States Census Bureau, 2010

2010 total housing units and percent change from 1950 to 2010 are provided in Table 51. Similar to population, Segment 3, Yellowstone County, accounts for over 50% of the total housing units in the River Corridor and had the highest percent increase from 1950 to 2010 (United States Census Bureau, 2010). Segment 3 is the only segment to outpace the percent change in the River Corridor, indicating that it is driving the average. In 2010, Segment 5 had the smallest number of housing units, and had the lowest percent increase over time (United States Census Bureau, 2010).

Table 51. 2010 Total Housing Units and Percent Change

	2010	Percent Change from 1950-2010
Segment 1	12,546	35%
Segment 2	10,039	51%
Segment 3	63,943	262%
Segment 4	13,392	103%
Segment 5	9,375	124%
River Corridor Total	109,295	146%

Source: United States Census Bureau, 2010

*A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

As shown in Table 52, Segments 1 and 2 are the least densely populated segments in the River Corridor, with 2.2 persons per square mile, while Segment 3 is substantially denser than any other segment in the River Corridor, with 56.2 persons per square mile (Table 52). Though most of the counties in the River Corridor remain characteristically rural, Yellowstone County is once again the exception. Segment 5 has the second highest population density, with 5.6 persons per square mile (United States Census Bureau, 2012).

Table 52. Population Density

	Land (square miles)	Population (2010)	Population density
Segment 1	8,953	19,891	2.2
Segment 2	9,771	21,650	2.2
Segment 3	2,633	147,972	56.2
Segment 4	5,699	21,846	3.8
Segment 5	2,803	15,636	5.6
River Corridor Total	29,860	226,995	7.6

Source: United States Census Bureau, 2012

Finally, Table 53 provides one year migration data for each segment in the River Corridor. As a portion of the population one year of age and older, Segment 5 has the highest percentage of residents living in the same house in 2012 as they were in 2011 while Segment 3 has the lowest percentage, 89.9% and 81.8%, respectively (United States Census Bureau, 2012a). Segment 3 has the highest percentage of residents that have moved, yet remained in the same county while Segment 2 has the highest percentage of residents that have moved into the area from other counties in the state. Likely due to the Bakken Oil Fields, Segment 1 had the most residents move into the area from a different state, with 5.0% of resident moving in from out of state. Residents moving into counties within the segments from abroad accounts for less than 1% of the population across all five segments.

Table 53. Percent Individuals by Residence 1 Year Ago, 2012

			Different House			
	Population 1 Year and Over	Same House	Same County	Same State/Different County	Different State	Abroad
Segment 1	26,372	84.6%	6.7%	3.6%	5.0%	0.1%
Segment 2	21,400	83.8%	8.4%	4.0%	3.7%	0.1%
Segment 3	150,218	81.8%	10.7%	3.8%	3.7%	0.0%
Segment 4	22,630	87.2%	6.3%	3.7%	4.7%	0.1%
Segment 5	15,523	89.9%	4.0%	1.6%	3.6%	0.9%
River Corridor Total	236143	83.4%	9.2%	3.6%	3.9%	0.1%

Source: United States Census Bureau, 2012a

Summary of Economic Trends

Income

Table 54, below, allows for the comparison of income across all segments and the River Corridor for 2010. Segment 3, Yellowstone County, has the largest population. This county also has the greatest total personal income and earnings by place of work in the River Corridor, $5.6 billion and $4.2 billion, respectively, overwhelmingly influencing the River Corridor totals (Bureau of Economic Analysis, 2010). Yellowstone County has the second largest per capita income, $38 thousand. Segment 1 has the highest per capita personal income at $43 thousand, the second highest personal income and earnings by place of work, at just over $1 billion and $850 million, respectively (Bureau of Economic Analysis, 2010). The smallest personal income is found in Segment 5, Park County, at half a billion dollars, while the smallest per capita personal income is in Segment 4, at $33 thousand. Most segments have a similar ratio of dividends, interests and rent and personal current transfer receipts. Dividends, interests and rent typically represent investment income or property income while personal current transfer receipts capture government payments such as retirement and disability insurance benefits, Medicare and Medicaid. Segment 2 is the only segment where income from government payments exceeded property income in 2010 (Bureau of Economic Analysis, 2010). Non-farm proprietors' income holds the largest share of proprietors' income in all segments, except Segment 1, where farm proprietors' income (7%) exceeds non-farm proprietors' income (6%) (Bureau of Economic Analysis, 2010).

Table 54. Person Income, 2010 (in Thousand $)

Source: Bureau of Economic Analysis, 2010

	Segment 1	Percent Total	**Segment 2**	Percen t Total	**Segment 3**	Percent Total	**Segmen t 4**	Percent Total	**Segment 5**	Percent Total	**River Corridor**	Percent Total
Personal income	1135380		749,960		5,609,050		753,023		527,320		8,774,733	
Per capita personal income	43		35		38		33		34		38	
Net earnings by place of residence	728531	64%	459,460	61%	3,571,236	64%	402,799	53%	271,851	52%	5,433,877	62%
Proprietors' income	146380	13%	51,869	7%	388,957	7%	38,573	5%	34,317	7%	660,096	8%
Farm proprietors' income	76263	7%	13,295	2%	-8,436	0%	-15,608	-2%	-1,625	0%	63,889	1%
Nonfarm proprietors' income	70117	6%	38,574	5%	397,393	7%	54,181	7%	35,942	7%	596,207	7%
Dividends, interest, and rent	232723	20%	133,405	18%	1,058,792	19%	194,311	26%	147,425	28%	1,766,656	20%
Personal current transfer receipts	174126	15%	157,095	21%	979,022	17%	155,913	21%	108,044	20%	1,574,200	18%
Retirement and disability insurance benefits	73904	7%	57,597	8%	386,396	7%	68,961	9%	47,184	9%	634,042	7%
Medical benefits	68721	6%	60,856	8%	372,616	7%	58,212	8%	36,630	7%	597,035	7%
Income maintenance benefits	12064	1%	17,348	2%	85,576	2%	8,773	1%	8,596	2%	132,357	2%
Other	19437	2%	21,294	3%	134,434	2%	19,967	3%	15,634	3%	210,766	2%

Earnings

Table 55 illustrates earnings by industry for each segment and the River Corridor for 2010. Government and Government Enterprises and various services sectors generally hold the largest share of earnings across all segments. Government and Government Enterprise earnings are highest in Segment 2 (28%) and lowest, but still significant, in Segment 3 (14%) (Bureau of Economic Analysis, 2010). Earnings from accommodation and food services make up the greatest percentage of earnings in Segment 5, Park County (11%). Earnings from the health care and social assistance sectors make up the greatest percentage of earnings in Segment 3 (18%) and second highest in Segment 5 (13%) (Bureau of Economic Analysis, 2010). Farm earnings are typically low in all segments, except for Segment 1 where they represent 10% of earnings. Earnings from mining are highest in Segment 1 (12%) and Segment 2 (8%) (Bureau of Economic Analysis, 2010). Earnings from the construction sector make sizable contributions to the total earnings, varying from 5% in Segment 4 to 9% in Segments 1 and 2. Earnings from the transportation and warehousing sector are highest in Segment 1 (9%), while retail trade is highest in Segments 3 (9%) and 5 (8%). Note that 42% of the 2010 earnings by industry data is suppressed in Segment 4 with 19% is suppressed in Segment 2 and 14% in Segment 1 (Bureau of Economic Analysis, 2010).

Table 55. Earnings by Industry, 2010 (in Thousand $)

Earnings by Industry 2010	**Segment 1**	Percent Total	**Segment 2**	Percent Total	**Segment 3**	Percent Total	**Segment 4**	Percent Total	**Segment 5**	Percent Total	**River Corridor**	Percent Total
Farm earnings	87,654	10%	23,522	4%	358	0%	-4,594	-1%	4,174	2%	111,114	2%
Forestry, fishing, and related activities	(D)	-	120	0%	7,072	0%	1,309	0%	(D)	-	8,501	0%
Mining	103,294	12%	44,873	8%	74,859	2%	3,977	1%	(D)	-	227,003	4%
Utilities	7,131	1%	(D)	-	36,072	1%	6,293	2%	4,216	2%	53,712	1%
Construction	73,195	9%	47,659	9%	315,580	7%	18,632	5%	19,909	8%	474,975	8%
Manufacturing	18,857	2%	2,997	1%	255,517	6%	17,318	4%	16,250	7%	310,939	5%
Wholesale trade	38,668	5%	8,193	1%	344,767	8%	9,138	2%	3,908	2%	404,674	6%
Retail trade	32,399	4%	35,200	6%	360,956	9%	21,316	5%	20,386	8%	470,257	8%
Transportation and warehousing	76,811	9%	9,088	2%	209,637	5%	5,510	1%	7,544	3%	308,590	5%
Information	7,339	1%	6,903	1%	82,050	2%	1,943	0%	4,133	2%	102,368	2%
Finance and insurance	17,811	2%	18,850	3%	223,395	5%	8,198	2%	10,333	4%	278,587	4%
Real estate and rental and leasing	16,934	2%	1,631	0%	55,103	1%	4,517	1%	3,420	1%	81,605	1%
Professional, scientific, and technical services	24,153	3%	10,290	2%	308,294	7%	17,923	5%	10,998	5%	371,658	6%
Management of companies and enterprises	(D)	-	3,042	1%	29,106	1%	(D)	-	(D)	-	32,148	1%
Administrative and waste management services	(D)	-	3,961	1%	162,613	4%	(D)	-	(D)	-	166,574	3%
Educational services	818	0%	1,009	0%	25,549	1%	458	0%	3,928	2%	31,762	1%
Health care and social assistance	35,921	4%	41,092	7%	769,834	18%	17,098	4%	31,089	13%	895,034	14%
Arts, entertainment, and recreation	5,527	1%	4,685	1%	43,232	1%	5,820	1%	4,088	2%	63,352	1%
Accommodation and food services	17,096	2%	14,583	3%	160,359	4%	15,084	4%	26,647	11%	233,769	4%
Other services, except public administration	22,883	3%	16,600	3%	160,038	4%	12,687	3%	16,960	7%	229,168	4%
Government and government enterprises	152,425	18%	153,484	28%	587,836	14%	66,306	17%	39,371	16%	999,423	16%
Provided Data Total	738,916	86%	447,782	81%	4,212,227	100%	228,933	58%	227,354	94%	5,855,215	94%
Suppressed Data Total	116,023	14%	106,729	19%	0	0%	164,661	42%	13,444	6%	400,858	6%
Earning by place of work	854,939		554,511		4,212,227		393,594		240,798		6,256,069	

Source: Bureau of Economic Analysis, 2010

*(D) suppressed data

*Other data may also be suppressed. Refer to county tables for additional information

Employment

Table 56 illustrates employment by industry across all segments and the River Corridor, for 2010. Segment 4 has the largest share of proprietors' employment (43%), followed closely by Segment 5, Park County (41%) (Bureau of Economic Analysis, 2010). Government and Government Enterprises employ the largest percent of total employment in Segments 2 (22%) and 1 (21%) (Bureau of Economic Analysis, 2010). A combination of various services contribute significantly to total employment in most segments. The accommodation and food services sector employs the greatest percentage of the workforce in Segment 5, Park County (14.6%), while the health care and social services sector is the major employer in Segment 3 (13.6%). Employment in retail trade is highest in Segment 3, Yellowstone County (12%), while farm employment is highest in Segment 4 (13%) and Segment 1 (8.9%). Mining accounts for 7.1% of the total employment in Segment 1 (Bureau of Economic Analysis, 2010).

Table 57 shows the labor force for all the segments and the River Corridor for year 2010. The number of individuals employed shown in Table 49 is lower than the numbers reported in Tables 55 and 56. The labor force data is produced by Bureau of Labor Statistics (BLS) while the previous data is reported by Bureau of Economic Analysis (BEA). The BEA estimates of employment differ from the BLS data as the BEA adjusts data to account for employment not covered, or not fully covered, by the state Unemployment Insurance (UI) and the Unemployment for Federal Employees (UCFE) programs. This may include nonprofit organizations not participating in the UI program, students and their spouses employed by public colleges or universities, elected officials and members of state and local judiciary, interns employed by hospitals and by social service agencies, and insurance agents classified as statutory employees. More information is provided in the Methods and Definitions section of the report. Table 57 shows that, in 2010, Segment 1 had the lowest unemployment rate at 3.4% while Segment 5, Park County, had the highest unemployment rate at 7.5%.

Employment by Industry data from BEA and Labor Force data from BLS at the county level can be found in the appendix of this report.

Table 56. Employment by Industry, 2010

	Segment 1	Percent Total	Segment 2	Percent Total	Segment 3	Percent Total	Segment 4	Percent Total	Segment 5	Percent Total	The River Corridor	Percent Total
Total employment	19,431		14,204		100,466		12,835		9,244		154,335	
Wage and salary employment	14,141	72.8%	10,550	74.3%	80,291	79.9%	7,327	57.1%	5,483	59.3%	117,792	76.3%
Proprietors employment	5,290	27.2%	3,654	25.7%	20,175	20.1%	5,508	42.9%	3,761	40.7%	38,388	24.9%
Farm proprietors employment	1,427		812		1,206		1,420		421		5,286	
Nonfarm proprietors employment	3,863		2,842		18,969		4,088		3,340		33,102	
Farm employment	1,738	8.9%	1,056	7.4%	1,384	1.4%	1,670	13.0%	545	5.9%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	14	0.1%	320	0.3%	95	0.7%	0	0.0%	429	0.3%
Mining	1,372	7.1%	613	4.3%	1,078	1.1%	83	0.6%	0	0.0%	3,146	2.0%
Utilities	60	0.3%	0	0.0%	324	0.3%	53	0.4%	46	0.5%	483	0.3%
Construction	1,360	7.0%	764	5.4%	6,472	6.4%	653	5.1%	703	7.6%	9,952	6.4%
Manufacturing	461	2.4%	133	0.9%	3,300	3.3%	462	3.6%	331	3.6%	4,687	3.0%
Wholesale trade	680	3.5%	251	1.8%	5,696	5.7%	201	1.6%	55	0.6%	6,883	4.5%
Retail trade	1,381	7.1%	1,422	10.0%	12,921	12.9%	1,019	7.9%	927	10.0%	17,670	11.4%
Transportation and warehousing	988	5.1%	134	0.9%	3,888	3.9%	184	1.4%	177	1.9%	5,371	3.5%
Information	188	1.0%	186	1.3%	1,562	1.6%	81	0.6%	142	1.5%	2,159	1.4%
Finance and insurance	490	2.5%	492	3.5%	4,694	4.7%	257	2.0%	405	4.4%	6,338	4.1%
Real estate and rental and leasing	540	2.8%	352	2.5%	4,273	4.3%	740	5.8%	536	5.8%	6,441	4.2%
Professional, scientific, and technical services	587	3.0%	386	2.7%	6,189	6.2%	565	4.4%	496	5.4%	8,223	5.3%
Management of companies and enterprises	0	0.0%	32	0.2%	449	0.4%	0	0.0%	0	0.0%	481	0.3%
Administrative and waste management services	34	0.2%	262	1.8%	6,184	6.2%	0	0.0%	0	0.0%	6,480	4.2%
Educational services	96	0.5%	85	0.6%	1,253	1.2%	68	0.5%	179	1.9%	1,681	1.1%
Health care and social assistance	1,001	5.2%	1,059	7.5%	13,710	13.6%	610	4.8%	783	8.5%	17,163	11.1%
Arts, entertainment, and recreation	373	1.9%	306	2.2%	2,718	2.7%	459	3.6%	416	4.5%	4,272	2.8%
Accommodation and food services	1,168	6.0%	1,027	7.2%	8,291	8.3%	933	7.3%	1,350	14.6%	12,769	8.3%
Other services, except public administration	982	5.1%	688	4.8%	5,971	5.9%	740	5.8%	760	8.2%	9,141	5.9%
Government and government enterprises	4,093	21.1%	3,153	22.2%	9,789	9.7%	1,549	12.1%	821	8.9%	19,405	12.6%

Source: Bureau of Economic Analysis, 2010

Table 57. Labor Force, 2010

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	The River Corridor
Labor Force	14,099	10,450	80,992	11,740	8,332	125,613
Employed	13,620	9,887	76,820	11,105	7,710	119,142
Unemployed	479	563	4,172	635	622	6,471
Unemployment Rate	3.4%	5.4%	5.2%	5.4%	7.5%	5.2%

Source: Bureau of Labor Statistics, 2010

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DEFINITION SET 1

Regional Profile of the Yellowstone River Corridor

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The following definitions are provided by Bureau of Economic Analysis. These definitions were collected for the convenience of the reader in this document from Bureau or Economic Analysis Regional Definitions page, which can be accessed at this link: http://www.bea.gov/regional/definitions/

Accommodation and food services- The Accommodation and Food Services NAICS sector comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption. The sector includes both accommodation and food services establishments because the two activities are often combined at the same establishment.

Administrative and waste management services- The Administrative and Support and Waste Management and Remediation Services NAICS sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. These essential activities are often undertaken in-house by establishments in many sectors of the economy. The establishments in this sector specialize in one or more of these support activities and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services.

The administrative and management activities performed by establishments in this sector are typically on a contract or fee basis. These activities may also be performed by establishments that are part of the company or enterprise. However, establishments involved in administering, overseeing, and managing other establishments of the company or enterprise, are classified in Sector 55, Management of Companies and Enterprises. These establishments normally undertake the strategic and organizational planning and decision-making role of the company or enterprise. Government establishments engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration.

Arts, entertainment, and recreation- The Arts, Entertainment, and Recreation NAICS sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises (1) establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure time interests.

Construction- Three broad types of construction activity are covered: (1) building construction by general contractors or by operative builders; (2) heavy construction other than building by general contractors and special trade contractors; and (3) construction activity by other special trade contractors.

NAICS definition:
The Construction (NAICS) sector comprises establishments primarily engaged in the construction of buildings and other structures, heavy construction (except buildings), additions, alterations, reconstruction, installation, and maintenance and repairs. Establishments engaged in demolition or wrecking of buildings and other structures, clearing of building sites, and sale of materials from demolished structures are also included. This sector also includes those establishments engaged in blasting, test drilling, landfill, leveling, earthmoving, excavating, land drainage, and other land preparation. The industries within this sector have been defined on the basis of their unique production processes. As with all industries, the production processes are distinguished by their use of specialized human resources and specialized physical capital. Construction activities are generally administered or managed at a relatively fixed place of business, but the actual construction work is performed at one or more different project sites. In certain regional estimates this sector is divided into three subsectors of construction activities: (1) building construction and land subdivision and land development; (2) heavy construction (except buildings), such as highways, power plants, and pipelines; and (3) construction activity by special trade contractors.

Core PCE Index
The "core" PCE price index is defined as personal consumption expenditures (PCE) prices excluding food and energy prices. The core PCE price index measures the prices paid by consumers for goods and services without the volatility caused by movements in food and energy prices to reveal underlying inflation trends. Food prices consist of those included in the PCE category of “food and beverages purchased for off-premises consumption.” Prices included in the PCE category “food services and accommodations” are not included in the “food” price index because these services prices tend to be far less volatile than those for food commodities such as meats, fresh vegetables and fruits. Energy prices consist of those included in the PCE categories of “gasoline and other energy goods” and of “electricity and gas” utilities.

See more at: http://www.bea.gov/faq/index.cfm?faq_id=518#sthash.5IBcGqPV.dpuf

Dividends, interest, and rent- Personal dividend income, personal interest income, and rental income of persons with capital consumption adjustment are sometimes referred to as "investment income" or "property income."

(1) Dividends: This component of personal income consists of the payments in cash or other assets, excluding the corporation's own stock, made by corporations located in the United States or abroad to persons who are U.S. residents. It excludes that portion of dividends paid by regulated investment companies (mutual funds) related to capital gains distributions.
(2) Interest: This component of personal income is the interest income (monetary and imputed) of persons from all sources.
(3) Rent: Rental income is the net income of persons from the rental of real property except for the income of persons primarily engaged in the real estate business; the imputed net rental income of the owner-occupants of nonfarm dwellings; and the royalties received from patents, copyrights, and the right to natural resources.

Earnings by place of work- Earnings by place of work is the sum of Wages and Salaries, supplements to wages and salaries and proprietors' income.

(D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

(L) Less than $50,000, but the estimates for this item are included in the totals.

Educational services- The term "Educational Services" is used in both the SIC system and in NAICS, but it does not have the same definition in both systems.

SIC definition:

This SIC major group (82) includes establishments providing academic or technical instruction. Also included are establishments providing educational services such as libraries, student exchange programs, and curriculum development. Schools for the instruction of beauticians and cosmetologists are classified in Industry 7231, and barber colleges are classified in Industry 7241. Establishments primarily engaged in providing job training for the unemployed, the underemployed, the handicapped, and to persons who have a job market disadvantage because of lack of education, job skill or experience are classified in Industry 8331.

NAICS definition:

The Educational Services (NAICS) sector comprises establishments that provide instruction and training in a wide variety of subjects. This instruction and training is provided by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated. They may also offer food and accommodation services to their students.

For the public sector, the income and employment are classified by level of government-federal, state, and local. The estimates for the federal government are sub classified into civilian and military.

The different treatment of the private and public sectors means that BEA's state and local government industry includes public education, public hospitals, and other types of government services while BEA reports only private schools in its educational services industry corresponding to NAICS code 61 and only private hospitals in its hospitals industry corresponding to NAICS code 622.

Educational services (NAICS) are usually delivered by teachers or instructors that explain, tell, demonstrate, supervise, and direct learning. Instruction is imparted in diverse settings, such as educational institutions, the workplace, or the home through correspondence, television, or other means. It can be adapted to the particular needs of the students, for example sign language can replace verbal language for teaching students with hearing impairments. All industries in the sector share this commonality of process, namely, labor inputs of instructors with the requisite subject matter expertise and teaching ability.

Farm proprietors' income- Farm proprietors' income consists of the income that is received by the sole proprietorships and the partnerships that operate farms. It excludes the income that is received by corporate farms.

Farm earnings- Farm Earnings is comprised of the net income of sole proprietors, partners and hired laborers arising directly from the current production of agricultural commodities, either livestock or crops. It includes net farm proprietors' income and the wages and salaries, pay-in-kind, and supplements to wages and salaries of hired farm laborers; but specifically excludes the income of farm corporations.

Farm employment- Farm employment is the number of workers engaged in the direct production of agricultural commodities, either livestock or crops; whether as a sole proprietor, partner, or hired laborer.

Finance and insurance- The Finance and Insurance NAICS sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:

(1) Raising funds by taking deposits and/or issuing securities and, in the process, incurring liabilities. Establishments engaged in this activity use raised funds to acquire financial assets by making loans and/or purchasing securities. Putting themselves at risk, they channel funds from lenders to borrowers and transform or repackage the funds with respect to maturity, scale and risk. This activity is known as financial intermediation.
(2) Pooling of risk by underwriting insurance and annuities. Establishments engaged in this activity collect fees, insurance premiums, or annuity considerations; build up reserves; invest those reserves; and make contractual payments. Fees are based on the expected incidence of the insured risk and the expected return on investment.
(3) Providing specialized services facilitating or supporting financial intermediation, insurance, and employee benefit programs.

In addition, monetary authorities charged with monetary control are included in this sector. The subsectors, industry groups, and industries within the NAICS Finance and Insurance sector are defined on the basis of their unique production processes. As with all industries, the production processes are distinguished by their use of specialized human resources and specialized physical capital. In addition, the way in which these establishments acquire and allocate financial capital, their source of funds, and the use of those funds provides a third basis for distinguishing characteristics of the production process. For instance, the production process in raising funds through deposit-taking is different from the process of raising funds in bond or money markets. The process of making loans to individuals also requires different production processes than does the creation of investment pools or the underwriting of securities.

Most of the Finance and Insurance subsectors contain one or more industry groups of (1) intermediaries with similar patterns of raising and using funds and (2) establishments engaged in activities that facilitate, or are otherwise related to, that type of financial or insurance intermediation.

Industries within this sector are defined in terms of activities for which a production process can be specified, and many of these activities are not exclusive to a particular type of financial institution. To deal with the varied activities taking place within existing financial institutions, the approach is to split these institutions into components performing specialized services. This requires defining the units engaged in providing those services and developing procedures that allow for their delineation. These units are the equivalents for finance and insurance of the establishments defined for other industries.

The output of many financial services, as well as the inputs and the processes by which they are combined, cannot be observed at a single location and can only be defined at a higher level of the organizational structure of the enterprise. Additionally, a number of independent activities that represent separate and distinct production processes may take place at a single location belonging to a multi-location financial firm. Activities are more likely to be homogeneous with respect to production characteristics than are locations, at least in financial services. The classification defines activities broadly enough that it can be used both by those classifying by location and by those employing a more top-down approach to the delineation of the establishment.

Establishments engaged in activities that facilitate, or are otherwise related to, the various types of intermediation have been included in individual subsectors, rather than in a separate subsector dedicated to services alone because these services are performed by intermediaries as well as by specialist establishments and the extent to which the activity of the intermediaries can be separately identified is not clear.

The Finance and Insurance sector has been defined to encompass establishments primarily engaged in financial transactions; that is, transactions involving the creation, liquidation, or change in ownership of financial assets or in facilitating financial transactions. Financial industries are extensive users of electronic means for facilitating the verification of financial balances, authorizing transactions, transferring funds to and from transactors' accounts, notifying banks (or credit card issuers) of the individual transactions, and providing daily summaries. Since these transaction processing activities are integral to the production of finance and insurance services, establishments that principally provide a financial transaction processing service are classified to this sector, rather than to the data processing industry in the Information sector.

Legal entities that hold portfolios of assets on behalf of others are significant and data on them are required for a variety of purposes. Thus for NAICS, these funds, trusts, and other financial vehicles are the fifth subsector of the Finance and Insurance sector. These entities earn interest, dividends, and other property income, but have little or no employment and no revenue from the sale of services. Separate establishments and employees devoted to the management of funds are classified in Industry Group 5239, Other Financial Investment Activities.

Forestry, fishing, and related activities- The Forestry, fishing, related activities NAICS sector comprises establishments primarily engaged in harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.

The sector distinguishes one basic activity: agricultural support. Agricultural support activities include establishments that perform one or more activities associated with farm operation, such as soil preparation, planting, harvesting, and management, on a contract or fee basis. Excluded from the Forestry, Hunting and Fishing sector are establishments primarily engaged in agricultural research and establishments primarily engaged in administering programs for regulating and conserving land, mineral, wildlife, and forest use. These establishments are classified in Industry 54171, Research and Development in the Physical, Engineering, and Life Sciences; and Industry 92412, Administration of Conservation Programs, respectively.

Industries in the Fishing, Hunting, and Trapping subsector harvest fish and other wild animals from their natural habitats and are dependent upon a continued supply of the natural resource. The harvesting of fish is the predominant economic activity of this subsector and it usually requires specialized vessels that, by the nature of their size, configuration and equipment, are not suitable for any other type of production, such as transportation.

Hunting and trapping activities utilize a wide variety of production processes and are classified in the same subsector as fishing because the availability of resources and the constraints imposed, such as conservation requirements and proper habitat maintenance, are similar.

Industries in the Forestry and Logging subsector grow and harvest timber on a long production cycle (i.e., of 10 years or more). Long production cycles use different production processes than short production cycles, which require more horticultural interventions prior to harvest, resulting in processes more similar to those found in the Crop Production subsector. Consequently, Christmas tree production and other production involving production cycles of less than 10 years, are classified in the Crop Production subsector.

Industries in this subsector specialize in different stages of the production cycle. Reforestation requires production of seedlings in specialized nurseries. Timber production requires natural forest or suitable areas of land that are available for a long duration. The maturation time for timber depends upon the species of tree, the climatic conditions of the region, and the intended purpose of the timber. The harvesting of timber (except when done on an extremely small scale) requires specialized machinery unique to the industry. Establishments gathering forest products, such as gums, barks, balsam needles, rhizomes, fibers, Spanish moss, and ginseng and truffles, are also included in this subsector.

Industries in the Support Activities for Agriculture and Forestry subsector provide support services that are an essential part of agricultural and forestry production. These support activities may be performed by the agriculture or forestry producing establishment or conducted independently as an alternative source of inputs required for the production process for a given crop, animal, or forestry industry. Establishments that primarily perform these activities independent of the agriculture or forestry producing establishment are in this subsector.

Government and government enterprises- In the national income and product accounts (NIPAs), gross domestic product and other major aggregates are presented in terms of three economic sectors: Business, households and institutions, and general government. Government includes Federal civilian, military, and state and local.

Government enterprises are government agencies that cover a substantial portion of their operating costs by selling goods and services to the public and that maintain separate accounts.

Health care and social assistance- The Health Care and Social Assistance NAICS sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals. All industries in the sector share this commonality of process, namely, labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry.

Excluded from this sector are aerobic classes in Subsector 713, Amusement, Gambling and Recreation Industries and nonmedical diet and weight reducing centers in Subsector 812, Personal and Laundry Services. Although these can be viewed as health services, these services are not typically delivered by health practitioners.

Information- The Information NAICS sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.

The main components of this sector are the publishing industries, including software publishing, and both traditional publishing and publishing exclusively on the Internet; the motion picture and sound recording industries; the broadcasting industries, including traditional broadcasting and those broadcasting exclusively over the Internet; the telecommunications industries; the industries known as Internet service providers and Web search portals; data processing industries; and the information services industries.

Management of companies and enterprises- The Management of Companies and Enterprises NAICS sector comprises (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decision-making role of the company or enterprise. Establishments that administer, oversee, and manage may hold the securities of the company or enterprise.

Establishments in this sector perform essential activities that are often undertaken, in-house, by establishments in many sectors of the economy. By consolidating the performance of these activities of the enterprise at one establishment, economies of scale are achieved.

Manufacturing- The term "Manufacturing" is used in both the SIC system and in NAICS, but it does not have the same definition in both systems.

SIC definition:

The manufacturing SIC division includes establishments engaged in the mechanical or chemical transformation of materials or substances into new products. These establishments are usually described as plants, factories, or mills and characteristically use power driven machines and materials handling equipment. Establishments engaged in assembling component parts of manufactured products are also considered manufacturing if the new product is neither a structure nor other fixed improvement. Also included is the blending of materials, such as lubricating oils, plastics resins, or liquors.

NAICS definition:

The Manufacturing NAICS sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction.

Establishments in the Manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment. However, establishments that transform materials or substances into new products by hand or in the worker's home and those engaged in selling to the general public products made on the same premises from which they are sold, such as bakeries, candy stores, and custom tailors, may also be included in this sector. Manufacturing establishments may process materials or may contract with other establishments to process their materials for them. Both types of establishments are included in manufacturing.

Mining- The term "Mining" is used in both the SIC system and in NAICS, but it does not have the same definition in both systems.

SIC definition:

This SIC division includes all establishments primarily engaged in mining. The term mining is used in the broad sense to include the extraction of minerals occurring naturally: solids, such as coal and ores; liquids, such as crude petroleum; and gases such as natural gas. The term mining is also used in the broad sense to include quarrying, well operations, milling (e.g., crushing, screening, washing, flotation), and other preparation customarily done at the mine site, or as a part of mining activity. Exploration and development of mineral properties are included. Services performed on a contract or fee basis in the development or operation of mineral properties are classified separately but within this division. Establishments which have complete responsibility for operating mines, quarries, or oil and gas wells for others on a contract or fee basis are classified according to the product mined rather than as mineral services.

NAICS definition:

The Mining sector under NAICS comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well operations, beneficiating (e.g., crushing, screening, washing, and flotation), and other preparation customarily performed at the mine site, or as a part of mining activity.

The Mining sector distinguishes two basic activities: mine operation and mining support activities. Mine operation includes establishments operating mines, quarries, or oil and gas wells on their own account or for others on a contract or fee basis. Mining support activities include establishments that perform exploration (except geophysical surveying) and/or other mining services on a contract or fee basis (except mine site preparation and construction of oil/gas pipelines).

Nonfarm proprietors' income- Nonfarm Proprietors' Income consists of the income that is received by nonfarm sole proprietorships and partnerships and the income that is received by tax-exempt cooperatives.

The national estimates of nonfarm proprietors' income are primarily derived from income tax data. Because these data do not always reflect current production and because they are incomplete, the estimates also include four major adjustments--the inventory valuation adjustment, the capital consumption adjustment, the "misreporting" adjustment, and the adjustment for the net margins on owner-built housing.

The inventory valuation adjustment offsets the effects of the gains and the losses that result from changes in the prices of products withdrawn from inventories; this adjustment for recent years has been small, but it is important to the definition of proprietors' income.

The capital consumption adjustment changes the value of the consumption, or depreciation, of fixed capital from the historical-cost basis used in the source data to a replacement-cost basis.

The "misreporting" adjustment adds an estimate of the income of sole proprietors and partnerships that is not reported on tax returns.

The adjustment for the net margins on owner-built housing is an addition to the estimate for the construction industry. It is the imputed net income of individuals from the construction or renovation of their own dwellings.

The source data necessary to prepare these adjustments are available only at the national level. Therefore, the national estimates of nonfarm proprietors' income that include the adjustments are allocated to states, and these state estimates are allocated to the counties, in proportion to tax return data that do not reflect the adjustments.

In addition, the national estimates include adjustments made to reflect decreases in monetary and imputed income that result from damage to fixed capital and to inventories that is caused by disasters, such as hurricanes, floods, and earthquakes. These adjustments are attributed to states and counties on the basis of information from the Federal Emergency Management Agency.

Other services, except public administration- The Other Services (except Public Administration) NAICS sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities, such as equipment and machinery repairing, promoting or administering religious activities, grant-making, advocacy, and providing dry-cleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.

Private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household are included in this sector.

Per capita personal income is calculated as the personal income of the residents of a given area divided by the resident population of the area. In computing per capita personal income, BEA uses the Census Bureau's annual midyear population estimates.

Professional, scientific, and technical services-
The Professional, Scientific, and Technical Services NAICS sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

This sector excludes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and recordkeeping, personnel, and physical distribution and logistics. These establishments are classified in Sector 56, Administrative and Support and Waste Management and Remediation Services.

Personal income is the income received by all persons from all sources. Personal income is the sum of net earnings by place of residence, property income, and personal current transfer receipts.

Personal current transfer receipts- This component of personal income is payments to persons for which no current services are performed. It consists of payments to individuals and to nonprofit institutions by Federal, state, and local governments and by businesses.

Government payments to individuals includes retirement and disability insurance benefits, medical payments (mainly Medicare and Medicaid), income maintenance benefits, unemployment insurance benefits, veterans benefits, and Federal grants and loans to students. Government payments to nonprofit institutions exclude payments by the Federal Government for work under research and development contracts. Business payments to persons consist primarily of liability payments for personal injury and of corporate gifts to nonprofit institutions.

Proprietors' income- This component of personal income is the current-production income (including income in kind) of sole proprietorships and partnerships and of tax-exempt cooperatives. Corporate directors' fees are included in proprietors' income, but the imputed net rental income of owner-occupants of all dwellings is included in rental income of persons. Proprietors' income excludes dividends and monetary interest received by nonfinancial business and rental incomes received by persons not primarily engaged in the real estate business; these incomes are included in dividends, net interest, and rental income of persons, respectively.

Proprietors employment- Proprietors employment includes both nonfarm proprietors and farm proprietors.

Nonfarm proprietors: The BEA local area estimates of nonfarm self-employment consist of the number of sole proprietorships and the number of individual business partners not assumed to be limited partners. The nonfarm self-employment estimates resemble the wage and salary employment estimates in that both series measure jobs--as opposed to workers--on a full-time and part-time basis. However, because of limitations in source data, two important measurement differences exist between the two sets of estimates. First, the self-employment estimates are largely on a place-of-residence basis rather than on the preferred place-of-work basis. Second, the self-employment estimates reflect the total number of sole proprietorships or partnerships active at any time during the year--as opposed to the annual average measure used for wage and salary employment.

Farm proprietors: Farm self-employment is defined as the number of non-corporate farm operators, consisting of sole proprietors and partners. A farm is defined as an establishment that produces, or normally would be expected to produce, at least $1,000 worth of farm products--crops and livestock--in a typical year. Because of the low cutoff point for this definition, the farm self-employment estimates are effectively on a full-time and part-time basis. The estimates are consistent with the job-count basis of the estimates of wage and salary employment because farm proprietors are counted without regard to any other employment. The distinction between place-of-work and place-of-residence is not significant because most farmers live on or near their land. Similarly, because of the annual production cycle of most farming, the distinctions between the point-in-time, the average annual, and the any-activity temporal concepts of employment measurement are not significant.

Real estate and rental and leasing- The Real Estate and Rental and Leasing NAICS sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks.

This sector also includes establishments primarily engaged in managing real estate for others, selling, renting and/or buying real estate for others, and appraising real estate. These activities are closely related to this sector's main activity, and it was felt that from a production basis they would best be included here. In addition, a substantial proportion of property management is self-performed by lessors.

The main components of this sector are the real estate lessors industries; equipment lessors industries (including motor vehicles, computers, and consumer goods); and lessors of nonfinancial intangible assets (except copyrighted works).

Retail trade- The term "retail trade" is used in the SIC system and in NAICS, but it does not have the same definition in both systems.

SIC definition:

This SIC division includes establishments engaged in selling merchandise for personal or household consumption and rendering services incidental to the sale of the goods. In general, retail establishments are classified by kind of business according to the principal lines of commodities sold (groceries, hardware, etc.), or the usual trade designation (drug store, cigar store, etc.). Some of the important characteristics of retail trade establishments are: the establishment is usually a place of business and is engaged in activities to attract the general public to buy; the establishment buys or receives merchandise as well as sells; the establishment may process its products, but such processing is incidental or subordinate to selling; the establishment is considered as retail in the trade; and the establishment sells to customers for personal or household use. Not all of these characteristics need be present and some are modified by trade practice.

NAICS definition:

The Retail Trade NAICS sector comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.

The retailing process is the final step in the distribution of merchandise; retailers are, therefore, organized to sell merchandise in small quantities to the general public. This sector comprises two main types of retailers: store and nonstore retailers.

(1) Store retailers operate fixed point-of-sale locations, located and designed to attract a high volume of walk-in customers. In general, retail stores have extensive displays of merchandise and use mass-media advertising to attract customers. They typically sell merchandise to the general public for personal or household consumption, but some also serve business and institutional clients. These include establishments, such as office supply stores, computer and software stores, building materials dealers, plumbing supply stores, and electrical supply stores. Catalog showrooms, gasoline services stations, automotive dealers, and mobile home dealers are treated as store retailers.

    In addition to retailing merchandise, some types of store retailers are also engaged in the provision of after-sales services, such as repair and installation. For example, new automobile dealers, electronic and appliance stores, and musical instrument and supply stores often provide repair services. As a general rule, establishments engaged in retailing merchandise and providing after-sales services are classified in this sector.

(2) Nonstore retailers, like store retailers, are organized to serve the general public, but their retailing methods differ. The establishments of this subsector reach customers and market merchandise with methods, such as the broadcasting of "infomercials," the broadcasting and publishing of direct-response advertising, the publishing of paper and electronic catalogs, door-to-door solicitation, in-home demonstration, selling from portable stalls (street vendors, except food), and distribution through vending machines. Establishments engaged in the direct sale (nonstore) of products, such as home heating oil dealers and home delivery newspaper routes are included here.

Services- This (SIC) division includes establishments primarily engaged in providing a wide variety of services for individuals, business and government establishments, and other organizations. Hotels and other lodging places; establishments providing personal, business, repair, and amusement services; health, legal, engineering, and other professional services; educational institutions; membership organizations, and other miscellaneous services, are included.

Establishments which provide specialized services closely allied to activities covered in other divisions are classified in such divisions.

Total employment- The BEA employment series for states and local areas comprises estimates of the number of jobs, full-time plus part-time, by place of work. Full-time and part-time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included

Transportation and warehousing-
The Transportation and Warehousing NAICS sector includes industries providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation. Establishments in these industries use transportation equipment or transportation related facilities as a productive asset. The type of equipment depends on the mode of transportation. The modes of transportation are air, rail, water, road, and pipeline.

The Transportation and Warehousing sector distinguishes three basic types of activities: subsectors for each mode of transportation, a subsector for warehousing and storage, and a subsector for establishments providing support activities for transportation. In addition, there are subsectors for establishments that provide passenger transportation for scenic and sightseeing purposes, postal services, and courier services

Utilities- The Utilities NAICS sector comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal. Within this sector, the specific activities associated with the utility services provided vary by utility: electric power includes generation, transmission, and distribution; natural gas includes distribution; steam supply includes provision and/or distribution; water supply includes treatment and distribution; and sewage removal includes collection, treatment, and disposal of waste through sewer systems and sewage treatment facilities.

Wholesale trade- The term "wholesale trade" is used in the SIC system and in NAICS, but it does not have the same definition in both systems.

SIC definition:

This SIC division includes establishments or places of business primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, farm, construction contractors, or professional business users; or to other wholesalers; or acting as agents or brokers in buying merchandise for or selling merchandise to such persons or companies.

NAICS definition:

The Wholesale Trade NAICS sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing.

What is the difference between BEA employment and wages and BLS and Census employment and wages?
Three widely used measures of annual county employment and wages by place of work are the Census Bureau's employment and payroll data in the County Business Patterns (CBP) series, the Bureau of Labor Statistics' (BLS) employment and wage tabulations from the unemployment insurance (UI) program, and BEA's estimates of total wage and salary disbursements and employment.

The CBP data on employment and payrolls are an annual extension of the Census Bureau's quinquennial economic censuses; the data are derived from Federal administrative records and survey information of business establishments. The BLS data on county employment and wages are the product of the Federal–state Covered Employment and Wages, or ES–202, Program; the data are derived from tabulations of monthly employment and quarterly total wages of workers covered by state UI legislation and of Federal workers covered by the unemployment compensation for Federal employees (UCFE) program. BEA's estimates of total employment and total wage and salary disbursements are derived from the BLS data, which account for 95 percent of the wage and salary component of BEA's personal income estimates.

The coverage of the CBP data primarily differs from that of the BLS data because the CBP data exclude most government employees, and the BLS data cover civilian government employees. The BLS data also include some agricultural production employees and household employees that are excluded by the CBP data. However, the CBP coverage of the employees of educational and membership organizations and of small nonprofit organizations in other industries is more complete than the coverage of these employees in the BLS data. Beginning in 2001, employees of the American Indian Tribal Councils are included in the local government component by BLS and BEA. Prior to 2001, these employees were included in the relevant private industry components. The CBP data continue to classify these employees in the relevant private industry components. Finally, CBP reports employment for the month of March, whereas the BLS employment data are an annual average of monthly data.

The BEA estimates of employment and wages differ from the BLS data because BEA makes adjustments to account for employment and wages not covered, or not fully covered, by the state UI and the UCFE programs. First, BEA adds estimates of employment and wages to the BLS data to bridge small gaps in UI coverage: For nonprofit organizations not participating in the UI program (several industries), for students and their spouses employed by public colleges or universities, for elected officials and members of the judiciary (state and local government), for interns employed by hospitals and by social service agencies, and for insurance agents classified as statutory employees (insurance agencies). Second, BEA uses additional source data to estimate most or all of the employment and wages for the following: Farms, farm labor contractors, private households, private elementary and secondary schools, religious membership organizations, railroads, military, and U.S. residents who are employed by international organizations and by foreign embassies and consulates in the United States. Third, BEA adjusts employment and wages for misreporting under the UI and UCFE programs.

The Census Bureau released 2001 data on county total employment and payrolls on its Web site on April 10, 2003. BLS released 2001 annual county data on total employment and average annual pay on its Web site on November 21, 2002. BEA released the 2001 estimates and the revised 1999–2000 estimates of total wage employment and total wage and salary disbursements on its Web site on December 30, 2002.

See more at: http://www.bea.gov/faq/index.cfm?faq_id=104#sthash.U1rbFBfA.dpuf

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APPENDIX 1

Regional Profile of the Yellowstone River Corridor

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Income (1970-2010), Bureau or Economic Analysis (1970-2010)

Income ($1,000)	McKenzie County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	100,042	143,617	124,528	155,601	356,659	-----	8,774,733	-----
Per capita personal income	16	20	20	27	56	-----	38	-----
Net earnings by place of residence	79,852	101,619	65,526	94,788	248,186	70%	5,433,877	62%
Proprietors' income	51,959	8,536	16,903	28,143	63,534	18%	660,096	8%
Farm proprietors' income	36,163	-8,687	8,844	16,385	40,227	11%	63,889	1%
Nonfarm proprietors' income	15,796	17,223	8,060	11,758	23,307	7%	596,207	7%
Dividends, interest, and rent	12,121	28,143	37,268	34,282	68,645	19%	1,766,656	20%
Personal current transfer receipts	8,069	13,855	21,734	26,531	39,828	11%	1,574,200	18%
Retirement and disability insurance benefits	3,547	7,284	9,873	10,771	14,916	4%	634,042	7%
Medical benefits	1,680	2,684	6,803	9,838	16,653	5%	597,035	7%
Income maintenance benefits	870	1,535	2,133	2,551	4,149	1%	132,357	2%
Other	1,972	2,353	2,926	3,371	4,110	1%	210,766	2%

Income ($1,000)	Richland County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	164,996	271,748	221,012	255,898	454,434	-----	8,774,733	-----
Per capita personal income	17	22	21	27	47	-----	38	-----
Net earnings by place of residence	126,971	198,623	128,645	152,066	296,053	65%	5,433,877	62%
Proprietors' income	57,691	19,643	25,468	31,719	61,236	13%	66,0096	8%
Farm proprietors' income	33,627	-9,625	12,543	8,505	24,720	5%	63,889	1%
Nonfarm proprietors' income	24,065	29,269	12,926	23,214	36,516	8%	596,207	7%
Dividends, interest, and rent	23,769	47,638	53,549	57,191	98,714	22%	1,766,656	20%
Personal current transfer receipts	14,257	25,487	38,819	46,641	59,667	13%	1,574,200	18%
Retirement and disability insurance benefits	7,886	13,996	20,673	21,930	25,500	6%	634,042	7%
Medical benefits	2,377	6,012	11,613	15,902	23,570	5%	597,035	7%
Income maintenance benefits	1,029	1,616	2,578	2,542	3,785	1%	132,357	2%
Other	2,964	3,863	3,955	6,267	6,812	1%	210,766	2%

Income ($1,000)	Dawson County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	181,830	274,586	197,476	227,803	287,724	-----	8,774,733	-----
Per capita personal income	16	23	21	25	32	-----	38	-----
Net earnings by place of residence	140,540	197,229	111,592	134,423	170,541	59%	5,433,877	62%
Proprietors' income	38,736	16,481	13,994	16,719	21,022	7%	660,096	8%
Farm proprietors' income	25,148	-2,825	4,668	4,373	11,165	4%	63,889	1%
Nonfarm proprietors' income	13,587	19,306	9,326	12,346	9,857	3%	596,207	7%
Dividends, interest, and rent	25,280	49,393	48,292	47,926	53,276	19%	1,766,656	20%
Personal current transfer receipts	16,010	27,965	37,592	45,454	63,907	22%	1,574,200	18%
Retirement and disability insurance benefits	8,888	15,686	22,550	23,958	28,844	10%	634,042	7%
Medical benefits	3,256	6,694	9,430	14,334	24,017	8%	597,035	7%
Income maintenance benefits	729	1,029	1,782	1,847	3,634	1%	132,357	2%
Other	3,137	4,556	3,830	5,315	7,412	3%	210,766	2%

Income ($1,000)	Prairie County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	25,062	35,040	30,016	30,048	36,563	-----	8,774,733	-----
Per capita personal income	14	19	22	25	31	-----	38	-----
Net earnings by place of residence	16,083	19,831	14,332	13,811	13,751	38%	5,433,877	62%
Proprietors' income	7,254	1,135	5,249	4,194	588	2%	660,096	8%
Farm proprietors' income	5,573	-666	3,483	2,650	151	0%	63,889	1%
Nonfarm proprietors' income	1,680	1,801	1,765	1,544	437	1%	596,207	7%
Dividends, interest, and rent	5,364	9,718	9,391	9,236	12,088	33%	1,766,656	20%
Personal current transfer receipts	3,615	5,492	6,293	7,001	10,724	29%	1,574,200	18%
Retirement and disability insurance benefits	1,885	3,252	3,913	3,590	4,644	13%	634,042	7%
Medical benefits	924	1,204	1,575	2,495	4,481	12%	597,035	7%
Income maintenance benefits	0	238	232	296	496	1%	132,357	2%
Other	806	797	573	620	1,103	3%	210,766	2%

Income ($1,000)	Custer County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	213,102	316,570	278,582	317,293	401,252	-----	8,774,733	-----
Per capita personal income	18	24	24	27	34	-----	38	-----
Net earnings by place of residence	154,728	208,930	151,282	176,351	237,800	59%	5,433,877	62%
Proprietors' income	40,789	34,939	23,714	29,854	29,393	7%	660,096	8%
Farm proprietors' income	15,750	6,384	613	-2,421	4,018	1%	63,889	1%
Nonfarm proprietors' income	25,039	28,554	23,100	32,275	25,375	6%	596,207	7%
Dividends, interest, and rent	36,605	71,207	78,451	78,991	79,220	20%	1,766,656	20%
Personal current transfer receipts	21,770	36,434	48,849	61,951	84,232	21%	1,574,200	18%
Retirement and disability insurance benefits	12,554	20,815	27,385	28,308	33,011	8%	634,042	7%
Medical benefits	3,274	6,831	12,285	23,633	33,524	8%	597,035	7%
Income maintenance benefits	1,006	2,339	3,156	4,329	6,270	2%	132,357	2%
Other	4,936	6,449	6,022	5,681	11,427	3%	210,766	2%

Income ($1,000)	Rosebud County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	84,283	185,708	240,240	254,822	324,526	-----	8,774,733	-----
Per capita personal income	14	18	23	27	35	-----	38	-----
Net earnings by place of residence	60,059	135,421	171,339	177,469	210,492	65%	5,433,877	62%
Proprietors' income	20,886	10,529	18,620	14,458	18,870	6%	660,096	8%
Farm proprietors' income	10,373	-559	8,973	658	6,069	2%	63,889	1%
Nonfarm proprietors' income	10,514	11,088	9,647	13,800	12,801	4%	596,207	7%
Dividends, interest, and rent	13,492	30,048	37,545	39,157	46,659	14%	1,766,656	20%
Personal current transfer receipts	10,732	20,240	31,356	38,196	67,375	21%	1,574,200	18%
Retirement and disability insurance benefits	4,722	8,141	15,010	15,138	21,873	7%	634,042	7%
Medical benefits	1,585	3,624	6,993	12,311	25,453	8%	597,035	7%
Income maintenance benefits	1,616	3,252	4,221	4,725	10,719	3%	132,357	2%
Other	2,809	5,222	5,133	6,023	9,330	3%	210,766	2%

Income ($1,000)	Treasure County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	22,876	24,317	20,744	17,780	24,182	-----	8,774,733	-----
Per capita personal income	21	25	24	21	34	-----	38	-----
Net earnings by place of residence	18,842	15,552	11,337	8,418	11,168	46%	5,433,877	62%
Proprietors' income	12,312	5,555	3,796	2,063	3,606	15%	660,096	8%
Farm proprietors' income	10,368	3,906	2,608	494	3,208	13%	63,889	1%
Nonfarm proprietors' income	1,944	1,648	1,188	1,569	398	2%	596,207	7%
Dividends, interest, and rent	2,691	6,371	6,292	5,491	7,526	31%	1,766,656	20%
Personal current transfer receipts	1,343	2,395	3,116	3,872	5,488	23%	1,574,200	18%
Retirement and disability insurance benefits	829	1,463	1,884	1,975	2,713	11%	634,042	7%
Medical benefits	0	423	782	1,201	1,879	8%	597,035	7%
Income maintenance benefits	0	176	146	210	359	1%	132,357	2%
Other	515	333	303	485	537	2%	210,766	2%

Income ($1,000)	Yellowstone County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	1,547,172	2,627,736	2,970,412	4,249,154	5,609,050	-----	8,774,733	-----
Per capita personal income	18	24	26	33	38	-----	38	-----
Net earnings by place of residence	1,176,928	1,911,637	1,901,772	2,813,885	3,571,236	64%	5,433,877	62%
Proprietors' income	227,919	266,958	267,907	437,911	388,957	7%	660,096	8%
Farm proprietors' income	53,566	-5,118	12,663	7,289	-8,436	0%	63,889	1%
Nonfarm proprietors' income	174,353	272,076	255,244	430,622	397,393	7%	596,207	7%
Dividends, interest, and rent	246,064	467,125	650,411	861,705	1,058,792	19%	1,766,656	20%
Personal current transfer receipts	124,180	248,975	418,229	573,563	979,022	17%	1,574,200	18%
Retirement and disability insurance benefits	65,992	135,883	242,412	273,838	386,396	7%	634,042	7%
Medical benefits	17,362	42,856	97,559	190,714	372,616	7%	597,035	7%
Income maintenance benefits	10,500	16,904	26,590	39,341	85,576	2%	132,357	2%
Other	30,325	53,332	51,669	69,671	134,434	2%	210,766	2%

Income ($1,000)	Carbon County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	107,519	156,624	181,723	289,495	340,837	-----	8,774,733	-----
Per capita personal income	15	19	22	30	34	-----	38	-----
Net earnings by place of residence	71,461	84,211	80,571	154,703	177,657	52%	5,433,877	62%
Proprietors' income	32,866	14,486	21,810	28,140	20,793	6%	660,096	8%
Farm proprietors' income	22,862	1,398	7,852	2,265	-4,124	-1%	63,889	1%
Nonfarm proprietors' income	10,004	13,088	13,958	25,876	24,917	7%	596,207	7%
Dividends, interest, and rent	21,364	45,133	66,867	91,778	91,738	27%	1,766,656	20%
Personal current transfer receipts	14,694	27,281	34,285	43,014	71,442	21%	1,574,200	18%
Retirement and disability insurance benefits	9,230	15,741	19,306	21,423	31,626	9%	634,042	7%
Medical benefits	1,953	5,890	10,158	14,680	27,019	8%	597,035	7%
Income maintenance benefits	678	1,613	1,497	1,966	4,108	1%	132,357	2%
Other	2,832	4,036	3,324	4,944	8,689	3%	2,107,66	2%

Income ($1,000)	Stillwater County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	81,952	115,211	143,893	261,137	314,081	-----	8,774,733	-----
Per capita personal income	17	20	22	32	34	-----	38	-----
Net earnings by place of residence	54,996	66,759	84,113	168,353	191,203	61%	5,433,877	62%
Proprietors' income	30,945	10,587	14,489	25,797	16,449	5%	660,096	8%
Farm proprietors' income	21,128	-603	5,300	3,091	-4,127	-1%	63,889	1%
Nonfarm proprietors' income	9,817	11,190	9,189	22,706	20,576	7%	596,207	7%
Dividends, interest, and rent	18,623	31,721	34,254	58,068	63,193	20%	1,766,656	20%
Personal current transfer receipts	8,333	16,731	25,525	34,717	59,685	19%	1,574,200	18%
Retirement and disability insurance benefits	5,031	9,413	14,749	17,620	26,967	9%	634,042	7%
Medical benefits	1,393	4,320	7,274	10,695	21,426	7%	597,035	7%
Income maintenance benefits	264	661	1,048	1,563	3,353	1%	132,357	2%
Other	1,644	2,337	2,454	4,839	7,939	3%	210,766	2%

Income ($1,000)	Sweet Grass County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	49,008	66,338	69,768	91,730	98,105	-----	8,774,733	-----
Per capita personal income	16	21	22	25	27	-----	38	-----
Net earnings by place of residence	31,127	34,543	28,346	40,516	33,939	35%	5,433,877	62%
Proprietors' income	14,061	9,713	7,858	12,677	1,331	1%	660,096	8%
Farm proprietors' income	8,059	3,227	371	-1,734	-7,357	-7%	63,889	1%
Nonfarm proprietors' income	6,001	6,486	7,487	14,411	8,688	9%	596,207	7%
Dividends, interest, and rent	12,749	22,905	29,267	35,538	39,380	40%	1,766,656	20%
Personal current transfer receipts	5,132	8,890	12,155	15,677	24,786	25%	1,574,200	18%
Retirement and disability insurance benefits	3,251	5,885	7,246	7,242	10,368	11%	634,042	7%
Medical benefits	678	1,308	3,242	6,142	9,767	10%	597,035	7%
Income maintenance benefits	0	310	354	610	1,312	1%	132,357	2%
Other	1,202	1,387	1,313	1,683	3,339	3%	210,766	2%

Income ($1,000)	Park County						The River Corridor	
	1970	1980	1990	2000	2010	Percent Total	2010	Percent Total
Personal income	172,714	264,845	284,794	410,247	527,320	-----	8,774,733	-----
Per capita personal income	15	20	19	26	34	-----	38	-----
Net earnings by place of residence	117,941	168,064	143,843	225,334	271,851	52%	5,433,877	62%
Proprietors' income	34,018	18,853	31,228	37,585	34,317	7%	660,096	8%
Farm proprietors' income	13,883	-1,616	2,318	-5,099	-1,625	0%	63,889	1%
Nonfarm proprietors' income	20,135	20,469	28,909	42,684	35,942	7%	596,207	7%
Dividends, interest, and rent	35,749	64,755	82,181	113,878	147,425	28%	1,766,656	20%
Personal current transfer receipts	19,024	32,026	58,770	71,035	108,044	20%	1,574,200	18%
Retirement and disability insurance benefits	9,466	16,742	35,261	36,192	47,184	9%	634,042	7%
Medical benefits	3,310	6,738	13,153	21,214	36,630	7%	597,035	7%
Income maintenance benefits	1,489	2,067	3,280	3,982	8,596	2%	132,357	2%
Other	4,758	6,479	7,075	9,647	15,634	3%	210,766	2%

Earnings by Industry 1970-2000, Bureau of Economic Analysis (1970-2000)

Earnings by Industry ($1,000)	McKenzie County					River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	39,296	-5,850	11,148	18,558	16%	63,423	2%
Agricultural services, forestry, and fishing	619	962	1,227	655	1%	36,789	1%
Mining	2,905	75,224	19,909	14,868	13%	125,855	3%
Construction	3,442	19,237	3,872	3,703	3%	249,388	6%
Manufacturing	264	615	728	1,233	1%	215,369	6%
Transportation and public utilities	3,265	9,498	6,498	8,747	7%	351,030	9%
Wholesale trade	4,066	6,280	4,943	3,548	3%	294,435	8%
Retail trade	11,010	9,341	5,348	3,518	3%	454,733	12%
Finance, insurance, and real estate	1,544	2,203	2,386	3,632	3%	265,990	7%
Services	5,350	13,518	8,103	12,444	10%	1,062,926	27%
Government and government enterprises	9,785	16,698	22,389	47,674	40%	646,562	17%
Provided Data Total	81,546	147,725	86,552	118,580	100%	3,766,500	97%
Suppressed Data Total	0	0	0	0	0%	124,695	3%
Earnings by place of work	81,546	147,725	86,552	118,580	-----	3,891,195	-----

Earnings by Industry ($1,000)	Richland County					River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	38,348	-1,865	15,967	13,156	8%	63,423	2%
Agricultural services, forestry, and fishing	1,771	1,470	1,115	1,772	1%	36,789	1%
Mining	2,035	70,904	18,730	16,001	9%	125,855	3%
Construction	8,023	26,439	6,952	10,691	6%	249,388	6%
Manufacturing	11,720	12,156	14,309	15,253	9%	215,369	6%
Transportation and public utilities	15,094	17,949	16,148	20,005	12%	351,030	9%
Wholesale trade	3,920	13,206	5,136	5,207	3%	294,435	8%
Retail trade	16,051	23,823	15,660	18,217	11%	454,733	12%
Finance, insurance, and real estate	4,827	6,891	4,729	6,493	4%	265,990	7%
Services	18,865	30,581	24,919	36,046	21%	1,062,926	27%
Government and government enterprises	14,689	19,914	24,657	28,606	17%	646,562	17%
Provided Data Total	135,344	221,467	148,323	171,448	100%	3,766,500	97%
Suppressed Data Total	0	0	0	0	0%	124,695	3%
Earnings by place of work	135,344	221,467	148,323	171,448	-----	3,891,195	-----

Earnings by Industry ($1,000)			Dawson County			River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	28,877	3,088	7,062	7,063	4%	63,423	2%
Agricultural services, forestry, and fishing	993	885	951	(D)	(D)	36,789	1%
Mining	11,547	21,076	5,148	7,716	5%	125,855	3%
Construction	11,005	16,835	4,483	(D)	(D)	249,388	6%
Manufacturing	3,338	4,468	2,342	1,873	1%	215,369	6%
Transportation and public utilities	39,810	76,206	38,540	42,541	27%	351,030	9%
Wholesale trade	4,740	10,917	6,060	5,127	3%	294,435	8%
Retail trade	15,377	20,489	13,869	16,165	10%	454,733	12%
Finance, insurance, and real estate	4,043	6,835	3,820	6,453	4%	265,990	7%
Services	14,867	25,173	20,423	31,201	20%	1,062,926	27%
Government and government enterprises	16,474	27,285	30,123	34,966	22%	646,562	17%
Provided Data Total	151,072	213,259	132,820	153,107	97%	3,766,500	97%
Suppressed Data Total	0	0	0	5,168	3%	124,695	3%
Earnings by place of work	151,072	213,259	132,820	158,275	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry ($1,000)			Prairie County			River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	7,627	2,261	4,680	4,114	30%	63,423	2%
Agricultural services, forestry, and fishing	(D)	(D)	184	(D)	(D)	36,789	1%
Mining	(D)	(D)	(D)	(D)	(D)	125,855	3%
Construction	747	6,738	152	(D)	(D)	249,388	6%
Manufacturing	(D)	(D)	(D)	(D)	(D)	215,369	6%
Transportation and public utilities	(D)	(D)	(D)	(D)	(D)	351,030	9%
Wholesale trade	351	1,096	576	(D)	(D)	294,435	8%
Retail trade	1,840	1,826	948	725	5%	454,733	12%
Finance, insurance, and real estate	355	513	(D)	772	6%	265,990	7%
Services	838	938	1,093	845	6%	1,062,926	27%
Government and government enterprises	3,547	3,992	4,160	4,878	35%	646,562	17%
Provided Data Total	15,304	17,364	11,793	11,333	82%	3,766,500	97%
Suppressed Data Total	1,002	2,961	2,243	2,480	18%	124,695	3%
Earnings by place of work	16,306	20,325	14,036	13,813	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry ($1,000)	Custer County					River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	22,589	13,469	4,205	1,482	1%	63,423	2%
Agricultural services, forestry, and fishing	1,903	1,241	3,874	3,828	2%	36,789	1%
Mining	4,572	1,720	1,943	208	0%	125,855	3%
Construction	15,267	35,577	9,168	13,006	6%	249,388	6%
Manufacturing	3,483	4,068	3,381	5,337	3%	215,369	6%
Transportation and public utilities	17,449	21,677	14,080	17,178	8%	351,030	9%
Wholesale trade	7,563	10,161	10,119	6,416	3%	294,435	8%
Retail trade	27,370	30,064	21,766	30,055	15%	454,733	12%
Finance, insurance, and real estate	5,419	8,462	7,674	13,776	7%	265,990	7%
Services	26,824	37,671	34,964	53,385	26%	1,062,926	27%
Government and government enterprises	33,586	58,710	60,677	58,723	29%	646,562	17%
Provided Data Total	166,025	222,822	171,851	203,394	100%	3,766,500	97%
Suppressed Data Total	0	0	0	0	0%	124,695	3%
Earnings by place of work	166,025	222,822	171,851	203,394	-----	3,891,195	-----

Earnings by Industry ($1,000)	Rosebud County					River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	16,515	6,856	13,553	4,452	2%	63,423	2%
Agricultural services, forestry, and fishing	656	781	710	(D)	(D)	36,789	1%
Mining	3,206	37,338	41,157	46,644	20%	125,855	3%
Construction	1,931	49,101	12,977	2,592	1%	249,388	6%
Manufacturing	5,159	7,059	3,829	(D)	(D)	215,369	6%
Transportation and public utilities	(D)	(D)	63,004	63,959	28%	351,030	9%
Wholesale trade	1,111	1,246	1,112	(D)	(D)	294,435	8%
Retail trade	7,877	12,411	9,409	9,557	4%	454,733	12%
Finance, insurance, and real estate	851	2,721	1,821	2,546	1%	265,990	7%
Services	(D)	(D)	20,339	17,300	8%	1,062,926	27%
Government and government enterprises	14,739	37,599	53,980	74,586	33%	646,562	17%
Provided Data Total	52,045	155,113	221,889	221,636	97%	3,766,500	97%
Suppressed Data Total	15,500	30,350	0	6,584	3%	124,695	3%
Earnings by place of work	67,545	185,463	221,889	228,220	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry ($1,000)			Treasure County			River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	12,809	6,819	4,732	2,135	24%	63,423	2%
Agricultural services, forestry, and fishing	(D)	245	338	(D)	(D)	36,789	1%
Mining	(D)	(D)	(D)	(D)	(D)	125,855	3%
Construction	483	534	684	282	3%	249,388	6%
Manufacturing	(D)	(D)	(D)	(D)	(D)	215,369	6%
Transportation and public utilities	806	1,872	1,028	2,212	25%	351,030	9%
Wholesale trade	(D)	645	(D)	(D)	(D)	294,435	8%
Retail trade	2,245	1,026	1,272	418	5%	454,733	12%
Finance, insurance, and real estate	301	624	(D)	(D)	(D)	265,990	7%
Services	414	444	430	427	5%	1,062,926	27%
Government and government enterprises	1,585	1,909	2,275	2,619	30%	646,562	17%
Provided Data Total	18,641	14,119	10,758	8,094	91%	3,766,500	97%
Suppressed Data Total	301	32	944	775	9%	124,695	3%
Earnings by place of work	18,942	14,151	11,702	8,869	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry ($1,000)			Yellowstone County			River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	62,928	6,313	19,998	14,816	0%	63,423	2%
Agricultural services, forestry, and fishing	6,343	10,178	20,854	33,010	1%	36,789	1%
Mining	20,003	42,583	26,232	63,698	2%	125,855	3%
Construction	94,123	177,724	102,356	230,041	7%	249,388	6%
Manufacturing	157,296	234,851	157,203	205,875	6%	215,369	6%
Transportation and public utilities	147,593	264,355	221,643	249,495	8%	351,030	9%
Wholesale trade	136,724	280,076	258,454	329,681	10%	294,435	8%
Retail trade	184,835	283,925	281,907	413,047	13%	454,733	12%
Finance, insurance, and real estate	61,420	108,004	127,210	263,346	8%	265,990	7%
Services	221,194	445,390	658,575	1,024,139	31%	1,062,926	27%
Government and government enterprises	192,517	285,915	348,340	456,245	14%	646,562	17%
Provided Data Total	1,284,975	2,139,313	2,222,774	3,283,392	100%	3,766,500	97%
Suppressed Data Total	0	0	0	0	0%	124,695	3%
Earnings by place of work	1,284,975	2,139,313	2,222,774	3,283,392	-----	3,891,195	-----

Earnings by Industry ($1,000)			Carbon County			River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	26,828	6,403	10,435	6,081	6%	63,423	2%
Agricultural services, forestry, and fishing	665	1,445	1,360	2,146	2%	36,789	1%
Mining	1,339	6,907	853	2,661	3%	125,855	3%
Construction	1,931	3,657	4,510	9,449	9%	249,388	6%
Manufacturing	2,031	636	2,229	3,292	3%	215,369	6%
Transportation and public utilities	2,049	5,596	4,557	5,415	5%	351,030	9%
Wholesale trade	1,935	1,734	1,134	2,831	3%	294,435	8%
Retail trade	7,590	8,617	10,497	13,632	13%	454,733	12%
Finance, insurance, and real estate	2,117	2,952	2,430	6,814	7%	265,990	7%
Services	7,103	10,335	12,659	27,546	27%	1,062,926	27%
Government and government enterprises	12,012	15,134	17,738	21,476	21%	646,562	17%
Provided Data Total	65,600	63,414	68,402	101,343	100%	3,766,500	97%
Suppressed Data Total	0	0	0	0	0%	124,695	3%
Earnings by place of work	65,600	63,414	68,402	101,343	-----	3,891,195	-----

Earnings by Industry ($1,000)			Stillwater County			River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Farm earnings	25,317	5,203	8,085	6,189	3%	63,423	2%
Agricultural services, forestry, and fishing	278	414	1,030	(D)	(D)	36,789	1%
Mining	(D)	2,302	(D)	(D)	(D)	125,855	3%
Construction	2,495	6,854	4,092	6,720	3%	249,388	6%
Manufacturing	2,286	4,357	9,024	13,631	6%	215,369	6%
Transportation and public utilities	2,345	2,746	3,055	3,162	2%	351,030	9%
Wholesale trade	1,006	1,392	1,342	(D)	(D)	294,435	8%
Retail trade	5,646	6,703	7,472	10,389	5%	454,733	12%
Finance, insurance, and real estate	1,334	1,932	668	3,121	1%	265,990	7%
Services	5,910	8,777	(D)	16,926	8%	1,062,926	27%
Government and government enterprises	6,466	9,473	13,177	17,351	8%	646,562	17%
Provided Data Total	53,083	50,153	47,946	77,489	37%	3,766,500	97%
Suppressed Data Total	82	0	42,754	132,750	63%	124,695	3%
Earnings by place of work	53,165	50,153	90,700	210,239	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry ($1,000)	Sweet Grass County					River Corridor	
	1970	**1980**	**1990**	**2000**	**Percent Total**	**2000**	**Percent Total**
Farm earnings	11,638	7,711	2,377	1,105	2%	63,423	2%
Agricultural services, forestry, and fishing	(D)	587	766	(D)	(D)	36,789	1%
Mining	(D)	347	143	350	1%	125,855	3%
Construction	2,204	2,896	3,744	7,758	17%	249,388	6%
Manufacturing	269	358	826	2,136	5%	215,369	6%
Transportation and public utilities	1,899	1,066	1,382	(D)	(D)	351,030	9%
Wholesale trade	360	728	473	1,814	4%	294,435	8%
Retail trade	5,223	6,419	6,812	7,622	17%	454,733	12%
Finance, insurance, and real estate	619	1,318	179	2,987	7%	265,990	7%
Services	3,811	3,705	5,071	6,875	15%	1,062,926	27%
Government and government enterprises	5,013	6,805	8,322	10,444	23%	646,562	17%
Provided Data Total	31,036	31,941	30,096	41,092	90%	3,766,500	97%
Suppressed Data Total	232	(D)	(D)	4,728	10%	124,695	3%
Earnings by place of work	31,268	31,941	30,096	45,819	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry ($1,000)	Park County					River Corridor	
	1970	**1980**	**1990**	**2000**	**Percent Total**	**2000**	**Percent Total**
Farm earnings	18,163	3,236	4,573	-1,595	-1%	63,423	2%
Agricultural services, forestry, and fishing	583	1,230	1,290	3,577	2%	36,789	1%
Mining	(D)	1,412	7,116	1,758	1%	125,855	3%
Construction	5,528	8,971	9,976	20,724	10%	249,388	6%
Manufacturing	7,431	13,587	10,147	14,737	7%	215,369	6%
Transportation and public utilities	36,987	81,731	14,694	16,547	8%	351,030	9%
Wholesale trade	1,507	1,986	3,673	5,430	3%	294,435	8%
Retail trade	16,556	20,464	22,674	32,729	15%	454,733	12%
Finance, insurance, and real estate	5,532	7,649	6,338	15,330	7%	265,990	7%
Services	19,356	27,794	44,009	72,677	34%	1,062,926	27%
Government and government enterprises	15,117	22,172	24,993	33,086	15%	646,562	17%
Provided Data Total	126,761	190,232	149,484	214,999	100%	3,766,500	97%
Suppressed Data Total	87	0	0	0	0%	124,695	3%
Earnings by place of work	126,848	190,232	149,484	214,999	-----	3,891,195	-----

(D) suppressed data

Earnings by Industry 2010, Bureau of Economic Analysis (2010)

Earnings by Industry 2010 ($1,000)	**McKenzie County**		**River Corridor**	
	2010	**Percent Total**	**2010**	**Percent Total**
Farm earnings	42,607	13.7%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	53,235	17.1%	227,003	3.6%
Utilities	(D)	(D)	53,712	0.9%
Construction	35,203	11.3%	474,975	7.6%
Manufacturing	2,299	0.7%	310,939	5.0%
Wholesale trade	15,901	5.1%	404,674	6.5%
Retail trade	(D)	(D)	470,257	7.5%
Transportation and warehousing	43,259	13.9%	308,590	4.9%
Information	690	0.2%	102,368	1.6%
Finance and insurance	5,279	1.7%	278,587	4.5%
Real estate and rental and leasing	7,639	2.5%	81,605	1.3%
Professional, scientific, and technical services	7,283	2.3%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	755	0.2%	31,762	0.5%
Health care and social assistance	7,089	2.3%	895,034	14.3%
Arts, entertainment, and recreation	1,027	0.3%	63,352	1.0%
Accommodation and food services	3,012	1.0%	233,769	3.7%
Other services, except public administration	5,324	1.7%	229,168	3.7%
Government and government enterprises	69,159	22.2%	999,422	16.0%
Provided Data Total	299,761	96.2%	5,855,212	93.6%
Suppressed Data Total	11,745	3.8%	400,857	6.4%
Earning by place of work	311,506	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Richland County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	30,390	9.1%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	50,059	14.9%	227,003	3.6%
Utilities	7131	2.1%	53,712	0.9%
Construction	33,673	10.0%	474,975	7.6%
Manufacturing	14,887	4.4%	310,939	5.0%
Wholesale trade	14,173	4.2%	404,674	6.5%
Retail trade	17032	5.1%	470,257	7.5%
Transportation and warehousing	33,072	9.9%	308,590	4.9%
Information	1,581	0.5%	102,368	1.6%
Finance and insurance	8,096	2.4%	278,587	4.5%
Real estate and rental and leasing	6,788	2.0%	81,605	1.3%
Professional, scientific, and technical services	12,785	3.8%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	(D)	(D)	31,762	0.5%
Health care and social assistance	(D)	(D)	895,034	14.3%
Arts, entertainment, and recreation	2,355	0.7%	63,352	1.0%
Accommodation and food services	7,661	2.3%	233,769	3.7%
Other services, except public administration	10,049	3.0%	229,168	3.7%
Government and government enterprises	37,119	11.1%	999,422	16.0%
Provided Data Total	286,851	85.5%	5,855,212	93.6%
Suppressed Data Total	48,557	14.5%	400,857	6.4%
Earning by place of work	335,408	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Dawson County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	13,538	7.0%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	(D)	(D)	53,712	0.9%
Construction	4,319	2.2%	474,975	7.6%
Manufacturing	1,671	0.9%	310,939	5.0%
Wholesale trade	8,594	4.4%	404,674	6.5%
Retail trade	15131	7.8%	470,257	7.5%
Transportation and warehousing	(D)	(D)	308,590	4.9%
Information	4,884	2.5%	102,368	1.6%
Finance and insurance	4,436	2.3%	278,587	4.5%
Real estate and rental and leasing	2,507	1.3%	81,605	1.3%
Professional, scientific, and technical services	3,315	1.7%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	63	0.0%	31,762	0.5%
Health care and social assistance	28,832	14.8%	895,034	14.3%
Arts, entertainment, and recreation	2,145	1.1%	63,352	1.0%
Accommodation and food services	6,280	3.2%	233,769	3.7%
Other services, except public administration	7,018	3.6%	229,168	3.7%
Government and government enterprises	37,771	19.4%	999,422	16.0%
Provided Data Total	140,504	72.3%	5,855,212	93.6%
Suppressed Data Total	53,906	27.7%	400,857	6.4%
Earning by place of work	194,410	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Prairie County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	1,119	8.2%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	(D)	(D)	53,712	0.9%
Construction	(D)	(D)	474,975	7.6%
Manufacturing	(D)	(D)	310,939	5.0%
Wholesale trade	(D)	(D)	404,674	6.5%
Retail trade	236	1.7%	470,257	7.5%
Transportation and warehousing	480	3.5%	308,590	4.9%
Information	184	1.4%	102,368	1.6%
Finance and insurance	0	0.0%	278,587	4.5%
Real estate and rental and leasing	0	0.0%	81,605	1.3%
Professional, scientific, and technical services	770	5.7%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	(D)	(D)	31,762	0.5%
Health care and social assistance	(D)	(D)	895,034	14.3%
Arts, entertainment, and recreation	(D)	(D)	63,352	1.0%
Accommodation and food services	143	1.1%	233,769	3.7%
Other services, except public administration	492	3.6%	229,168	3.7%
Government and government enterprises	8,376	61.5%	999,422	16.0%
Provided Data Total	11,800	86.7%	5,855,212	93.6%
Suppressed Data Total	1,815	13.3%	400,857	6.4%
Earning by place of work	13,615	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Custer County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	8,530	3.1%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	(D)	(D)	53,712	0.9%
Construction	33,290	12.0%	474,975	7.6%
Manufacturing	2,499	0.9%	310,939	5.0%
Wholesale trade	7,299	2.6%	404,674	6.5%
Retail trade	26938	9.7%	470,257	7.5%
Transportation and warehousing	(D)	(D)	308,590	4.9%
Information	3,214	1.2%	102,368	1.6%
Finance and insurance	16,097	5.8%	278,587	4.5%
Real estate and rental and leasing	1,258	0.5%	81,605	1.3%
Professional, scientific, and technical services	8,777	3.2%	371,658	5.9%
Management of companies and enterprises	3042	1.1%	32,148	0.5%
Administrative and waste management services	2363	0.9%	166,574	2.7%
Educational services	1,009	0.4%	31,762	0.5%
Health care and social assistance	41,092	14.8%	895,034	14.3%
Arts, entertainment, and recreation	2,124	0.8%	63,352	1.0%
Accommodation and food services	11,108	4.0%	233,769	3.7%
Other services, except public administration	8,828	3.2%	229,168	3.7%
Government and government enterprises	66,128	23.8%	999,422	16.0%
Provided Data Total	243,596	87.8%	5,855,212	93.6%
Suppressed Data Total	34,004	12.2%	400,857	6.4%
Earning by place of work	277,600	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Rosebud County		River Corridor	
	2010		2010	Percent Total
Farm earnings	10,146	3.8%	111,114	1.8%
Forestry, fishing, and related activities	0	0.0%	8,501	0.1%
Mining	44,873	16.8%	227,003	3.6%
Utilities	0	0.0%	53,712	0.9%
Construction	14,369	5.4%	474,975	7.6%
Manufacturing	498	0.2%	310,939	5.0%
Wholesale trade	0	0.0%	404,674	6.5%
Retail trade	8262	3.1%	470,257	7.5%
Transportation and warehousing	9,088	3.4%	308,590	4.9%
Information	3,689	1.4%	102,368	1.6%
Finance and insurance	2,753	1.0%	278,587	4.5%
Real estate and rental and leasing	373	0.1%	81,605	1.3%
Professional, scientific, and technical services	1,513	0.6%	371,658	5.9%
Management of companies and enterprises	0	0.0%	32,148	0.5%
Administrative and waste management services	1598	0.6%	166,574	2.7%
Educational services	(D)	(D)	31,762	0.5%
Health care and social assistance	(D)	(D)	895,034	14.3%
Arts, entertainment, and recreation	2,561	1.0%	63,352	1.0%
Accommodation and food services	3,475	1.3%	233,769	3.7%
Other services, except public administration	7,547	2.8%	229,168	3.7%
Government and government enterprises	84,917	31.9%	999,422	16.0%
Provided Data Total	195,662	73.4%	5,855,212	93.6%
Suppressed Data Total	70,730	26.6%	400,857	6.4%
Earning by place of work	266,392	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Treasure County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	4,846	46.1%	111,114	1.8%
Forestry, fishing, and related activities	120	1.1%	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	(D)	(D)	53,712	0.9%
Construction	(D)	(D)	474,975	7.6%
Manufacturing	(D)	(D)	310,939	5.0%
Wholesale trade	894	8.5%	404,674	6.5%
Retail trade	(D)	(D)	470,257	7.5%
Transportation and warehousing	(D)	(D)	308,590	4.9%
Information	(D)	(D)	102,368	1.6%
Finance and insurance	(D)	(D)	278,587	4.5%
Real estate and rental and leasing	(L)	(L)	81,605	1.3%
Professional, scientific, and technical services	(D)	(D)	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	(D)	(D)	31,762	0.5%
Health care and social assistance	(D)	(D)	895,034	14.3%
Arts, entertainment, and recreation	(D)	(D)	63,352	1.0%
Accommodation and food services	(D)	(D)	233,769	3.7%
Other services, except public administration	225	2.1%	229,168	3.7%
Government and government enterprises	2,439	23.2%	999,422	16.0%
Provided Data Total	8,524	81.0%	5,855,212	93.6%
Suppressed Data Total	1,995	19.0%	400,857	6.4%
Earning by place of work	10,519	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Yellowstone County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	358	0.0%	111,114	1.8%
Forestry, fishing, and related activities	7072	0.2%	8,501	0.1%
Mining	74,859	1.8%	227,003	3.6%
Utilities	36072	0.9%	53,712	0.9%
Construction	315,580	7.5%	474,975	7.6%
Manufacturing	255,517	6.1%	310,939	5.0%
Wholesale trade	344,767	8.2%	404,674	6.5%
Retail trade	360956	8.6%	470,257	7.5%
Transportation and warehousing	209,637	5.0%	308,590	4.9%
Information	82,050	1.9%	102,368	1.6%
Finance and insurance	223,395	5.3%	278,587	4.5%
Real estate and rental and leasing	55,103	1.3%	81,605	1.3%
Professional, scientific, and technical services	308,294	7.3%	371,658	5.9%
Management of companies and enterprises	29106	0.7%	32,148	0.5%
Administrative and waste management services	162613	3.9%	166,574	2.7%
Educational services	25,549	0.6%	31,762	0.5%
Health care and social assistance	769,834	18.3%	895,034	14.3%
Arts, entertainment, and recreation	43,232	1.0%	63,352	1.0%
Accommodation and food services	160,359	3.8%	233,769	3.7%
Other services, except public administration	160,038	3.8%	229,168	3.7%
Government and government enterprises	587,836	14.0%	999,422	16.0%
Provided Data Total	4,212,227	100.0%	5,855,212	93.6%
Suppressed Data Total	0	0.0%	400,857	6.4%
Earning by place of work	4,212,227	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Carbon County		River Corridor	
	2010	Percent Total	2010	Percent Total
Farm earnings	-921	-0.8%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	3,977	3.5%	227,003	3.6%
Utilities	3729	3.2%	53,712	0.9%
Construction	12,957	11.3%	474,975	7.6%
Manufacturing	2,045	1.8%	310,939	5.0%
Wholesale trade	3,026	2.6%	404,674	6.5%
Retail trade	8933	7.8%	470,257	7.5%
Transportation and warehousing	4,060	3.5%	308,590	4.9%
Information	1,130	1.0%	102,368	1.6%
Finance and insurance	3,656	3.2%	278,587	4.5%
Real estate and rental and leasing	2,758	2.4%	81,605	1.3%
Professional, scientific, and technical services	6,705	5.8%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	282	0.2%	31,762	0.5%
Health care and social assistance	10,101	8.8%	895,034	14.3%
Arts, entertainment, and recreation	3,789	3.3%	63,352	1.0%
Accommodation and food services	9,061	7.9%	233,769	3.7%
Other services, except public administration	5,420	4.7%	229,168	3.7%
Government and government enterprises	29,605	25.8%	999,422	16.0%
Provided Data Total	110,313	96.1%	5,855,212	93.6%
Suppressed Data Total	4,476	3.9%	400,857	6.4%
Earning by place of work	114,789	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Stillwater County		River Corridor	
	2010	**Percent Total**	**2010**	**Percent Total**
Farm earnings	-301	-0.1%	111,114	1.8%
Forestry, fishing, and related activities	1309	0.6%	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	2564	1.2%	53,712	0.9%
Construction	(D)	(D)	474,975	7.6%
Manufacturing	12,793	6.0%	310,939	5.0%
Wholesale trade	4,239	2.0%	404,674	6.5%
Retail trade	7981	3.7%	470,257	7.5%
Transportation and warehousing	1,450	0.7%	308,590	4.9%
Information	813	0.4%	102,368	1.6%
Finance and insurance	2,279	1.1%	278,587	4.5%
Real estate and rental and leasing	747	0.4%	81,605	1.3%
Professional, scientific, and technical services	9,722	4.6%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	176	0.1%	31,762	0.5%
Health care and social assistance	6,997	3.3%	895,034	14.3%
Arts, entertainment, and recreation	1,478	0.7%	63,352	1.0%
Accommodation and food services	3,514	1.7%	233,769	3.7%
Other services, except public administration	4,411	2.1%	229,168	3.7%
Government and government enterprises	21,604	10.1%	999,422	16.0%
Provided Data Total	81,776	38.4%	5,855,212	93.6%
Suppressed Data Total	131,082	61.6%	400,857	6.4%
Earning by place of work	212,858	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Sweet Grass County		River Corridor	
	2010		2010	Percent Total
Farm earnings	-3,372	-5.1%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	(D)	(D)	53,712	0.9%
Construction	5,675	8.6%	474,975	7.6%
Manufacturing	2,480	3.8%	310,939	5.0%
Wholesale trade	1,873	2.8%	404,674	6.5%
Retail trade	4402	6.7%	470,257	7.5%
Transportation and warehousing	(D)	(D)	308,590	4.9%
Information	(D)	(D)	102,368	1.6%
Finance and insurance	2,263	3.4%	278,587	4.5%
Real estate and rental and leasing	1,012	1.5%	81,605	1.3%
Professional, scientific, and technical services	1,496	2.3%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	(D)	(D)	31,762	0.5%
Health care and social assistance	(D)	(D)	895,034	14.3%
Arts, entertainment, and recreation	553	0.8%	63,352	1.0%
Accommodation and food services	2,509	3.8%	233,769	3.7%
Other services, except public administration	2,856	4.3%	229,168	3.7%
Government and government enterprises	15,097	22.9%	999,422	16.0%
Provided Data Total	36,844	55.9%	5,855,212	93.6%
Suppressed Data Total	29,103	44.1%	400,857	6.4%
Earning by place of work	65,947	-----	**6,256,069**	-----

(D) suppressed data

Earnings by Industry 2010 ($1,000)	Park County		River Corridor	
	2010	**Percent Total**	**2010**	**Percent Total**
Farm earnings	4,174	1.7%	111,114	1.8%
Forestry, fishing, and related activities	(D)	(D)	8,501	0.1%
Mining	(D)	(D)	227,003	3.6%
Utilities	4216	1.8%	53,712	0.9%
Construction	19,909	8.3%	474,975	7.6%
Manufacturing	16,250	6.7%	310,939	5.0%
Wholesale trade	3,908	1.6%	404,674	6.5%
Retail trade	20386	8.5%	470,257	7.5%
Transportation and warehousing	7,544	3.1%	308,590	4.9%
Information	4,133	1.7%	102,368	1.6%
Finance and insurance	10,333	4.3%	278,587	4.5%
Real estate and rental and leasing	3,420	1.4%	81,605	1.3%
Professional, scientific, and technical services	10,998	4.6%	371,658	5.9%
Management of companies and enterprises	(D)	(D)	32,148	0.5%
Administrative and waste management services	(D)	(D)	166,574	2.7%
Educational services	3,928	1.6%	31,762	0.5%
Health care and social assistance	31,089	12.9%	895,034	14.3%
Arts, entertainment, and recreation	4,088	1.7%	63,352	1.0%
Accommodation and food services	26,647	11.1%	233,769	3.7%
Other services, except public administration	16,960	7.0%	229,168	3.7%
Government and government enterprises	39,371	16.4%	999,422	16.0%
Provided Data Total	227,354	94.4%	5,855,212	93.6%
Suppressed Data Total	13,444	5.6%	400,857	6.4%
Earning by place of work	240,798	-----	**6,256,069**	-----

(D) suppressed data

Employment Totals by Industry (1970-2000) Bureau of Economic Analysis (2010)

Employment	**McKenzie County, ND**					**The River Corridor**	
	1970	**1980**	**1990**	**2000**	**Percent Total**	**2000**	**Percent Total**
Total full-time and part-time employment	2,562	4,587	3,400	3,970	-----	138,767	-----
Proprietors’ employment	1,249	1,212	1,226	1,391	35%	32,826	24%
Farm proprietors’ employment	937	879	824	675	17%	6,016	4%
Nonfarm proprietors’ employment	312	333	402	716	18%	26,810	19%
Farm employment	1,121	1,022	922	746	19%	7,556	5%
Agricultural services, forestry, and fishing	39	61	60	68	2%	1,607	1%
Mining	78	1,228	439	304	8%	2,053	1%
Construction	63	290	106	138	3%	7,698	6%
Manufacturing	14	18	32	50	1%	5,526	4%
Transportation and public utilities	100	187	136	163	4%	8,618	6%
Wholesale trade	74	154	132	93	2%	7,720	6%
Retail trade	311	397	321	305	8%	26,278	19%
Finance, insurance, and real estate	78	78	115	119	3%	8,884	6%
Services	212	576	485	702	18%	43,052	31%
Government and government enterprises	472	576	652	1,282	32%	17,590	13%

Employment	Richland County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	4,609	7,158	5,428	6,151	-----	138,767	-----
Proprietors' employment	1,592	1,562	1,504	1,824	30%	32,826	24%
Farm proprietors' employment	818	567	587	557	9%	6,016	4%
Nonfarm proprietors' employment	774	995	917	1,267	21%	26,810	19%
Farm employment	1,040	774	728	753	12%	7,556	5%
Agricultural services, forestry, and fishing	122	93	102	112	2%	1,607	1%
Mining	68	1,395	403	313	5%	2,053	1%
Construction	205	538	234	350	6%	7,698	6%
Manufacturing	398	357	334	421	7%	5,526	4%
Transportation and public utilities	301	325	325	360	6%	8,618	6%
Wholesale trade	108	382	163	209	3%	7,720	6%
Retail trade	774	1,196	923	1,142	19%	26,278	19%
Finance, insurance, and real estate	291	324	277	277	5%	8,884	6%
Services	756	1,152	1,183	1,439	23%	43,052	31%
Government and government enterprises	546	622	756	775	13%	17,590	13%

Employment			Dawson County			The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	5,317	6,631	5,052	5,606	-----	138,767	-----
Proprietors' employment	1,326	1,318	1,293	1,346	24%	32,826	24%
Farm proprietors' employment	646	491	427	455	8%	6,016	4%
Nonfarm proprietors' employment	680	827	866	891	16%	26,810	19%
Farm employment	813	629	533	590	11%	7,556	5%
Agricultural services, forestry, and fishing	66	52	64	0	0%	1,607	1%
Mining	280	364	90	148	3%	2,053	1%
Construction	316	393	150	0	0%	7,698	6%
Manufacturing	116	127	77	66	1%	5,526	4%
Transportation and public utilities	855	1,267	616	596	11%	8,618	6%
Wholesale trade	142	286	203	184	3%	7,720	6%
Retail trade	867	1,037	896	941	17%	26,278	19%
Finance, insurance, and real estate	284	306	277	283	5%	8,884	6%
Services	939	1,247	1,225	1,606	29%	43,052	31%
Government and government enterprises	639	923	921	955	17%	17,590	13%

Employment	Prairie County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	841	929	654	642	-----	138,767	-----
Proprietors’ employment	378	328	263	264	41%	32,826	24%
Farm proprietors’ employment	248	168	161	145	23%	6,016	4%
Nonfarm proprietors’ employment	130	160	102	119	19%	26,810	19%
Farm employment	335	267	216	215	33%	7,556	5%
Agricultural services, forestry, and fishing	0	0	11	0	0%	1,607	1%
Mining	0	0	0	0	0%	2,053	1%
Construction	26	109	0	0	0%	7,698	6%
Manufacturing	0	0	0	0	0%	5,526	4%
Transportation and public utilities	0	0	0	0	0%	8,618	6%
Wholesale trade	13	35	20	0	0%	7,720	6%
Retail trade	115	127	62	78	12%	26,278	19%
Finance, insurance, and real estate	43	28	0	23	4%	8,884	6%
Services	82	91	94	81	13%	43,052	31%
Government and government enterprises	189	177	186	178	2%	17,590	13%

Employment	Custer County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	5,480	7,088	6,424	6,978	-----	138,767	-----
Proprietors' employment	1,234	1,484	1,521	1,760	25%	32,826	24%
Farm proprietors' employment	357	330	375	410	6%	6,016	4%
Nonfarm proprietors' employment	877	1,154	1,146	1,350	19%	26,810	19%
Farm employment	615	514	559	533	8%	7,556	5%
Agricultural services, forestry, and fishing	87	72	91	110	2%	1,607	1%
Mining	79	21	11	0	0%	2,053	1%
Construction	365	679	257	339	5%	7,698	6%
Manufacturing	130	156	132	187	3%	5,526	4%
Transportation and public utilities	410	430	377	378	5%	8,618	6%
Wholesale trade	202	301	300	192	3%	7,720	6%
Retail trade	1,144	1,427	1,242	1,522	22%	26,278	19%
Finance, insurance, and real estate	310	374	343	500	7%	8,884	6%
Services	1,103	1,636	1,671	2,024	29%	43,052	31%
Government and government enterprises	1,035	1,478	1,441	1,186	17%	17,590	13%

Employment			Rosebud County			The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	2,649	5,101	5,758	5,836	-----	138,767	-----
Proprietors' employment	767	808	1,077	1,298	22%	32,826	24%
Farm proprietors' employment	410	313	335	396	7%	6,016	4%
Nonfarm proprietors' employment	357	495	742	902	15%	26,810	19%
Farm employment	722	521	539	529	9%	7,556	5%
Agricultural services, forestry, and fishing	24	46	60	0	0%	1,607	1%
Mining	53	451	528	511	9%	2,053	1%
Construction	62	865	273	105	2%	7,698	6%
Manufacturing	226	155	167	0	0%	5,526	4%
Transportation and public utilities	0	0	897	795	14%	8,618	6%
Wholesale trade	21	33	42	0	0%	7,720	6%
Retail trade	313	583	601	665	11%	26,278	19%
Finance, insurance, and real estate	46	108	110	119	2%	8,884	6%
Services	0	0	986	999	17%	43,052	31%
Government and government enterprises	636	1,286	1,555	1,871	32%	17,590	13%

Employment	Treasure County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	518	470	458	407	-----	138,767	-----
Proprietors' employment	227	191	167	161	40%	32,826	24%
Farm proprietors' employment	143	91	101	106	26%	6,016	4%
Nonfarm proprietors' employment	84	100	66	55	14%	26,810	19%
Farm employment	259	158	171	162	40%	7,556	5%
Agricultural services, forestry, and fishing	13	17	20	0	0%	1,607	1%
Mining	0	0	0	0	0%	2,053	1%
Construction	24	22	26	0	0%	7,698	6%
Manufacturing	0	0	0	0	0%	5,526	4%
Transportation and public utilities	25	50	17	29	7%	8,618	6%
Wholesale trade	0	28	0	0	0%	7,720	6%
Retail trade	66	72	58	51	13%	26,278	19%
Finance, insurance, and real estate	19	13	0	0	0%	8,884	6%
Services	37	28	50	39	10%	43,052	31%
Government and government enterprises	66	80	84	86	21%	17,590	13%

Employment	Yellowstone					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	40,151	61,138	69,909	88,455	-----	138,767	-----
Proprietors' employment	7,450	10,717	14,442	16,992	19%	32,826	24%
Farm proprietors' employment	1,014	998	1,028	1,227	1%	6,016	4%
Nonfarm proprietors' employment	6,436	9,719	13,414	15,765	18%	26,810	19%
Farm employment	1,393	1,335	1,288	1,474	2%	7,556	5%
Agricultural services, forestry, and fishing	233	471	549	947	1%	1,607	1%
Mining	598	820	882	693	1%	2,053	1%
Construction	2,194	3,513	2,803	5,179	6%	7,698	6%
Manufacturing	3,525	4,450	3,539	3,759	4%	5,526	4%
Transportation and public utilities	3,213	4,890	4,564	5,725	6%	8,618	6%
Wholesale trade	3,369	5,797	5,781	6,671	8%	7,720	6%
Retail trade	7,406	12,171	13,867	17,905	20%	26,278	19%
Finance, insurance, and real estate	3,531	4,939	5,941	6,274	7%	8,884	6%
Services	8,481	14,918	21,935	30,822	35%	43,052	31%
Government and government enterprises	6,208	7,834	8,760	9,006	10%	17,590	13%

Employment	Carbon County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	2,747	3,118	3,549	4,846	-----	138,767	-----
Proprietors' employment	1,287	1,335	1,590	2,198	45%	32,826	24%
Farm proprietors' employment	770	620	653	698	14%	6,016	4%
Nonfarm proprietors' employment	517	715	937	1,500	31%	26,810	19%
Farm employment	937	787	778	845	17%	7,556	5%
Agricultural services, forestry, and fishing	30	90	105	119	2%	1,607	1%
Mining	36	125	34	54	1%	2,053	1%
Construction	71	126	190	392	8%	7,698	6%
Manufacturing	99	45	126	145	3%	5,526	4%
Transportation and public utilities	67	106	108	113	2%	8,618	6%
Wholesale trade	44	36	50	104	2%	7,720	6%
Retail trade	459	601	610	814	17%	26,278	19%
Finance, insurance, and real estate	109	162	174	362	7%	8,884	6%
Services	451	535	826	1,280	26%	43,052	31%
Government and government enterprises	444	505	548	618	13%	17,590	13%

Employment	Stillwater County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	1,888	2,221	3,224	4,894	-----	138,767	-----
Proprietors' employment	932	849	1,184	1,735	35%	32,826	24%
Farm proprietors' employment	488	418	459	522	11%	6,016	4%
Nonfarm proprietors' employment	444	431	725	1,213	25%	26,810	19%
Farm employment	662	576	580	614	13%	7,556	5%
Agricultural services, forestry, and fishing	15	29	87	0	0%	1,607	1%
Mining	0	46	0	0	0%	2,053	1%
Construction	83	137	122	235	5%	7,698	6%
Manufacturing	79	123	223	366	7%	5,526	4%
Transportation and public utilities	54	81	107	103	2%	8,618	6%
Wholesale trade	32	38	54	0	0%	7,720	6%
Retail trade	254	325	407	681	14%	26,278	19%
Finance, insurance, and real estate	174	107	86	227	5%	8,884	6%
Services	264	436	0	767	16%	43,052	31%
Government and government enterprises	267	323	411	478	10%	17,590	13%

Employment	Sweet Grass County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	1,368	1,500	1,754	2,158	-----	138,767	-----
Proprietors' employment	542	570	772	952	44%	32,826	24%
Farm proprietors' employment	304	264	313	339	16%	6,016	4%
Nonfarm proprietors' employment	238	306	459	613	28%	26,810	19%
Farm employment	473	413	431	464	22%	7,556	5%
Agricultural services, forestry, and fishing	11	31	63	0	0%	1,607	1%
Mining	0	0	0	0	0%	2,053	1%
Construction	53	93	99	226	10%	7,698	6%
Manufacturing	22	28	55	81	4%	5,526	4%
Transportation and public utilities	46	25	41	0	0%	8,618	6%
Wholesale trade	0	25	24	59	3%	7,720	6%
Retail trade	255	326	333	366	17%	26,278	19%
Finance, insurance, and real estate	67	56	109	102	5%	8,884	6%
Services	223	224	313	359	17%	43,052	31%
Government and government enterprises	210	279	282	332	15%	17,590	13%

Employment	Park County					The River Corridor	
	1970	1980	1990	2000	Percent Total	2000	Percent Total
Total full-time and part-time employment	4,692	6,287	6,598	8,824	-----	138,767	-----
Proprietors' employment	1,248	1,528	2,299	2,905	33%	32,826	24%
Farm proprietors' employment	416	373	393	486	6%	6,016	4%
Nonfarm proprietors' employment	832	1,155	1,906	2,419	27%	26,810	19%
Farm employment	630	523	505	631	7%	7,556	5%
Agricultural services, forestry, and fishing	47	71	125	251	3%	1,607	1%
Mining	0	14	128	30	0%	2,053	1%
Construction	156	294	379	734	8%	7,698	6%
Manufacturing	295	414	347	451	5%	5,526	4%
Transportation and public utilities	744	1,371	322	356	4%	8,618	6%
Wholesale trade	37	55	132	208	2%	7,720	6%
Retail trade	872	1,052	1,236	1,808	20%	26,278	19%
Finance, insurance, and real estate	357	409	461	598	7%	8,884	6%
Services	998	1,413	2,214	2,934	33%	43,052	31%
Government and government enterprises	555	671	749	823	9%	17,590	13%

Employment Totals by Industry (2010) Bureau of Economic Analysis (2010)

Employment	McKenzie County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	5,638	-----	154,335	-----
Wage and salary employment	4,151	73.6%	117,792	76.3%
Proprietors’ employment	1,487	26.4%	38,388	24.9%
Farm proprietors’ employment	484	32.5%	5,286	13.8%
Nonfarm proprietors’ employment	1,003	67.5%	33,102	68.2%
Farm employment	554	9.8%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	653	11.6%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	537	9.5%	9,952	6.4%
Manufacturing	78	1.4%	4,687	3.0%
Wholesale trade	167	3.0%	6,883	4.5%
Retail trade	0	0.0%	17,670	11.4%
Transportation and warehousing	483	8.6%	5,371	3.5%
Information	30	0.5%	2,159	1.4%
Finance and insurance	123	2.2%	6,338	4.1%
Real estate and rental and leasing	136	2.4%	6,441	4.2%
Professional, scientific, and technical services	147	2.6%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	66	1.2%	1,681	1.1%
Health care and social assistance	251	4.5%	17,163	11.1%
Arts, entertainment, and recreation	61	1.1%	4,272	2.8%
Accommodation and food services	201	3.6%	12,769	8.3%
Other services, except public administration	176	3.1%	9,141	5.9%
Government and government enterprises	1,519	26.9%	19,405	12.6%

Employment	Richland County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	7,585	-----	154,335	-----
Wage and salary employment	5,638	74.3%	117,792	76.3%
Proprietors’ employment	1,947	25.7%	38,388	24.9%
Farm proprietors’ employment	426	5.6%	5,286	13.8%
Nonfarm proprietors’ employment	1,521	20.1%	33,102	86.2%
Farm employment	561	7.4%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	719	9.5%	3,146	2.0%
Utilities	60	0.8%	483	0.3%
Construction	649	8.6%	9,952	6.4%
Manufacturing	326	4.3%	4,687	3.0%
Wholesale trade	276	3.6%	6,883	4.5%
Retail trade	756	10.0%	17,670	11.4%
Transportation and warehousing	488	6.4%	5,371	3.5%
Information	45	0.6%	2,159	1.4%
Finance and insurance	222	2.9%	6,338	4.1%
Real estate and rental and leasing	266	3.5%	6,441	4.2%
Professional, scientific, and technical services	276	3.6%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	0	0.0%	1,681	1.1%
Health care and social assistance	0	0.0%	17,163	11.1%
Arts, entertainment, and recreation	169	2.2%	4,272	2.8%
Accommodation and food services	510	6.7%	12,769	8.3%
Other services, except public administration	414	5.5%	9,141	5.9%
Government and government enterprises	763	10.1%	19,405	12.6%

Employment	Dawson County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	5,387	-----	154,335	-----
Wage and salary employment	4,000	74.3%	117,792	76.3%
Proprietors' employment	1,387	25.7%	38,388	24.9%
Farm proprietors' employment	389	7.2%	5,286	13.8%
Nonfarm proprietors' employment	998	18.5%	33,102	86.2%
Farm employment	454	8.4%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	174	3.2%	9,952	6.4%
Manufacturing	57	1.1%	4,687	3.0%
Wholesale trade	237	4.4%	6,883	4.5%
Retail trade	576	10.7%	17,670	11.4%
Transportation and warehousing	0	0.0%	5,371	3.5%
Information	103	1.9%	2,159	1.4%
Finance and insurance	145	2.7%	6,338	4.1%
Real estate and rental and leasing	138	2.6%	6,441	4.2%
Professional, scientific, and technical services	134	2.5%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	16	0.3%	1,681	1.1%
Health care and social assistance	738	13.7%	17,163	11.1%
Arts, entertainment, and recreation	126	2.3%	4,272	2.8%
Accommodation and food services	417	7.7%	12,769	8.3%
Other services, except public administration	354	6.6%	9,141	5.9%
Government and government enterprises	865	16.1%	19,405	12.6%

Employment	Prairie County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	821	-----	154,335	-----
Wage and salary employment	352	42.9%	117,792	76.3%
Proprietors’ employment	469	57.1%	38,388	24.9%
Farm proprietors’ employment	128	15.6%	5,286	13.8%
Nonfarm proprietors’ employment	341	41.5%	33,102	86.2%
Farm employment	169	20.6%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	0	0.0%	9,952	6.4%
Manufacturing	0	0.0%	4,687	3.0%
Wholesale trade	0	0.0%	6,883	4.5%
Retail trade	49	6.0%	17,670	11.4%
Transportation and warehousing	17	2.1%	5,371	3.5%
Information	10	1.2%	2,159	1.4%
Finance and insurance	0	0.0%	6,338	4.1%
Real estate and rental and leasing	0	0.0%	6,441	4.2%
Professional, scientific, and technical services	30	3.7%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	34	4.1%	6,480	4.2%
Educational services	14	1.7%	1,681	1.1%
Health care and social assistance	12	1.5%	17,163	11.1%
Arts, entertainment, and recreation	17	2.1%	4,272	2.8%
Accommodation and food services	40	4.9%	12,769	8.3%
Other services, except public administration	38	4.6%	9,141	5.9%
Government and government enterprises	190	23.1%	19,405	12.6%

Employment	Custer County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	7,768	-----	154,335	-----
Wage and salary employment	5,791	74.5%	117,792	76.3%
Proprietors’ employment	1,977	25.5%	38,388	24.9%
Farm proprietors’ employment	332	16.8%	5,286	13.8%
Nonfarm proprietors’ employment	1,645	83.2%	33,102	86.2%
Farm employment	432	5.6%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	487	6.3%	9,952	6.4%
Manufacturing	92	1.2%	4,687	3.0%
Wholesale trade	214	2.8%	6,883	4.5%
Retail trade	984	12.7%	17,670	11.4%
Transportation and warehousing	0	0.0%	5,371	3.5%
Information	117	1.5%	2,159	1.4%
Finance and insurance	409	5.3%	6,338	4.1%
Real estate and rental and leasing	227	2.9%	6,441	4.2%
Professional, scientific, and technical services	295	3.8%	8,223	5.3%
Management of companies and enterprises	32	0.4%	481	0.3%
Administrative and waste management services	145	1.9%	6,480	4.2%
Educational services	85	1.1%	1,681	1.1%
Health care and social assistance	1,059	13.6%	17,163	11.1%
Arts, entertainment, and recreation	161	2.1%	4,272	2.8%
Accommodation and food services	714	9.2%	12,769	8.3%
Other services, except public administration	456	5.9%	9,141	5.9%
Government and government enterprises	1,221	15.7%	19,405	12.6%

Employment	Rosebud County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	5,923	-----	154,335	-----
Wage and salary employment	4,549	76.8%	117,792	76.3%
Proprietors’ employment	1,374	23.2%	38,388	24.9%
Farm proprietors’ employment	406	29.5%	5,286	13.8%
Nonfarm proprietors’ employment	968	70.5%	33,102	86.2%
Farm employment	507	8.6%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	613	10.3%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	277	4.7%	9,952	6.4%
Manufacturing	41	0.7%	4,687	3.0%
Wholesale trade	0	0.0%	6,883	4.5%
Retail trade	438	7.4%	17,670	11.4%
Transportation and warehousing	134	2.3%	5,371	3.5%
Information	69	1.2%	2,159	1.4%
Finance and insurance	83	1.4%	6,338	4.1%
Real estate and rental and leasing	79	1.3%	6,441	4.2%
Professional, scientific, and technical services	91	1.5%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	117	2.0%	6,480	4.2%
Educational services	0	0.0%	1,681	1.1%
Health care and social assistance	0	0.0%	17,163	11.1%
Arts, entertainment, and recreation	145	2.4%	4,272	2.8%
Accommodation and food services	313	5.3%	12,769	8.3%
Other services, except public administration	195	3.3%	9,141	5.9%
Government and government enterprises	1,854	31.3%	19,405	12.6%

Employment	Treasure County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	513	-----	154,335	-----
Wage and salary employment	210	40.9%	117,792	76.3%
Proprietors’ employment	303	59.1%	38,388	24.9%
Farm proprietors’ employment	74	24.4%	5,286	13.8%
Nonfarm proprietors’ employment	229	75.6%	33,102	86.2%
Farm employment	117	22.8%	6,393	4.1%
Forestry, fishing, and related activities	14	2.7%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	0	0.0%	9,952	6.4%
Manufacturing	0	0.0%	4,687	3.0%
Wholesale trade	37	7.2%	6,883	4.5%
Retail trade	0	0.0%	17,670	11.4%
Transportation and warehousing	0	0.0%	5,371	3.5%
Information	0	0.0%	2,159	1.4%
Finance and insurance	0	0.0%	6,338	4.1%
Real estate and rental and leasing	46	9.0%	6,441	4.2%
Professional, scientific, and technical services	0	0.0%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	0	0.0%	1,681	1.1%
Health care and social assistance	0	0.0%	17,163	11.1%
Arts, entertainment, and recreation	0	0.0%	4,272	2.8%
Accommodation and food services	0	0.0%	12,769	8.3%
Other services, except public administration	37	7.2%	9,141	5.9%
Government and government enterprises	78	15.2%	19,405	12.6%

Employment	Yellowstone County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	100,466	-----	154,335	-----
Wage and salary employment	80,291	79.9%	117,792	76.3%
Proprietors’ employment	20,175	20.1%	38,388	24.9%
Farm proprietors’ employment	1,206	6.0%	5,286	13.8%
Nonfarm proprietors’ employment	18,969	94.0%	33,102	86.2%
Farm employment	1,384	1.4%	6,393	4.1%
Forestry, fishing, and related activities	320	0.3%	429	0.3%
Mining	1,078	1.1%	3,146	2.0%
Utilities	324	0.3%	483	0.3%
Construction	6,472	6.4%	9,952	6.4%
Manufacturing	3,300	3.3%	4,687	3.0%
Wholesale trade	5,696	5.7%	6,883	4.5%
Retail trade	12,921	12.9%	17,670	11.4%
Transportation and warehousing	3,888	3.9%	5,371	3.5%
Information	1,562	1.6%	2,159	1.4%
Finance and insurance	4,694	4.7%	6,338	4.1%
Real estate and rental and leasing	4,273	4.3%	6,441	4.2%
Professional, scientific, and technical services	6,189	6.2%	8,223	5.3%
Management of companies and enterprises	449	0.4%	481	0.3%
Administrative and waste management services	6,184	6.2%	6,480	4.2%
Educational services	1,253	1.2%	1,681	1.1%
Health care and social assistance	13,710	13.6%	17,163	11.1%
Arts, entertainment, and recreation	2,718	2.7%	4,272	2.8%
Accommodation and food services	8,291	8.3%	12,769	8.3%
Other services, except public administration	5,971	5.9%	9,141	5.9%
Government and government enterprises	9,789	9.7%	19,405	12.6%

Employment	Carbon County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	5,176	-----	154,335	-----
Wage and salary employment	2,703	52.2%	117,792	76.3%
Proprietors' employment	2,473	47.8%	38,388	24.9%
Farm proprietors' employment	601	24.3%	5,286	13.8%
Nonfarm proprietors' employment	1,872	75.7%	33,102	86.2%
Farm employment	669	12.9%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	83	1.6%	3,146	2.0%
Utilities	32	0.6%	483	0.3%
Construction	458	8.8%	9,952	6.4%
Manufacturing	96	1.9%	4,687	3.0%
Wholesale trade	93	1.8%	6,883	4.5%
Retail trade	401	7.7%	17,670	11.4%
Transportation and warehousing	100	1.9%	5,371	3.5%
Information	51	1.0%	2,159	1.4%
Finance and insurance	96	1.9%	6,338	4.1%
Real estate and rental and leasing	434	8.4%	6,441	4.2%
Professional, scientific, and technical services	268	5.2%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	42	0.8%	1,681	1.1%
Health care and social assistance	315	6.1%	17,163	11.1%
Arts, entertainment, and recreation	262	5.1%	4,272	2.8%
Accommodation and food services	525	10.1%	12,769	8.3%
Other services, except public administration	325	6.3%	9,141	5.9%
Government and government enterprises	649	12.5%	19,405	12.6%

Employment	Stillwater County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	5,107	-----	154,335	-----
Wage and salary employment	3,159	61.9%	117,792	76.3%
Proprietors’ employment	1,948	38.1%	38,388	24.9%
Farm proprietors’ employment	534	10.5%	5,286	13.8%
Nonfarm proprietors’ employment	1,414	27.7%	33,102	86.2%
Farm employment	620	12.1%	6,393	4.1%
Forestry, fishing, and related activities	95	1.9%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	21	0.4%	483	0.3%
Construction	0	0.0%	9,952	6.4%
Manufacturing	289	5.7%	4,687	3.0%
Wholesale trade	69	1.4%	6,883	4.5%
Retail trade	421	8.2%	17,670	11.4%
Transportation and warehousing	84	1.6%	5,371	3.5%
Information	30	0.6%	2,159	1.4%
Finance and insurance	92	1.8%	6,338	4.1%
Real estate and rental and leasing	204	4.0%	6,441	4.2%
Professional, scientific, and technical services	211	4.1%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	26	0.5%	1,681	1.1%
Health care and social assistance	295	5.8%	17,163	11.1%
Arts, entertainment, and recreation	129	2.5%	4,272	2.8%
Accommodation and food services	250	4.9%	12,769	8.3%
Other services, except public administration	237	4.6%	9,141	5.9%
Government and government enterprises	512	10.0%	19,405	12.6%

Employment	Sweet Grass County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	2,552	-----	154,335	-----
Wage and salary employment	1,465	57.4%	117,792	76.3%
Proprietors' employment	1,087	42.6%	38,388	24.9%
Farm proprietors' employment	285	26.2%	5,286	13.8%
Nonfarm proprietors' employment	802	73.8%	33,102	86.2%
Farm employment	381	14.9%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	0	0.0%	483	0.3%
Construction	195	7.6%	9,952	6.4%
Manufacturing	77	3.0%	4,687	3.0%
Wholesale trade	39	1.5%	6,883	4.5%
Retail trade	197	7.7%	17,670	11.4%
Transportation and warehousing	0	0.0%	5,371	3.5%
Information	0	0.0%	2,159	1.4%
Finance and insurance	69	2.7%	6,338	4.1%
Real estate and rental and leasing	102	4.0%	6,441	4.2%
Professional, scientific, and technical services	86	3.4%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	0	0.0%	1,681	1.1%
Health care and social assistance	0	0.0%	17,163	11.1%
Arts, entertainment, and recreation	68	2.7%	4,272	2.8%
Accommodation and food services	158	6.2%	12,769	8.3%
Other services, except public administration	178	7.0%	9,141	5.9%
Government and government enterprises	388	15.2%	19,405	12.6%

Employment	Park County		The River Corridor	
	2010	Percent Total	2010	Percent Total
Total employment	9,244	-----	154,335	-----
Wage and salary employment	5,483	59.3%	117,792	76.3%
Proprietors’ employment	3,761	40.7%	38,388	24.9%
Farm proprietors’ employment	421	11.2%	5,286	13.8%
Nonfarm proprietors’ employment	3,340	88.8%	33,102	86.2%
Farm employment	545	5.9%	6,393	4.1%
Forestry, fishing, and related activities	0	0.0%	429	0.3%
Mining	0	0.0%	3,146	2.0%
Utilities	46	0.5%	483	0.3%
Construction	703	7.6%	9,952	6.4%
Manufacturing	331	3.6%	4,687	3.0%
Wholesale trade	55	0.6%	6,883	4.5%
Retail trade	927	10.0%	17,670	11.4%
Transportation and warehousing	177	1.9%	5,371	3.5%
Information	142	1.5%	2,159	1.4%
Finance and insurance	405	4.4%	6,338	4.1%
Real estate and rental and leasing	536	5.8%	6,441	4.2%
Professional, scientific, and technical services	496	5.4%	8,223	5.3%
Management of companies and enterprises	0	0.0%	481	0.3%
Administrative and waste management services	0	0.0%	6,480	4.2%
Educational services	179	1.9%	1,681	1.1%
Health care and social assistance	783	8.5%	17,163	11.1%
Arts, entertainment, and recreation	416	4.5%	4,272	2.8%
Accommodation and food services	1,350	14.6%	12,769	8.3%
Other services, except public administration	760	8.2%	9,141	5.9%
Government and government enterprises	821	8.9%	19,405	12.6%

Labor (1990-2010), Bureau of Labor Statistics (1990-2010)

Labor	McKenzie County, ND			The River Corridor
	1990	2000	2010	2010
Labor Force	2,954	2,704	3,514	125,613
Employed	2,888	2,621	3,437	119,142
Unemployed	66	83	77	6,471
Unemployment Rate	2.2%	3.1%	2.2%	5.2%

Labor	Richland County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	5,419	4,979	5,798	125,613
Employed	5,076	4,717	5,600	119,142
Unemployed	343	262	198	6,471
Unemployment Rate	6.3%	5.3%	3.4%	5.2%

Labor	Dawson County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	4,936	4,770	4,229	125,613
Employed	4,746	4,577	4,051	119,142
Unemployed	190	193	178	6,471
Unemployment Rate	3.8%	4.0%	4.2%	5.2%

Labor	Prairie County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	682	617	558	125,613
Employed	656	585	532	119,142
Unemployed	26	32	26	6,471
Unemployment Rate	3.8%	5.2%	4.7%	5.2%

Labor	Custer County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	6,042	6,042	6,042	125,613
Employed	5,739	5,721	5,840	119,142
Unemployed	303	271	271	6,471
Unemployment Rate	5.0%	4.5%	4.4%	5.2%

Labor	Rosebud County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	4,967	4,279	3,957	125,613
Employed	4,605	4,029	3,684	119,142
Unemployed	362	250	273	6,471
Unemployment Rate	7.3%	5.8%	6.9%	5.2%

Labor	Treasure County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	486	458	382	125,613
Employed	469	437	363	119,142
Unemployed	17	21	19	6,471
Unemployment Rate	3.5%	4.6%	5.0%	5.2%

Labor	Yellowstone County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	62,741	71,487	80,992	125,613
Employed	59,567	68,572	76,820	119,142
Unemployed	3,174	2,915	4,172	6,471
Unemployment Rate	5.1%	4.1%	5.2%	5.2%

Labor	Carbon County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	3,796	4,993	5,237	125,613
Employed	3,632	4,773	4,938	119,142
Unemployed	164	220	299	6,471
Unemployment Rate	4.3%	4.4%	5.7%	5.2%

Labor	Stillwater County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	3,348	4,423	4,221	125,613
Employed	3,216	4,223	3,969	119,142
Unemployed	132	200	252	6,471
Unemployment Rate	3.9%	4.5%	6.0%	5.2%

Labor	Sweet Grass County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	1,558	1,991	2,282	125,613
Employed	1,520	1,928	2,198	119,142
Unemployed	38	63	84	6,471
Unemployment Rate	2.4%	3.2%	3.7%	5.2%

Labor	Park County, MT			The River Corridor
	1990	2000	2010	2010
Labor Force	7,845	9,051	8,332	125,613
Employed	7,417	8,589	7,710	119,142
Unemployed	303	271	271	6,471
Unemployment Rate	5.0%	4.5%	4.4%	5.2%

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SOCIOECONOMIC REPORT

Analysis of Agriculture, Urban/Ex-Urban Development and Transportation Sectors

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Table of Contents

Abstract

The Yellowstone River Corridor, located in southern Montana and eastern North Dakota, spans 12 counties. This report details socioeconomic data for each of the counties grouped, according to economic characteristics, into five segments. This report focuses on the three sectors: agriculture, exurban and urban development, and transportation. Each section of this report provides historic and current data for each segment along the River Corridor. In some cases, data are provided at the county level to highlight important differences between the counties within a single segment, while in other cases, aggregate data are provided at the segment level.

Introduction

The Yellowstone River Corridor, located in southern Montana and eastern North Dakota, spans 12 counties. The corridor covers a geographically and economically diverse area. For ease of discussion, the 12 counties have been grouped into five segments that reflect economically similar areas. It should be noted that this is the same geographic grouping applied in the Yellowstone River Cultural Inventory Report. Segment 1 encompasses the counties located in eastern Montana and western North Dakota: Prairie, Dawson, Richland Counties, MT; and McKenzie County, ND. Segment 2 spans eastern central Montana, including Treasure, Rosebud and Custer Counties, MT. Given the uniqueness of the economy of Yellowstone County, it is the only county included in Segment 3. Segment 4 includes Sweet Grass, Stillwater and Carbon Counties, MT. Segment 5, similar to Segment 3, only consists of Park County, MT. Again this is due to the unique economy of this county. The region shares a unique history and is culturally important; while each of the counties is distinct in its own way, together, they are facing many of the same opportunities and uncertainties moving into the future.

Today, counties in the River Corridor are experiencing an increase in the diversity of economic sectors driving local economies. Natural resource extraction continues to drive the economy of many communities within the River Corridor. The Bakken Oil Field is having notable effects on communities in Segment 1, coal mines continue to be an important source of employment for residents of the counties in Segment 2, and coal and metal mines are still fully operational in Segment 4 (Southeastern Montana Development Corporation, 2010; Bohnenkamp and others, 2011; Montana Department of Labor and Industry, 2012b). In addition to extractive natural resource industries, counties along the corridor are well known for abundant recreation opportunities. Yellowstone National Park, Gallatin and Custer National Forests, several blue ribbon streams and rivers, as well as over a hundred lakes and reservoirs make the counties along the River Corridor a heavily-used area for recreation. These recreation-based industries are viewed as important economic drivers for several counties within the corridor, especially Park County (Segment 5) (Northern Rocky Mountain Economic Development District, 2012). In the future, the continued development of extractive industries may conflict with the emerging tourism and recreation industries.

This report details agricultural, exurban and urban development and transportation data for each of the five segments. Each section of this report provides historic and current data for each River Corridor segment. In some cases, data are provided at the county level to highlight important similarities or differences between the counties within a single segment, while in other cases, aggregate data are provided at the segment level.

Agriculture

Segment 1

Historical Introduction

Beginning in the early 1900s, the Enlarged Homestead Act drove an increase in population and dryland agriculture in Eastern Montana (Barber, 2012). The Enlarged Homestead Act allowed 320-acre claims of land, which made farming west of the 100th meridian possible. In addition to the Enlarged Homestead Act, the arrival of the railroad in Eastern Montana also led to an increase in population (Barber, 2012).

The development of a large-scale irrigation project, known as the Lower Yellowstone Project, completed in 1909, allowed for the irrigation of approximately 54,000 acres of land along the Yellowstone River. The project created a diversion dam near the town of Glendive, located in Dawson County, MT. In 1925, the Yellowstone irrigation project, along with rail transportation, allowed for the creation of the Midland Sugar Company, a sugar beet processing plant, in Sidney, Montana (Dawson County) (Sidney Sugars Inc.). The Midland Sugar Company remains in operation today as Sidney Sugars Incorporated and has grown from contracting just over 8,000 acres in 1925 to over 45,000 today.

Today, the Lower Yellowstone Project continues to play an important role in the agricultural production of Eastern Montana. Currently, the project consists of a pumping plant, the Main Canal, 225 miles of lateral ditches and 118 miles of drains (Bureau of Reclamation, 2012). The irrigation project continues to support crops including small grains, alfalfa and other hay crops, pasture, silage, beans and sugar beets.

Agricultural Statistics

The agricultural data presented here are representative of county level statistics. The River Corridor Counties column demonstrates the representative statistic for all the 12 counties in which Yellowstone River is located. As the size of the counties varies, so does the length of the river stretch contained within those counties. For example, McKenzie County, North Dakota, is a large county but with only a short section of the Yellowstone River.

Between 1950 and 2012, the agricultural landscape in Segment 1 changed. All counties in the segment experienced a decrease in the number of farms, with as much as a 50% decrease in the number of farms in McKenzie and Richland Counties (Table 1 and Table 2). The amount of land in farms, however remained fairly constant in most counties, decreasing in some and increasing in other counties. This is likely attributed to the consolidation of land into fewer but larger farms. Irrigated acres in McKenzie County remained nearly constant between 1949 and 2012, while almost doubling in Richland and increasing 34% and 57 % in Dawson and Prairie counties respectfully. Counties in Segment 2 experienced a slightly lower increase in irrigated land while all other counties along the River Corridor saw a decrease in irrigated agricultural land from 1950 to 2012 (United States Department of Agriculture, 2012).

McKenzie, Richland and Dawson counties have a similar number of farms as well as a comparable number of acres of land in farms, approximately 500 farms and 1 million acres as of 2012 (Table 2). The average farm size is much larger in Prairie County (4,135 acres) than the other counties in Segment 1. In 2012, Richland County had the largest number of irrigated farms, 154 irrigated out of a total of 544 with the largest number of irrigated acres in the Segment, 62,730 acres. In Richland County, acres under irrigation represent almost 5% of total land in farms. In Prairie County, about a quarter of the farms are irrigated (45 farms under irrigation compared to a total of 186), with slightly over 1% of land in farms under irrigation (see Table 2). In the River Corridor counties as a whole, almost 3% of the land in farms is irrigated. Despite the Lower Yellowstone Project, the majority of farming in McKenzie County, ND and Dawson County, MT continues to be dryland farming. Additionally, McKenzie County, ND and Richland County, MT have the largest production of cattle and calves in the Segment, each producing over 62,000 head in 2012. The main crop produced in Segment 1 is wheat, with the largest acres in wheat production located in McKenzie County, ND and Richland County, MT, 203,519 and 199,851 acres, respectively. Prairie and Dawson Counties, MT each produce nearly 40,000 head of cattle and calves, with fewer acres under wheat production, 179,575 and 27,019 acres, respectively (United States Department of Agriculture, 2012).

Table 1. Agricultural Statistics for Counties in Segment 1, 1950

	McKenzie	Richland	Dawson	Prairie	River Corridor Counties
Number of Farms	1,234	1,057	758	257	8,593
Land in farms (acres)	1,193,921	1,218,545	1,404,965	661,564	15,261,807
Land in farms\ Average size of farm (acres)	968	1,153	1,854	2,574	1,776
Irrigated land (farms)	173	375	108	40	4,149
Irrigated land (acres)*	19,856	33,995	12,808	5,891	421, 408

Source: United States Dept. of Agriculture, 1950
*1949 values

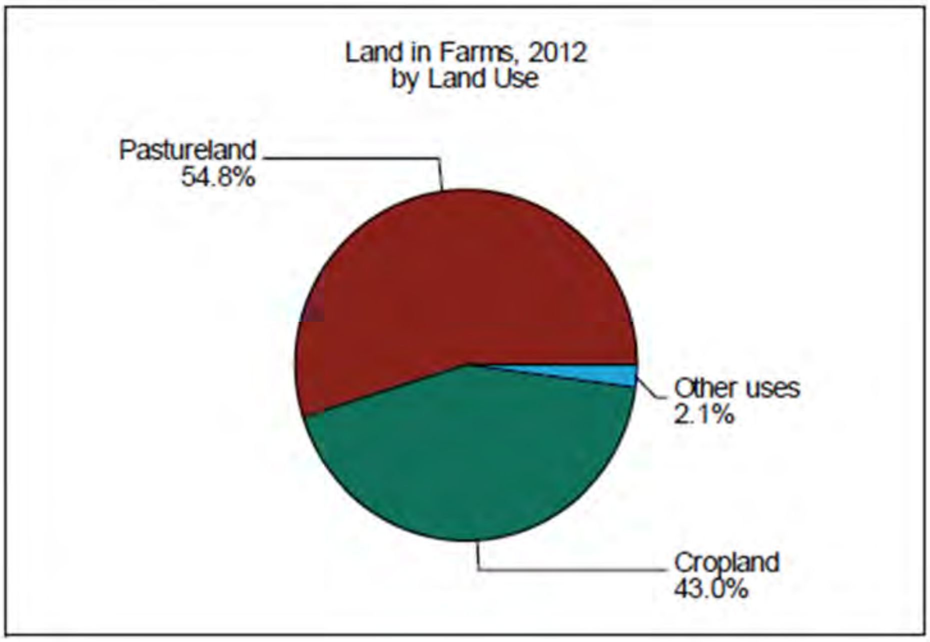
Table 2. Agricultural Statistics for Counties in Segment 1, 2012

	McKenzie	Richland	Dawson	Prairie	River Corridor Counties
Number of Farms	574	544	485	186	6,303
Land in farms (acres)	1,064,191	1,293,012	1,258,119	769,046	15,232,307
Land in farms\ Average size of farm (acres)	1,854	2,377	2,594	4,135	2,416
Irrigated land (farms)	49	154	74	45	2,326
Irrigated land (acres)	19,913	62,730	17,151	9,240	457,531

Source: United States Dept. of Agriculture, 2012

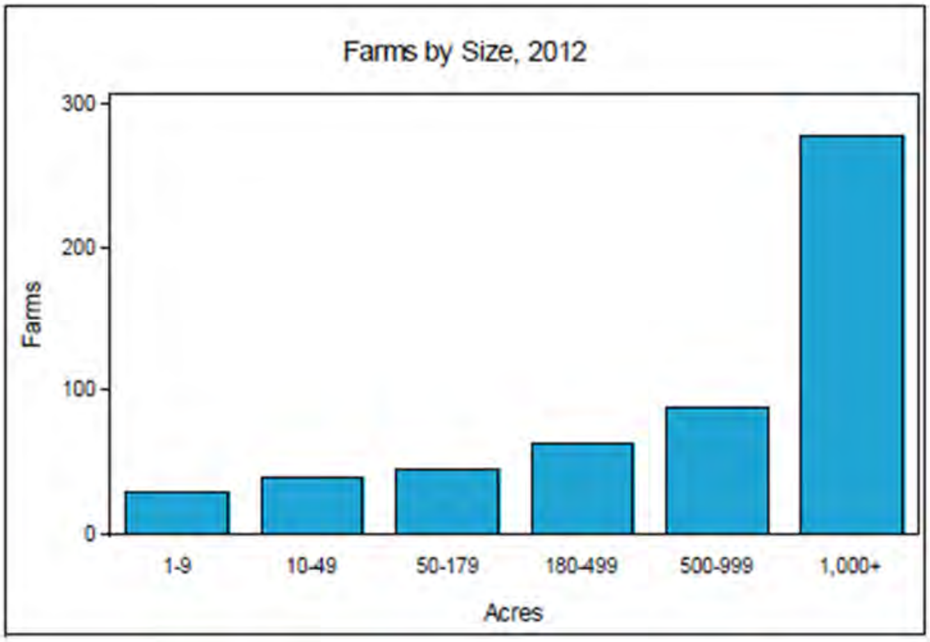
Across all counties in Segment 1, the majority of the farms are larger than 1,000 acres (Figures 2, 4, 6 and 8). Further, more than half of the land in farms within the four – county areas is used for pastureland with an average of 1/3 used as cropland (Figures 1,3,5, and 7) (United States Department of Agriculture, 2012). Pastureland is defined by the agricultural census as grazable land that does not qualify as woodland pasture or cropland pasture. Pastureland may be irrigated or dry land. In some areas, it can be a high quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland.

Figure 1: Richland County Land in Farms by Land Use, 2012



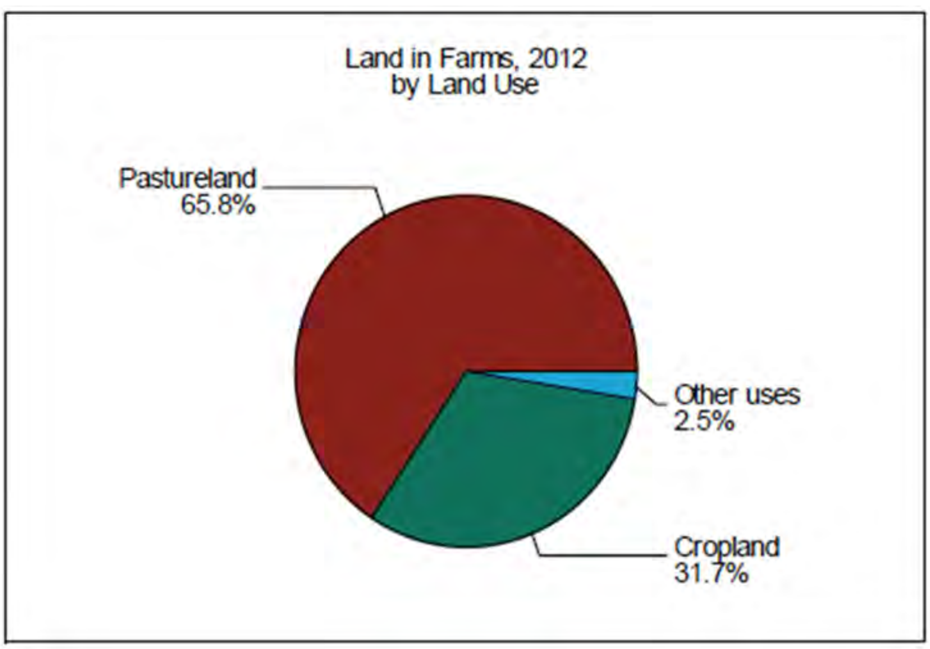
Source: United States Dept. of Agriculture, 2012

Figure 2: Richland County Farms by Size, 2012



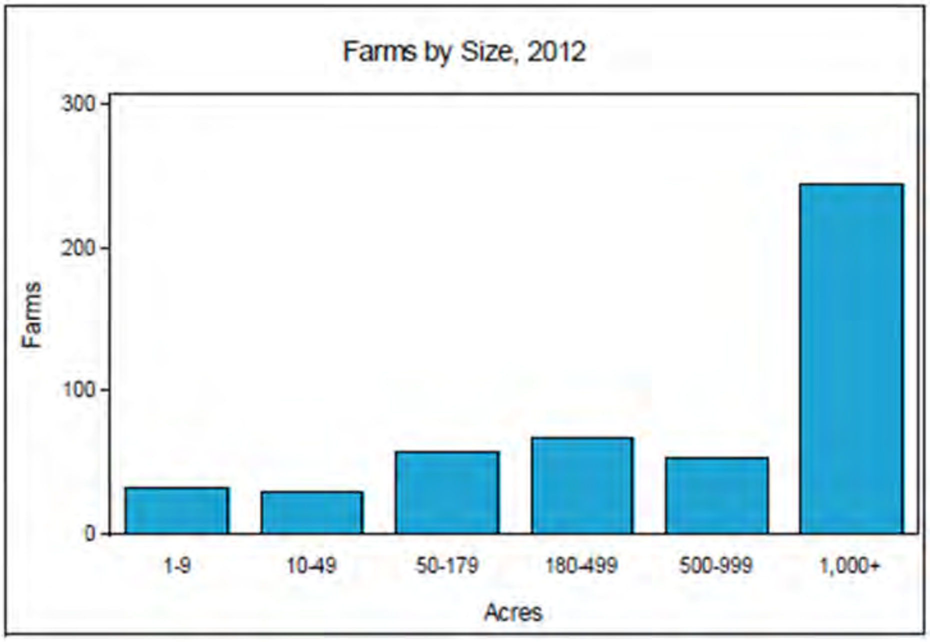
Source: United States Dept. of Agriculture, 2012

Figure 3: Dawson County Land in Farms by Land Use, 2012



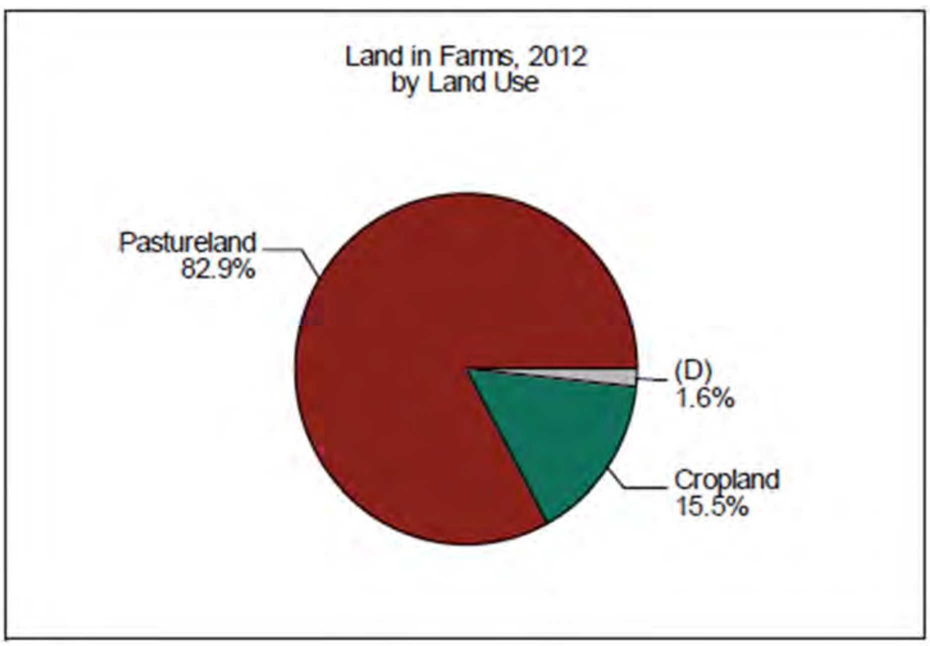
Source: United States Dept. of Agriculture, 2012

Figure 4: Dawson County Farms by Size, 2012



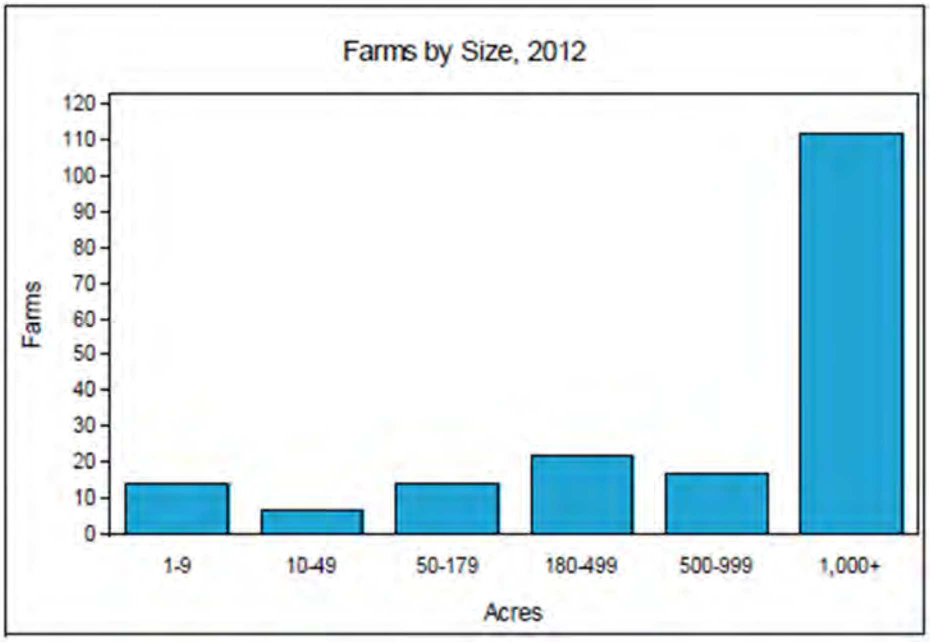
Source: United States Dept. of Agriculture, 2012

Figure 5: Prairie County Land in Farms by Land Use, 2012



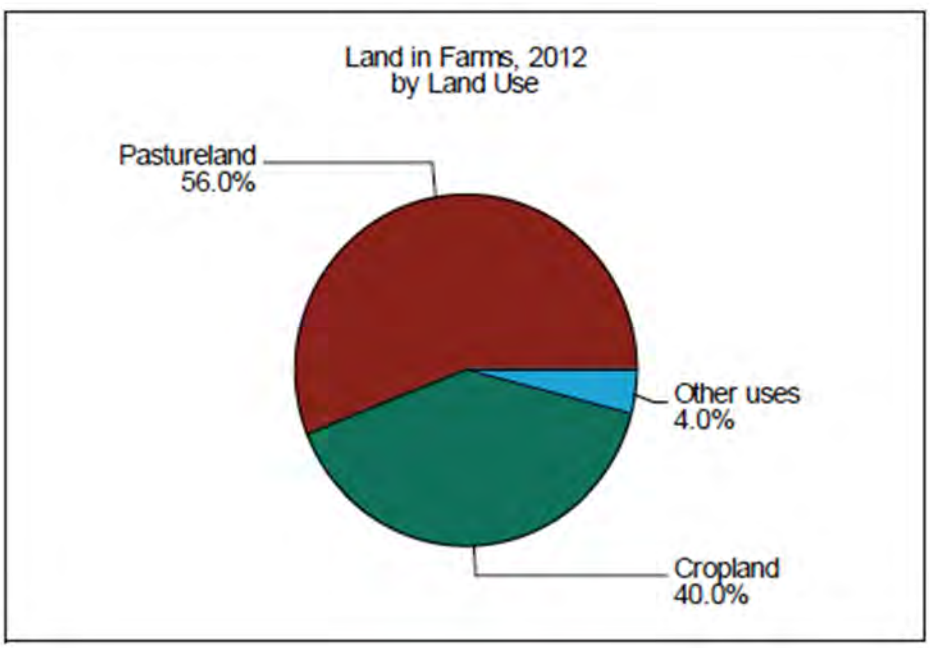
Source: United States Dept. of Agriculture, 2012

Figure 6: Prairie County Farms by Size, 2012



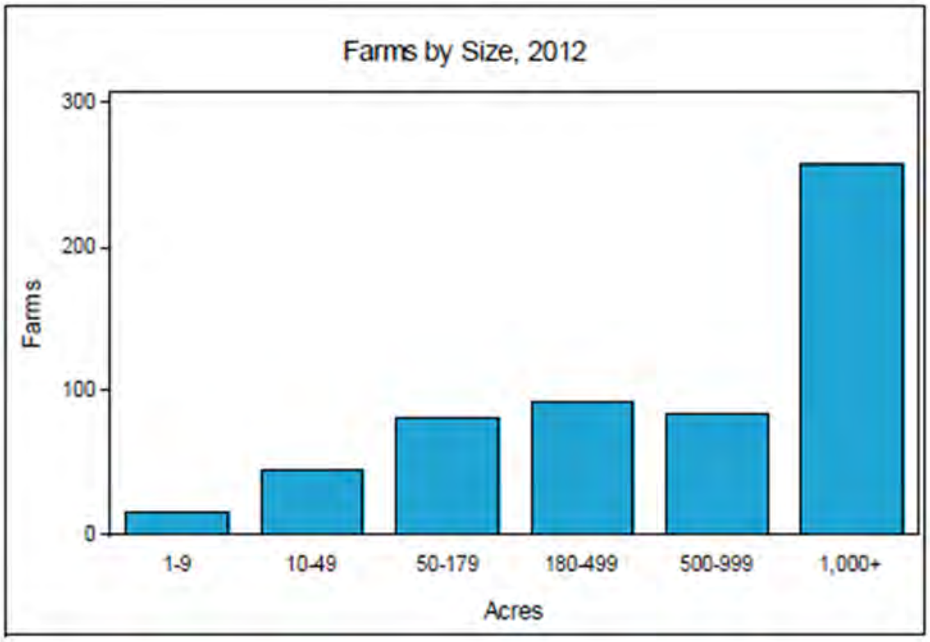
Source: United States Dept. of Agriculture, 2012

Figure 7: McKenzie County Land in Farms by Land Use, 2012



Source: United States Dept. of Agriculture, 2012

Figure 8: McKenzie County Farms by Size, 2012



Source: United States Dept. of Agriculture, 2012

Market Value of Products and Capital/Farm Equity

The market value of products sold represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the farm in 2012 (United States Department of Agriculture, 2012). The value of products from the 2012 harvest cannot be inferred from the market value of products sold because the values of products harvested in previous years, held in storage and sold in 2012 are also included into this market value. "Market value of agricultural products sold does not include payments received for participation in other federal farm programs. Also, it does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources" (United States Department of Agriculture, 2012).

McKenzie County, ND and Richland County, MT report some of the largest market values of products sold in Segment 1 as well as the River Corridor (Table 3). Yellowstone County in Segment 3 is the only county that shows a higher total value for agricultural products sold in 2012. The majority of the value is found in crops in McKenzie, Richland and Dawson Counties. Prairie County has the lowest total value of agricultural products sold with nearly an even division between the value of crops and the value of livestock. This ratio more closely represents the River Corridor, where the majority of the total value of agricultural products sold comes from livestock, poultry and their products (United States Department of Agriculture, 2012).

Table 3. Market Value of Products Sold in Segment 1, 2012 ($1,000)

	McKenzie	Richland	Dawson	Prairie	River Corridor Counties
Total value of agricultural products sold	114,448	139,166	80,365	31,194	1,035,226
value of crops including nursery and greenhouse	78,937	93,696	55,488	14,947	429,403
value of livestock, poultry and their products	35,510	45,470	24,877	16,247	605,823

Source: United States Dept. of Agriculture, 2012

Prairie County has the largest average per farm market value of land and buildings in Segment 1 (Table 4). This value is more similar to that of the counties in Segment 2 and Sweet Grass County in Segment 4. The estimated market value of all machinery and equipment is highest is Richland County, MT and McKenzie County, ND and lowest in Prairie County, MT (United States Department of Agriculture, 2012).

Table 4. Market Value of Farm Capital in Segment 1, 2012

	McKenzie	Richland	Dawson	Prairie
Market value of land and buildings \ Average per farm ($)	1,366,372	1,418,388	1,163,130	2,331,347
Estimated market value of all machinery and equipment \ Average per farm ($)	246,225	263,979	171,186	147,819

Source: United States Dept. of Agriculture, 2012

Government Payments

Government payments consist of "direct payments as defined by the 2008 Farm Bill; payments from Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), and Conservation Reserve Enhancement Program (CREP); loan deficiency payments; disaster payments; other conservation programs; and all other federal farm programs under which payments were made directly to farm operators" (United States Department of Agriculture, 2012). Government payments do not include Commodity Credit Corporation proceeds, the amount from State and local government agricultural program payments, and federal crop insurance payments (United States Department of Agriculture, 2012).

Richland and Dawson Counties, MT receive the highest government payments of the counties in Segment 1, with payments totaling more than $6 million and averaging slightly over $15 thousand per farm in Richland County and over $18 thousand per farm in Dawson County (Table 5). When compared to other counties in the River Corridor, McKenzie, Richland and Dawson Counties each receive the largest total government payments. Prairie County receives the smallest total government payment while McKenzie County receives the smallest government payment amount per farm in Segment 1 (United States Department of Agriculture, 2012).

Table 5. Government Payments Segment 1, 2012

	McKenzie	Richland	Dawson	Prairie	River Corridor Counties
Total ($)	4,116,000	6,117,000	6,390,000	1,749,000	32,789,000
Average per farm ($)	10,238	15,330	18,576	13,354	

Source: United States Dept. of Agriculture, 2012

Tax Revenue

The Montana Legislature has identified 14 different classes of property for property taxes, and agricultural land is one of the 14. Each class of property is valued differently. For example, agricultural land is valued differently than railroads. However, properties within each class, such as grazing land and tillable irrigated land, are valued the same. Agricultural land class is reappraised by the state every 6 years and is based on the productivity of the land. The last valuation cycle occurred in 2008. The productivity value is multiplied by the tax rate (2.63 percent for 2012) to determine the taxable value. Non-productive mining claims and non-qualified agricultural land are also included in the agricultural land class. Non-qualified agricultural land is defined as parcels of land between 20 to 160 acres, not used primarily for agricultural purposes. In 2012, these parcels were taxed at 18.41 percent. (Montana Department of Revenue, 2012).

Estimated tax revenues for each county in Segment 1 from agricultural land in 2012 are reported in Table 6. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue. Subtracting the average millage rate associated with the state revenue (0.101) from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Compared to the estimated total revenue for all counties in the River Corridor (excluding McKenzie County), the counties in Segment 1 receive a higher percentage of revenue from agricultural lands (Table 6). Prairie County in particular derives nearly 30% of total tax revenue from agriculture. Irrigated land accounts for 14% of revenue in Prairie County, 9% in Richland County and 12% in Dawson County. Over 70% of property tax revenue comes from sources other than agricultural land in Segment 1.

Table 6. Agricultural Property Tax Revenue for Counties in Segment 1, 2012 (in 2012 $)

	Richland		Dawson		Prairie		River Corridor Counties (MT only)*	
	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated Property Tax Revenue	% Total Property Tax Revenue
Agricultural Land	1,764,575	13%	1,675,072	19%	539,466	28%	12,607,835	5%
Tillable Irrigated	287,766	2%	108,747	1%	86,036	5%	2,247,812	1%
Tillable Non Irrigated	982,786	7%	1,007,498	11%	171,604	9%	3,363,055	1%
Grazing	401,416	3%	496,441	6%	257,178	13%	5,319,837	2%
Wild Hay	41,832	> 1%	36,683	> 1%	22,456	1%	616,523	> 1%
Non-Qualified Ag Land	50,979	> 1%	25,703	> 1%	2,192	> 1%	1,060,766	> 1%
Other	11,960,733	87%	7,228,296	81%	1,367,495	72%	259,597,393	95%
Total Property Revenue	13,725,307		8,903,368		1,906,961		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

*Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. (Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government). The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). To determine the secondary effects, a combination of input, output and employment multipliers are calculated and will vary depending on the defined local area. The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is defined as a functional economic area that includes primary labor markets and economic flows. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis all four counties in Segment 1, McKenzie County, ND and Richland, Dawson and Prairie Counties, MT, were included as the region. The year 2012 IMPLAN v3 county-level data profiles for these four counties were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- Employment represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- Labor Income includes employee wages and salaries, including income of sole proprietors and payroll benefits.

- Value Added measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of agriculture in the four-county area were estimated in IMPLAN using total output values for 19 agriculture-related sectors including among others grain farming, sugarcane and sugar beet farming, cattle ranching and dairy cattle and commercial logging. Economic contribution analyses address the importance or contribution of an existing industry to a local economy.

Table 7 summarizes the results of the contribution analysis for the four-county area. All results are presented in 2012 dollars. In 2012, agriculture in Segment 1 directly accounts for an estimated 2,800 jobs, $84.8 million in labor income, and $126.8 million in value added to the local economy. Secondary or multiplier effects of agriculture account for an additional estimated 600 jobs, $28.7 million in labor income, and $62.8 million in value added to the local economy. Accounting for both direct and secondary effects, agriculture in Segment 1 contributes an estimated total of 3,500 jobs, $113.5 million in labor income, and $189.6 million in value added to the local economy of the counties in Segment 1. Though agriculture contributes the greatest number of jobs in Segment 2, labor income and value added contributed by agriculture are highest in Segment 1.

Table 7. Contribution of Agriculture, Segment 1

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	2,800	$84.8	$126.8
Secondary Effects	600	$28.7	$62.8
Total Effect*	3,500	$113.5	$189.6

*Please note due to rounding, Total Effect reported may not be equal to the sum of Direct and Secondary Effects, as reported.

Segment 2

Historical Introduction

Similar to Segment 1, agriculture in Segment 2 has historically been a mix of both dryland and irrigated crops. Like the counties in Segment 1, the Homestead Act and Desert Land Act brought homesteaders into the three counties of Segment 2 (State Engineers Office, 1948). In 1886, the Miles City Irrigation and Ditch Company was formed. The Miles City Irrigation and Ditch Company, now the Tongue and Yellowstone River Irrigation District, remains in operation with 100 miles of canals pumping water to 9,400 acres and serving approximately 300 families, as of 2005 (Dickson, 2005). Crops grown within the irrigation district include alfalfa, corn and barley, vegetables, and orchard fruit (Dickson, 2005). In addition to the Tongue and Yellowstone Irrigation District, Cartersville Irrigation District was constructed in the early 1900s. The dam is located in Rosebud County and serves an area of about 12,000 acres (Tootell, 1932).

In addition to crops, cattle and sheep ranching has historically been a significant agricultural activity amongst the counties in Segment 2. Again the Enlarged Homestead Act, coupled with Eastern Montana's vast prairies, brought cattle ranchers to the area (State of Montana, 2014). Miles City was a part of the brief period (1880-1890) when thousands of cattle were brought in to stock the ranges created with the killing off of the buffalo. After a disastrous winter in 1886-1887 the open range rapidly disappeared and a more complex range of ranching and farming operations replaced open range ranching." Today, agriculture continues to be an important economic driver in this segment, and Eastern Montana. Both dryland and irrigation farming practices continue to be common practices in these counties. Additionally, cattle operations continue to be a driver of the economy in South Eastern Montana; both Custer and Rosebud Counties are in the top 10 counties for producing cattle and calves in the state of Montana, as of 2007 (United States Department of Agriculture, 2007).

Current Agricultural Statistics

The agricultural data presented here are representative of county level statistics. The River Corridor Counties column demonstrates the representative statistic for all the 12 counties in which Yellowstone River is located. As the size of the counties varies, so does the length of the river stretch contained within those counties. For example, Custer is a larger county compared to Treasure although the river stretch within the two counties is more similar to one another.

Between 1950 and 2012, the number of farms in Segment 2 decreased in each county (Tables 8 and 9). Counties in Segment 2 lost between 16-33% of the total number of farms during this time period. Land in farms decreased slightly in Custer County, but increased in Rosebud and Treasure Counties. While Treasure County saw a 33% decrease in the number of farms, it also experienced a 28% increase in the acreage of land in farms. It is likely that, similar to Segment 1, smaller farms were consolidated into larger farms, resulting in the increase in farmland acreage but decrease in total number of farms. Between 1949 and 2012, the number of irrigated acres decreased Rosebud County, increased slightly in Custer, while nearly doubling in Treasure County. (United States Department of Agriculture, 2012).

In both, 1950 and 2012, Custer and Rosebud Counties are comparable in the number of farms, although Rosebud has significantly more land in farms in both years (Table 9). In 2012, Rosebud County had the lowest acreage of irrigated land, 17,485 acres; this is comparable to Dawson County, MT in Segment 1

(17,151 acres). In 2012, irrigated agriculture accounts for 1.4 % of agricultural land use in Custer County, and about 3.5% in Rosebud and Treasure Counties (Table 9). While forage is the highest produced commodity in Custer County, Rosebud and Treasure Counties primarily grow wheat, as of 2012 (United States Department of Agriculture, 2012). Cattle and calves production are present within each county with 112 thousand head in Custer County, 95 thousand in Rosebud County and 28 thousand in Treasure County, according to the 2012 Agricultural Census.

Table 8. Agricultural Statistics for Segment 2, 1950

	Custer	Rosebud	Treasure	River Corridor Counties
Number of Farms	506	550	163	8,593
Land in farms (acres)	2,412,808	3,055,710	483,326	15,261,807
Land in farms\ Average size of farm (acres)	4,768	5,556	2,965	1,776
Irrigated land (farms)	254	173	97	4,149
Irrigated land (acres)*	25,541	20,556	11,405	421,408

Source: United States Dept. of Agriculture, 1950
*1949 values

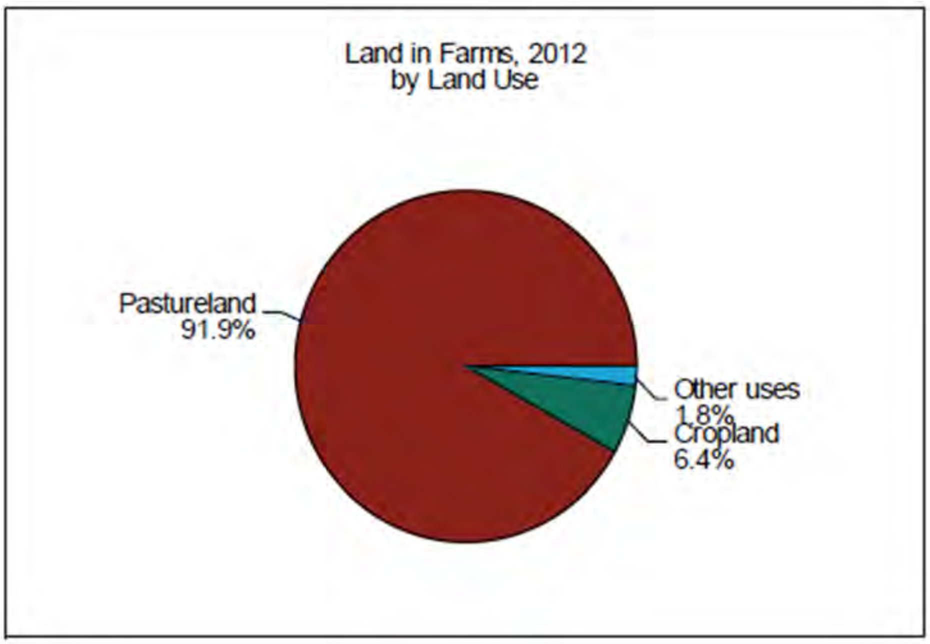
Table 9. Agricultural Statistics for Segment 2, 2012

	Custer	Rosebud	Treasure	River Corridor Counties
Number of Farms	423	437	109	6,303
Land in farms (acres)	2,189,930	3,141,524	617,635	15,232,307
Land in farms\ Average size of farm (acres)	5,177	7,189	5,666	2,416
Irrigated land (farms)	175	99	59	2,326
Irrigated land (acres)	30,315	35,894	21,907	457,531

Source: United States Dept. of Agriculture, 2012

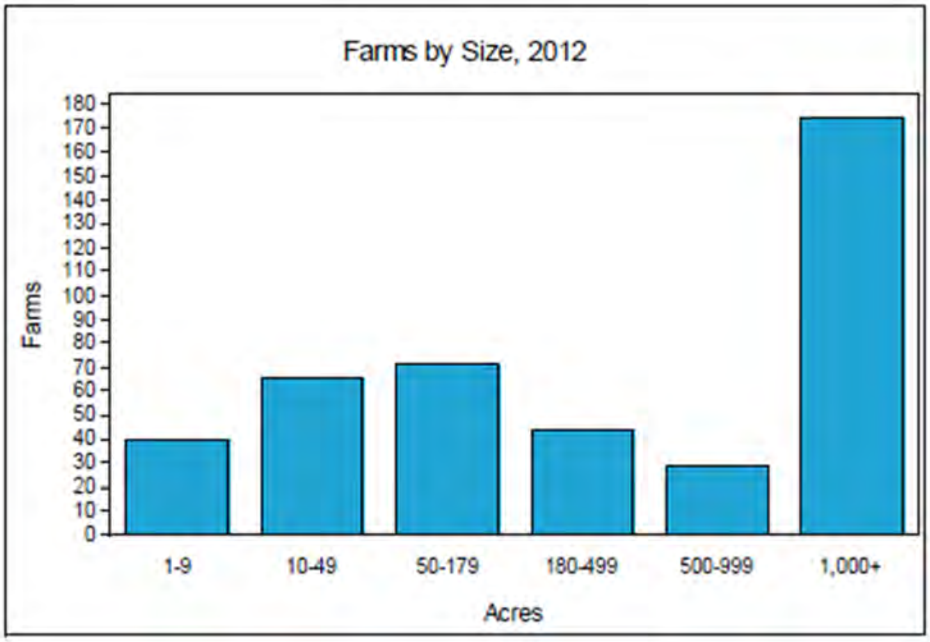
In Segment 2, nearly 90% of all land in farms was used for pastureland, in 2012 (Figures 9, 11, 13). Of the land in farms in Rosebud County, 5.4% is classified as woodland. Pastureland is defined by the agricultural census as grazable land that does not qualify as woodland pasture or cropland pasture. Pastureland may be irrigated or dry land. In some areas, it can be a high quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland. The Census of Agriculture defines woodland as planted woodlots or timer tracts, cutover and deforested land with young growth which has or will have value for wood products or woodland pastured. This category includes natural or woodland pasrture. Only two other counties in the River Corridor have land classified as woodland, Sweet Grass County, MT with 5.6% of land in farms classified as woodland and Park County, MT with 14.3% of land in farms classified as woodland. The majority of farms in the three counties of Segment 2 are 1000 acres or larger (Figures 10, 12, 14). This is similar to the distribution of farm size seen in Segment 1 (United States Department of Agriculture, 2012).

Figure 9. Custer County Land in Farms by Land Use, 2012



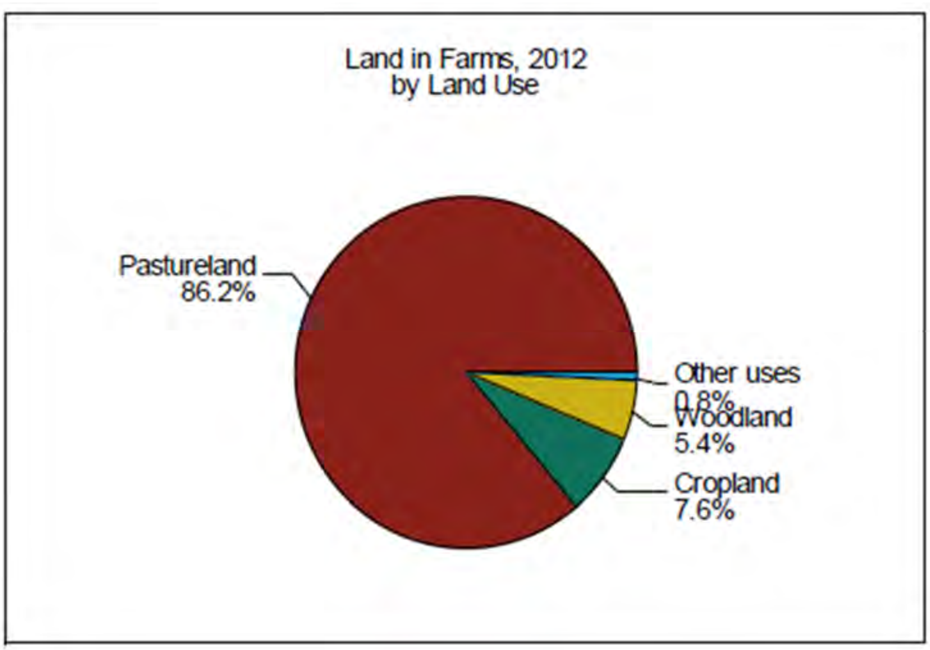
Source: United States Dept. of Agriculture, 2012

Figure 10. Custer County Farms by Size, 2012



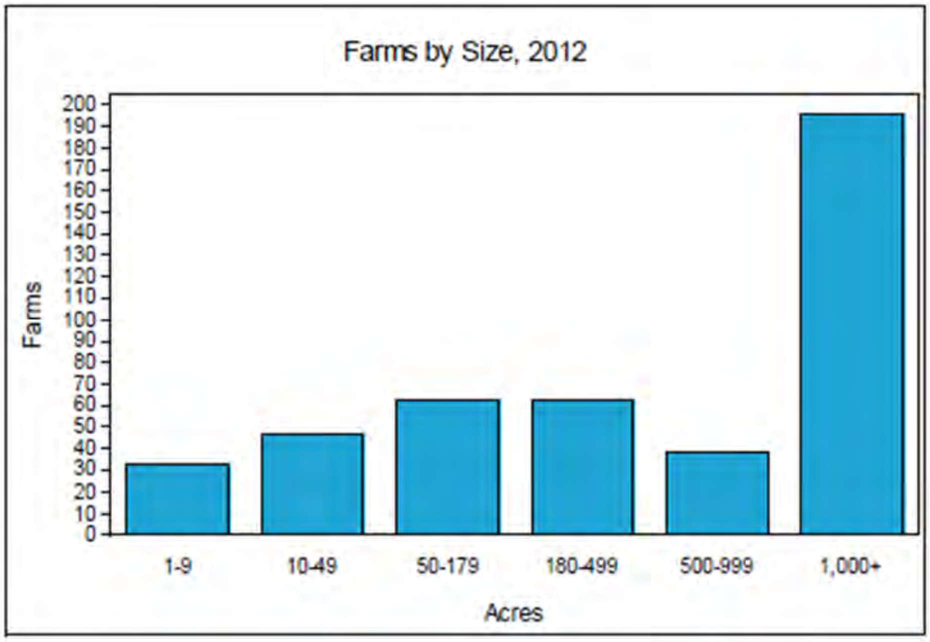
Source: United States Dept. of Agriculture, 2012

Figure 11. Rosebud County Land in Farms by Land Use, 2012



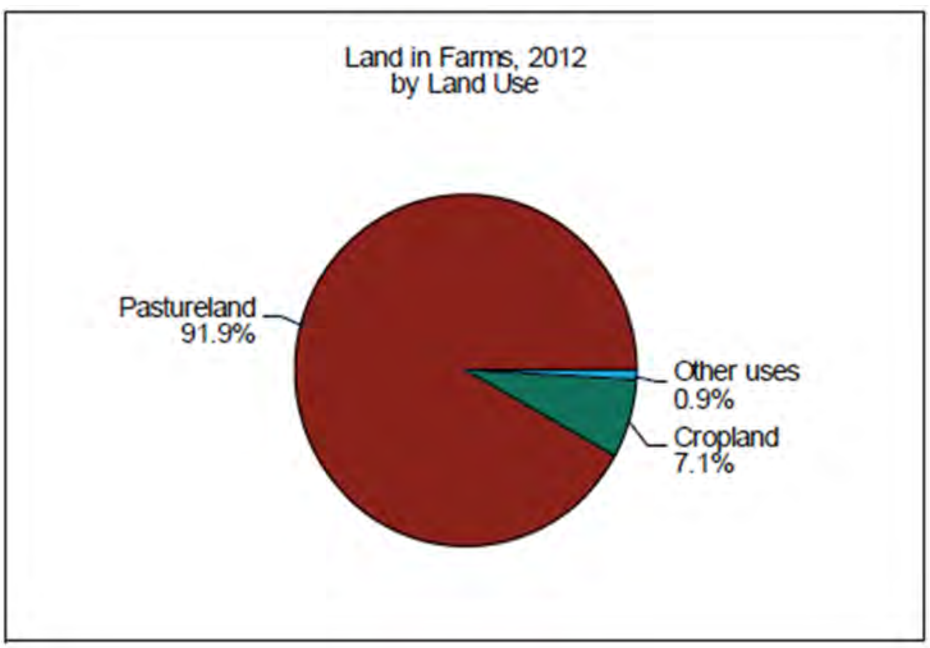
Source: United States Dept. of Agriculture, 2012

Figure 12. Rosebud County Farms by Size, 2012



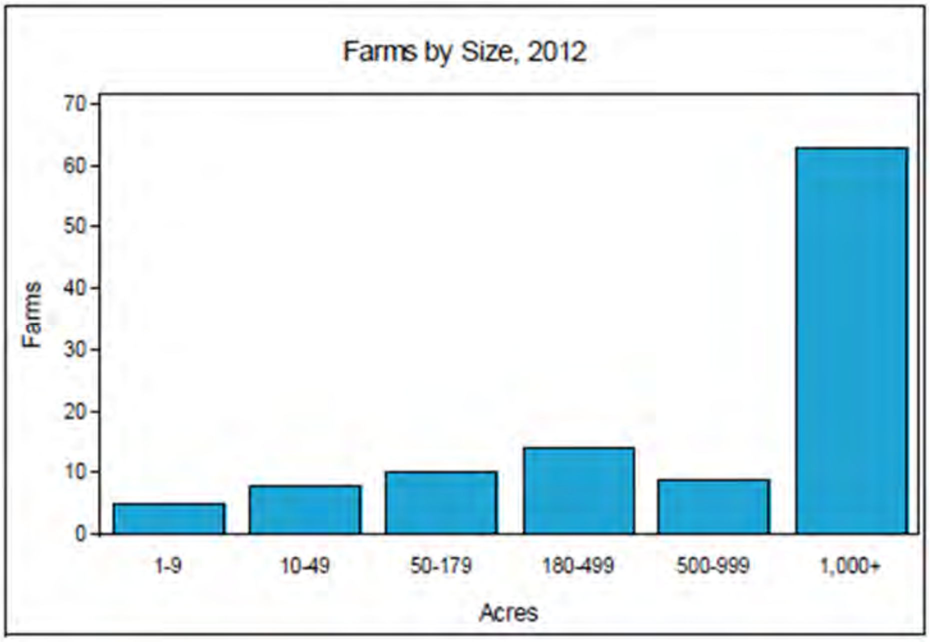
Source: United States Dept. of Agriculture, 2012

Figure 13. Treasure County Land in Farms by Land Use, 2012



Source: United States Dept. of Agriculture, 2012

Figure 14. Treasure County Farms by Size, 2012



Source: United States Dept. of Agriculture, 2012

Market Value of Farm Products and Capital/Farm Equity

The market value of products sold represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the farm in 2012 (United States Department of Agriculture, 2012). The market value of products sold also does not infer that the value of 2012 harvest; the values of products harvested in a previous year, held in storage and sold in 2012, are also included into this market value. "Market value of agricultural products sold does not include payments received for participation in other federal farm programs. Also, it does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources." (United States Department of Agriculture, 2012).

A large majority of the total value of agricultural products sold in Custer and Rosebud Counties is derived from livestock, poultry and their products (Table 10). The total value of agricultural products is more evenly distributed between crops and livestock in Treasure County (United States Department of Agriculture, 2012).

Table 10. Market Value of Products Sold in Segment 2, 2012 ($1,000)

	Custer	Rosebud	Treasure	River Corridor Counties
Total value of ag products sold	109,201	91,739	46,565	1,035,226
value of crops including nursery and greenhouse	21,165	25,759	22,387	429,403
value of livestock, poultry and their products	88,036	65,981	24,178	605,823

Source: United States Dept. of Agriculture, 2012

The market value of land and buildings is similar in Rosebud County and Treasure County, with a per farm average of nearly $3 million. This value is most similar to that of Park County, MT ($3,502,195) and Sweet Grass County, MT ($ 2,771,481). These five counties show the largest average per farm market value of land and buildings across all River Corridor counties. In Segment 2, the average per farm estimated market value of all machinery and equipment in Treasure County is more than double that of Custer or Rosebud Counties. Within the River Corridor, the highest average per farm market value of machinery and equipment is in Treasure County (Table 11) (United States Department of Agriculture, 2012).

Table 11. Market Value of Farm Capital in Segment 2, 2012

	Custer	Rosebud	Treasure
Market value of land and buildings \ Average per farm ($)	2,082,524	2,970,357	2,847,427
Estimated market value of all machinery and equipment \ Average per farm ($)	132,859	141,041	329,849

Source: United States Dept. of Agriculture, 2012

Government Payments

Government payments consist of "direct payments as defined by the 2008 Farm Bill; payments from Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), and Conservation Reserve Enhancement Program (CREP); loan deficiency payments; disaster payments; other conservation programs; and all other federal farm programs under which payments were made directly to farm operators" (United States Department of Agriculture, 2012). Government payments do not include Commodity Credit Corporation proceeds, amount from State and local government agricultural program payments, and federal crop insurance payments (United States Department of Agriculture, 2012).

Custer and Rosebud Counties each received close to $2 million in total government payments, in 2012. Treasure County received only a quarter of that amount, $548 thousand. On an average per farm basis, the payment varied from $9 thousand to almost $15 thousand in the three counties (see Table 12). These average per farm payments are similar to those seen in Segment 1 (United States Department of Agriculture, 2012).

Table 12. Government Payments, 2012

	Custer	Rosebud	Treasure	River Corridor Counties
Total ($)	1,847,000	2,043,000	548,000	32,789,000
Average per farm ($)	10,738	14,806	8,990	

Source: United States Dept. of Agriculture, 2012

Tax Revenue

Montana legislature determined 14 different classes of property for property taxes, and agricultural land is one of the 14. Each class of property is valued differently. For example, agricultural land is valued differently than railroads. However, properties within each class, such as grazing land and tillable irrigated land are valued the same. Agricultural land class is reappraised by the state every 6 years based on productivity of the land. The last valuation cycle took place in 2008. The phased-in productivity value is multiplied by the tax rate at 2.63 percent for 2012 to determine the taxable value. The Montana Department of Revenue reports that non-productive mining claims and non-qualified agricultural land are also included in the agricultural land class. Non-qualified agricultural land is defined as parcels of land between 20 to 160 acres, not used primarily for agricultural purposes. These parcels are taxed at 18.41 percent in 2012 (Montana Department of Revenue, 2012).

Estimated 2012 tax revenues for each county in Segment 2 from agricultural land class are reported in Table 13. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue.

Subtracting the average millage rate associated with the state revenue (0.101), from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Although Rosebud County has the largest number of farms, the greatest acreage of land in farms, and receives the highest number of total and per farm government payments in Segment 2, only 3% of its total county revenue comes from agriculture. Custer and Treasure Counties both receive about 20% of tax revenue from agricultural property taxes, a large portion of which comes from grazing (Table 13). This is similar to the tax revenue derived from agricultural property seen in Dawson and Prairie Counties located in Segment 1. Aside from these four counties, the remaining counties within the River corridor received less revenue from agricultural property taxes as compared to their total property tax revenue (Montana Department of Revenue, 2012).

Table 13. Agricultural Property Tax Revenue in Segment 2, 2012 (In 2012 $)

	Custer		Rosebud		Treasure		River Corridor Counties*	
	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated Property Tax Revenue	% Total Property Tax Revenue
Agricultural Land	1,419,691	19%	1,608,416	3%	460,133	22%	12,607,835	5%
Tillable Irrigated	186,245	3%	191,620	> 1%	153,231	7%	2,247,812	1%
Tillable Non Irrigated	167,518	2%	306,378	1%	27,570	1%	3,363,055	1%
Grazing	909,354	12%	974,687	2%	246,225	12%	5,319,837	2%
Wild Hay	64,295	1%	77,166	> 1%	26,515	1%	616,523	> 1%
Non-Qualified Ag Land	92,279	1%	58,566	> 1%	6,593	> 1%	1,060,766	> 1%
Other	5,886,228	81%	44,994,714	97%	1,592,915	78%	259,597,393	95%
Total Property Revenue	7,305,919		46,603,130		2,053,048		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

*Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis all three counties in Segment 2, Custer, Rosebud and Treasure Counties, MT, were included as the region. The year 2012 IMPLAN v3 county-level data profiles for these three counties were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- Employment represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- Labor Income includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- Value Added measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of agriculture in the three-county area were estimated in IMPLAN using total output values for 19 agriculture-related sectors including grain farming, tree nut and fruit farming,

animal production and commercial logging. Economic contribution analyses address the importance or contribution of an existing industry to a local economy.

Table 14 summarizes the results of the contribution analysis for the three-county area. All results are presented in 2012 dollars. Labor income and value added are presented in 2012 dollars. In 2012, agriculture in Segment 2 directly accounts for an estimated 4,200 jobs, $74.1 million in labor income, and $97.0 million in value added to the local economy. Secondary or multiplier effects of agriculture account for an additional estimated 500 jobs, $17.6 million in labor income, and $38.4 million in value added to the local economy. Accounting for both direct and secondary effects, agriculture in Segment 2 contributes an estimated total of 4,800 jobs, $91.6 million in labor income, and $135.4 million in value added to the local economy of the counties in Segment 2. Segment 2 has the highest number of jobs contributed by agriculture to the local economy in the River Corridor.

Table 14. Contribution of Agriculture, Segment 2

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	4,200	$74.1	$97.0
Secondary Effects	500	$17.6	$38.4
Total Effect*	4,800	$91.6	$135.4

*Please note due to rounding, Total Effect reported may not equal than the sum of Direct and Secondary Effects, as reported.

Segment 3

Historical Overview

Outside of Billings, MT is another large irrigation project, the Huntley Project. The Huntley Project was not created as a result of growth, but rather prompted agricultural growth in this area (Dick, 1996). Land was originally purchased by the United States Government from the Crow Indian Reservation and following the acquisition and development of the Huntley Project, was opened to homesteading. Following its establishment in 1907, land served by the Huntley Project was opened and 585 farm units were available to homesteaders. In total, the project serves three irrigation districts, covering 27,000 acres of land, and consists of a 32 mile main canal (Dick, 1996).

Billings, MT is home to a sugar beet refinery, owned by the Western Sugar Cooperative, which processes beets grown in south central Montana (The Western Sugar Cooperative, 2006). In addition to the sugar beet refinery, two livestock auctions are located in Billings, Public Auction Yard and the Billings Live Stock Commission (BLS). Founded in 1934, BLS is one of the oldest continuous livestock operations and holds both cattle and horse auctions today (Billings Live Stock Commission, 2014). Yellowstone County remains an important producer and distribution point for agricultural products today.

Current Agricultural Statistics

The agricultural data presented here are representative of county level statistics. The River Corridor Counties column demonstrates the representative statistic for all the 12 counties in which Yellowstone River is located. As the size of the counties varies, so does the length of the river stretch contained within those counties. Yellowstone County contains the longest stretch of the river.

From 1950 to 2012, Yellowstone County experienced changes in the county's agricultural sector. The number of farms decreased from 1,475 to 1,330 while the land in farms increased from 1,581,320 to 1,668,346. The number of irrigated farms decreased by about 45%, while acres in irrigated land decreased 17% (see Tables 15 and 16). Yellowstone County produced the largest number of cattle and calves in 2012, as compared to other counties in the River Corridor. The top producing crop in the county is wheat, covering nearly 100 thousand acres of production (United States Department of Agriculture, 2012).

Table 15. Agricultural Statistics for Segment 3, 1950

	Yellowstone	River Corridor Counties
Number of Farms	1,475	8,593
Land in farms (acres)	1,581,320	15,261,807
Land in farms\ Average size of farm (acres)	1,072	1,776
Irrigated land (farms)	1,134	4,149
Irrigated land (acres)*	88,409	421,408

Source: United States Dept. of Agriculture, 1950
*1949 values

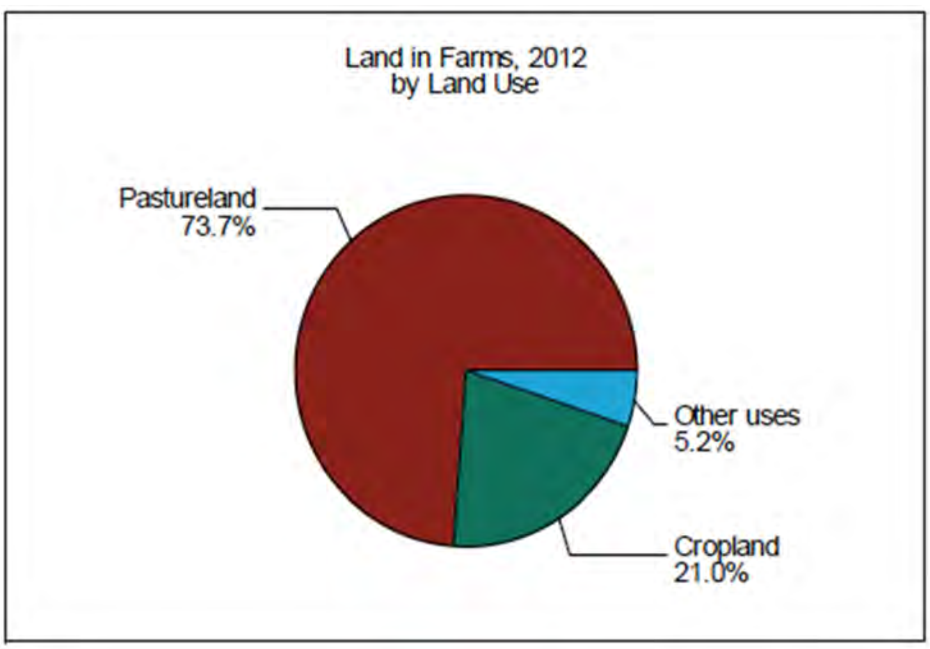
Table 16. Agricultural Statistics for Segment 3, 2012

	Yellowstone	River Corridor
Number of Farms	1,330	6,303
Land in farms (acres)	1,668,346	15,232,307
Land in farms\ Average size of farm (acres)	1,254	2,416
Irrigated land (farms)	636	2,326
Irrigated land (acres)	73,161	457,531

Source: United States Dept. of Agriculture, 2012

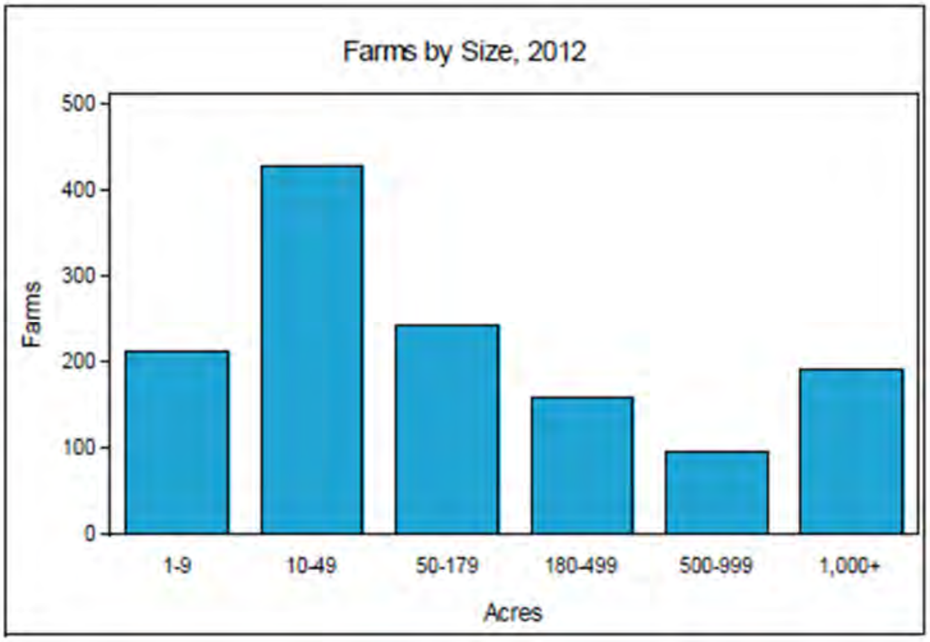
Pastureland accounts for close to 74% of land in farms within the county (see Figure 15). Unlike most counties in the River Corridor where the average farm size is 1,000 acres or greater, the majority of the farms in Yellowstone County are between 1-179 acres (Figure 16) (United States Department of Agriculture, 2012). Pastureland is defined by the agricultural census as grazable land that does not qualify as woodland pasture or cropland pasture. Pastureland may be irrigated or dry land. In some areas, it can be a high quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland.

Figure 15. Yellowstone County Land in Farms by Land Use, 2012



Source: United States Dept. of Agriculture, 2012

Figure 16. Yellowstone County Farms by Size, 2012



Source: United States Dept. of Agriculture, 2012

Market Value of Farm Products and Capital/Farm Equity

The market value of products sold is a category that represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the place in 2012 (Agricultural Census, 2012). The market value of products sold also does not infer the value of 2012 harvest. Values of products harvested in a previous year, held in storage and sold in 2012, are also included into this market value. "Market value of agricultural products sold does not include payments received for participation in other federal farm programs. Also, it does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources" (United States Department of Agriculture, 2012). A higher percentage of the total value of agricultural products sold comes from livestock in Yellowstone County than in the rest of the River Corridor counties (Table 17). The average per farm market value of land and buildings in Yellowstone County is slightly less than $1 million (see Table 18) (United States Department of Agriculture, 2012).

Table 17. Market Value of Products Sold in Segment 3, 2012 ($1,000)

	Yellowstone	River Corridor
Total value of agricultural products sold	216,815	1,035,226
value of crops including nursery and greenhouse	60,667	429,403
value of livestock, poultry and their products	156,148	605,823

Source: United States Dept. of Agriculture, 2012

Table 18. Market Value of Farm Capital in Segment 3, 2012

	Yellowstone
Market value of land and buildings \ Average per farm ($)	957,953
Estimated market value of all machinery and equipment \ Average per farm ($)	95,176

Source: United States Dept. of Agriculture, 2012

Government Payments

Government payments consist of "direct payments as defined by the 2008 Farm Bill; payments from Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), and Conservation Reserve Enhancement Program (CREP); loan deficiency payments; disaster payments; other conservation programs; and all other federal farm programs under which payments were made directly to farm operators" (Agricultural Census, 2012). Government payments do not include Commodity Credit Corporation proceeds, the amount from State and local government agricultural program payments, and federal crop insurance payments (United States Department of Agriculture, 2012).

Table 19 shows payments received by agricultural producers in Yellowstone County. Payments in Yellowstone County are similar to the median payment received by other counties in the River Corridor.

Table 19: Government Payments in Segment 3, 2012

	Yellowstone	River Corridor
Total ($)	3,843,000	32,789,000
Average per farm ($)	9,559	

Source: United States Dept. of Agriculture, 2012

Tax Revenue

Montana legislature determined 14 different classes of property for property taxes, and agricultural land is one of the fourteen classifications. Each class of property is valued differently. For example, agricultural land is valued differently than railroads. However, properties within each class, such as grazing land and tillable irrigated land are valued the same. Agricultural land class is reappraised by the state every 6 years based on productivity of the land. The last valuation cycle took place in 2008. The phased-in productivity value is multiplied by the tax rate at 2.63 percent for 2012 to determine the taxable value. Non-productive mining claims and non-qualified agricultural land are also included in the agricultural land class. Non-qualified agricultural land is defined as parcels of land between 20 to 160 acres, not used primarily for agricultural purposes. These parcels are taxed at 18.41 percent in 2012 (Montana Department of Revenue, 2012).

Estimated tax revenues for each county in Segment 3 in 2012 from agricultural land class are reported in Table 19. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue. Subtracting the average millage rate associated with the state revenue (0.101), from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

As shown in Table 20, agricultural land produces about 1% of the total tax revenue in Yellowstone County. This is below the 5% average, as seen across the River Corridor.

Table 20. Agricultural Property Tax Revenue in Segment 3, 2012 (in 2012 $)

	Yellowstone		River Corridor Counties *	
	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated Property Tax Revenue	% Total Property Tax Revenue
Agricultural Land	1,562,636	1%	12,607,835	5%
Tillable Irrigated	365,531	> 1%	2,247,812	1%
Tillable Non Irrigated	380,852	> 1%	3,363,055	1%
Grazing	483,163	> 1%	5,319,837	2%
Wild Hay	40,279	> 1%	616,523	> 1%
Non-Qualified Ag Land	292,810	> 1%	1,060,766	> 1%
Other	132,029,704	99%	259,597,393	95%
Total Property Revenue	133,592,340		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis Yellowstone County, MT was included as the region. The year 2012 IMPLAN v3 county-level data profiles for the county were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- Employment represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- Labor Income includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- Value Added measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of agriculture in the one-county area were estimated in IMPLAN using total output values for 19 agriculture-related sectors including grain farming, tree nut and fruit farming, animal production and commercial logging . Economic contribution analyses address the importance or contribution of an existing industry to a local economy.

Table 21 summarizes the results of the contribution analysis. All results are presented in 2012 dollars. In 2012, agriculture in Segment 3 directly accounts for an estimated 1,600 jobs, $28.9 million in labor income, and $49.9 million in value added to the local economy. Secondary or multiplier effects of agriculture account for an additional estimated 500 jobs, $21.1 million in labor income, and $42.6 million in value added to the local economy. Accounting for both direct and secondary effects, agriculture in Segment 3 contributes an estimated total of 2,100 jobs, $50.0 million in labor income, and $92.5 million in value added to the local economy of Yellowstone County, MT. Agriculture contributes the fewest jobs in Segment 3, as compared to the other segments of the River Corridor.

Table 21. Analysis of Agricultural Contribution, Segment 3

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	1,600	$28.9	$49.9
Secondary Effects	500	$21.1	$42.6
Total Effect*	2,100	$50.0	$92.5

*Please note due to rounding, Total Effect reported may not be equal to the sum of Direct and Secondary Effects, as reported.

Segment 4

Historical Overview

Similar to other segments along the River Corridor, the formation of irrigation ditches along with the Enlarged Homestead Act and Desert Act led to the development of the counties in Segment 4 (City of Columbus Montana, 2012). Specifically, the Columbus Irrigation Project (1906-1938) and the Columbus Water Users Association Stillwater County (formed in 1938), promoted the development of agriculture in Stillwater County, MT (City of Columbus Montana, 2012).

Unlike other counties along the River Corridor, the base of agriculture in Sweet Grass County, MT has historically been sheep and wool production (Sweet Grass County, 2003), and as of 2007, Sweet Grass County remained in the top ten counties for sheep production in the State of Montana (Sweet Grass County, 2009). Though agriculture is, and has been, important in the development of the counties in Segment 4, mining has played an even greater role, which makes the counties in Segment 4, along with Rosebud County in Segment 2, somewhat unique as compared to the rest within the River Corridor (Sweet Grass County, 2009).

Current Agricultural Statistics

The agricultural data presented here are representative of county level statistics. The River Corridor Counties column demonstrates the representative statistic for all the 12 counties in which Yellowstone River is located. As the size of the counties varies, so does the length of the river stretch contained within those counties. For example, Carbon is a large county but with only a short section of the Yellowstone River.

Unlike other segments in the River Corridor, the counties that make up Segment 4 experienced a smaller change in the number of farms and acres in agricultural production between 1950 to 2012. The number of farms decreased in all three counties, while the land in farms increased in Carbon County, decreased in Stillwater County, and remained stable in Sweet Grass. Average farm size remained relatively unchanged in Stillwater and Sweet Grass, and increased by about 70% in Carbon County. From 1949 to 2012, the number of irrigated farms decreased significantly (between 42-45%) while irrigated acres saw only a smaller decrease (between 7-23%), Tables 22 and 23. In 2012, the main crop produced in Carbon and Sweet Grass Counties was forage while in Stillwater County it was wheat. Carbon County had the largest number of cattle and calves in 2012 with 72,073 head as compared to 42,642 and 37,962 head in Stillwater and Sweet Grass Counties, respectively (United States Department of Agriculture, 2012).

Table 22. Agricultural Statistics for Segment 4, 1950

	Carbon	Stillwater	Sweet Grass	River Corridor Counties
Number of Farms	998	647	384	8,593
Land in farms (acres)	652,287	901,132	855,125	15,261,807
Land in farms\ Average size of farm (acres)	654	1,393	2,227	1,776
Irrigated land (farms)	787	314	263	4,149
Irrigated land (acres)*	80,847	28,305	38,335	421,408

Source: United States Dept. of Agriculture, 1950
*1949 values

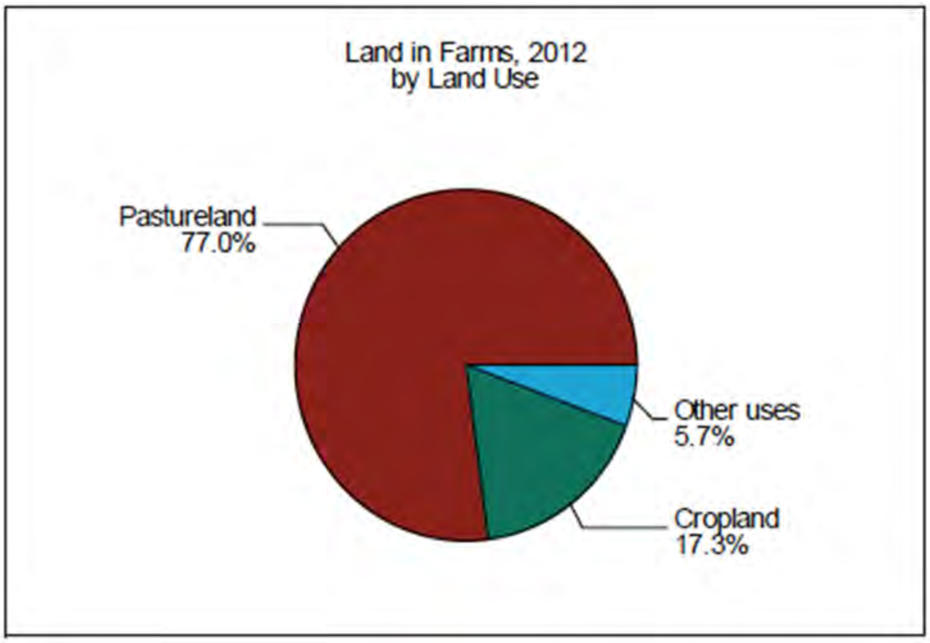
Table 23. Agricultural Statistics for Segment 4, 2012

	Carbon	Stillwater	Sweet Grass	River Corridor Counties
Number of Farms	726	593	332	6,303
Land in farms (acres)	791,295	809,443	855,709	15,232,307
Land in farms\ Average size of farm (acres)	1,090	1,365	2,577	2,416
Irrigated land (farms)	431	179	152	2,326
Irrigated land (acres)	72,781	21,557	35,770	457,531

Source: United States Dept. of Agriculture, 2012

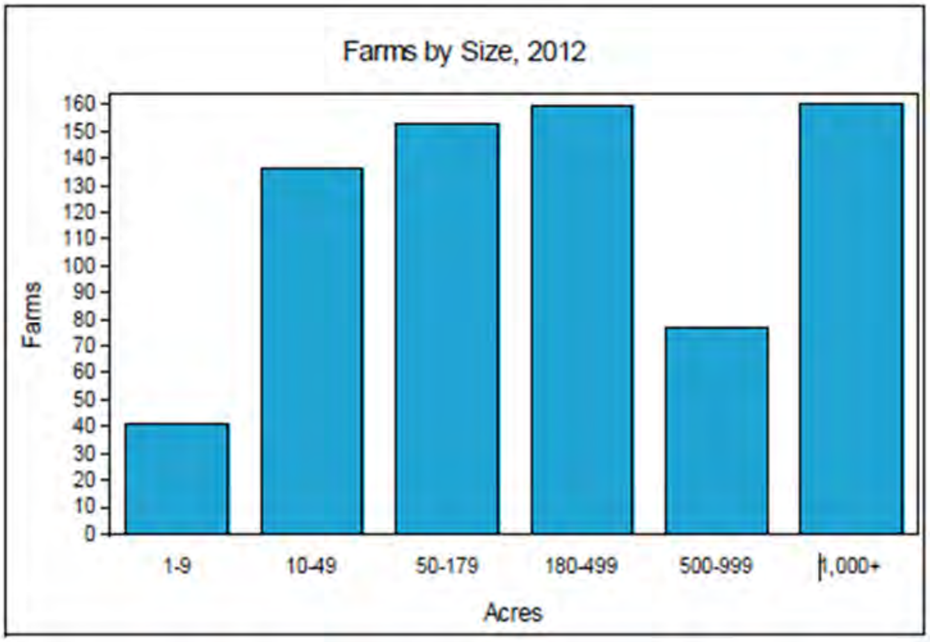
Similarly to other segments in the River Corridor, the majority of the land in farms is pastureland, with over 70% classified as such in each county (Figures 17, 19, and 21). Pastureland is defined by the agricultural census as grazable land that does not qualify as woodland pasture or cropland pasture. Pastureland may be irrigated or dry land. In some areas, it can be a high quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland. The Census of Argiculture defines woodland as planted woodlots or timer tracts, cutover and deforested land with young growth which has or will have value for wood products or woodland pastured. This category includes natural or woodland pasrture. In 2012, 5.6% of land in farms was considered woodland in Sweet Grass County. The other two counties in the River Corridor that have land use classified as woodland are Rosebud (5.4%) and Park (14.3%) Counties. The distribution of farm size in this segment varies. For example, the majority of farms in Carbon and Stillwater Counties are between 10-499 acres, although there is also a large number of farms 1000 acres and over (Figures 18, 20, and 22). The majority of the farms in Sweet Grass County are over 1000 acres, which is more representative of other counties in the River Corridor (United States Department of Agriculture, 2012).

Figure 17. Carbon County Land in Farms by Land Use, 2012



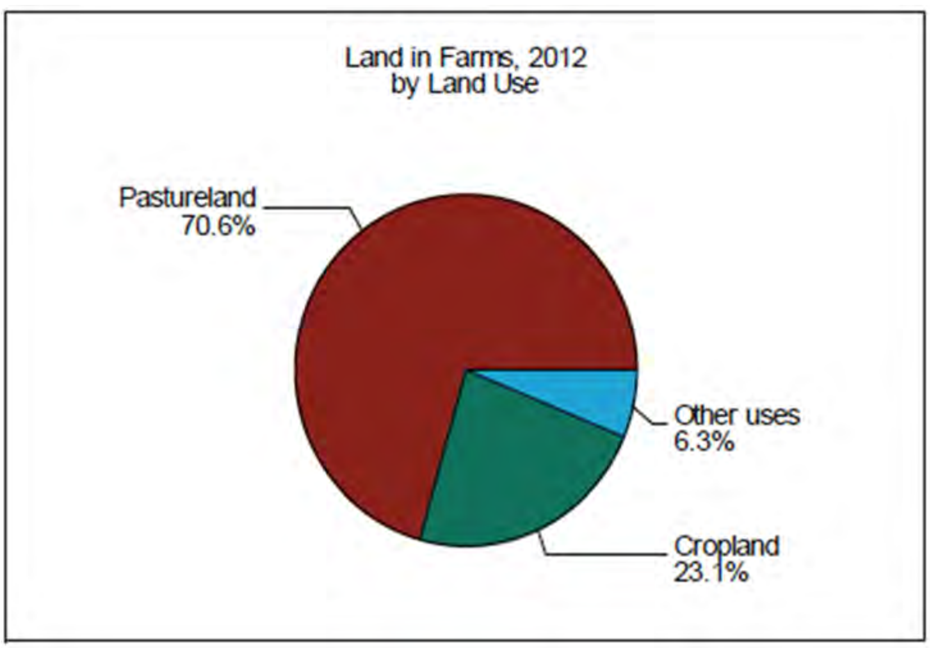
Source: United States Dept. of Agriculture, 2012

Figure 18. Carbon County Farms by Size, 2012



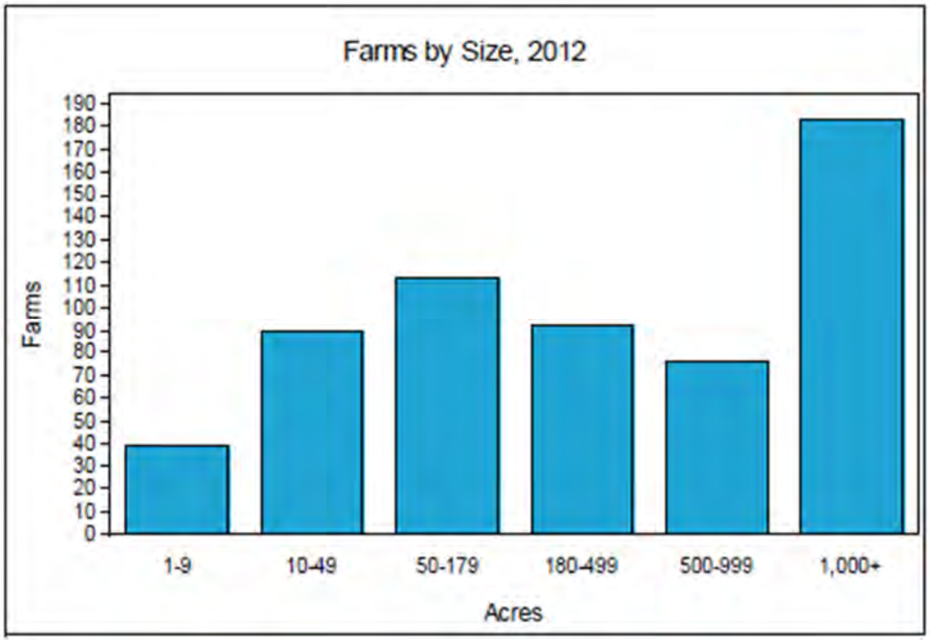
Source: United States Dept. of Agriculture, 2012

Figure 19. Stillwater County Land in Farms by Land Use, 2012



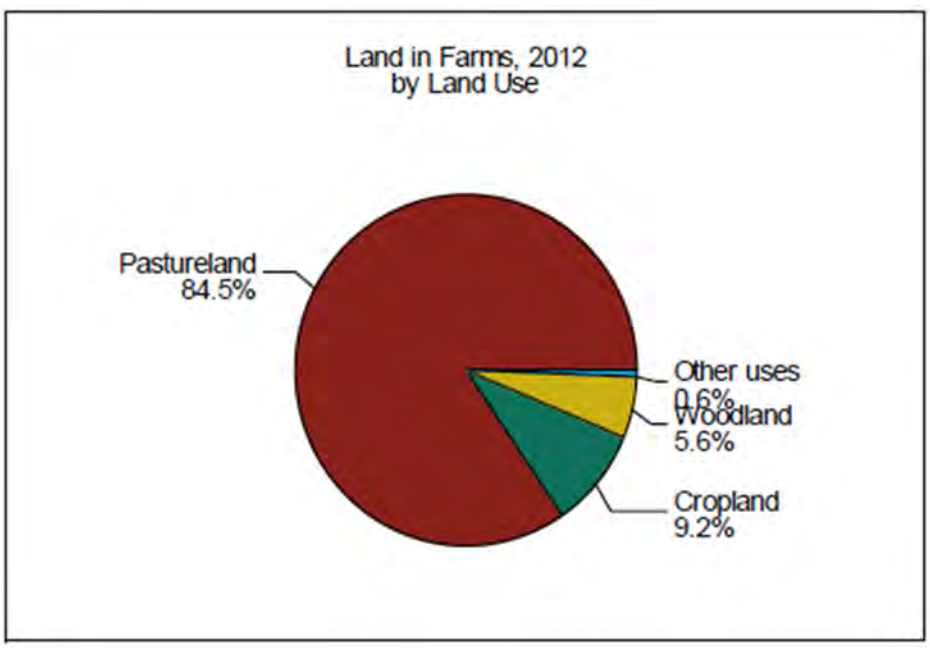
Source: United States Dept. of Agriculture, 2012

Figure 20. Stillwater County Farms by Size, 2012



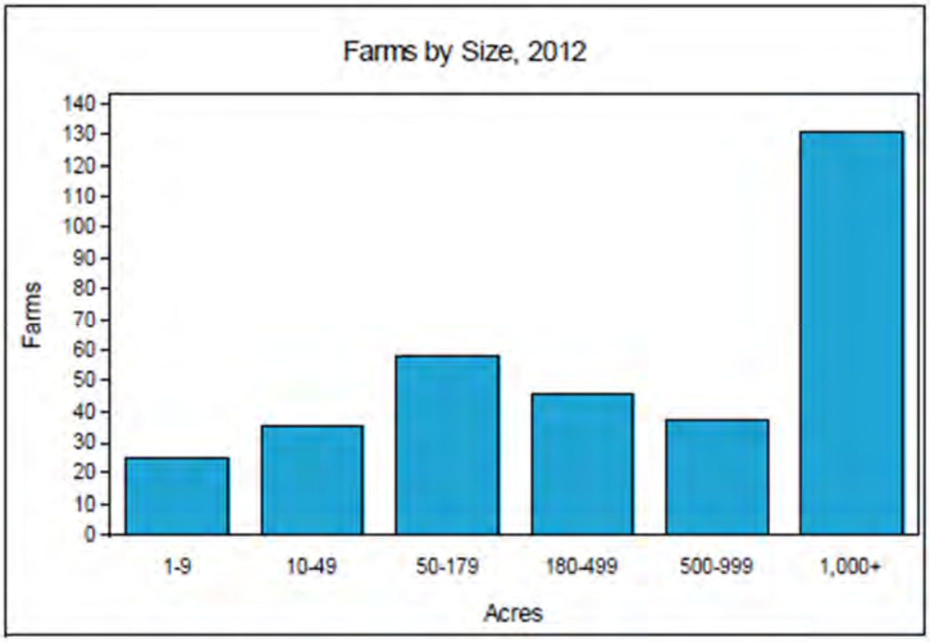
Source: United States Dept. of Agriculture, 2012

Figure 21. Sweet Grass County Land in Farms by Land Use, 2012



Source: United States Dept. of Agriculture, 2012

Figure 22. Sweet Grass County Farms by Size, 2012



Source: United States Dept. of Agriculture, 2012

Market Value of Farm Products and Capital/Farm Equity

The market value of products sold is a category that represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the place in (United States Department of Agriculture, 2012). The market value of products sold also does not infer the value of the 2012 harvest. Values of products harvested in a previous year, held in storage and sold in 2012, are also included into this market value. “Market value of agricultural products sold does not include payments received for participation in other federal farm programs. Also, it does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources” (United States Department of Agriculture, 2012).

Of the three counties in Segment 4, Carbon County had the highest market value of products sold in 2012, valued at nearly $77 million, with $50 million in value from livestock, poultry and their products Table 24). Sweet Grass County had the lowest market value of all three counties in the segment.

Table 24. Market Value of Products Sold in Segment 4, 2012 ($1,000)

	Carbon	Stillwater	Sweet Grass	River Corridor Counties
Total value of ag products sold	76,862	56,888	33,496	1,035,226
value of crops including nursery and greenhouse	25,966	12,989	4,276	429,403
value of livestock, poultry and their products	50,896	43,898	29,221	605,823

Source: United States Dept. of Agriculture, 2012

Though Sweet Grass County had the lowest value of agricultural products sold, it has the highest average per farm market value of land and buildings. Carbon County had the highest estimated market value of machinery and equipment (see Table 25) (United States Department of Agriculture, 2012).

Table 25. Market Value of Capital in Segment 4, 2012

	Carbon	Stillwater	Sweet Grass
Market value of land and buildings \ Average per farm ($)	1,283,405	1,905,004	2,771,481
Estimated market value of all machinery and equipment \ Average per farm ($)	115,977	84,404	105,374

Source: United States Dept. of Agriculture, 2012

Government Payments

Government payments consist of "direct payments as defined by the 2008 Farm Bill; payments from Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), and Conservation Reserve Enhancement Program (CREP); loan deficiency payments; disaster payments; other conservation programs; and all other federal farm programs under which payments were made directly to farm operators" (Agricultural Census, 2012). Government payments do not include Commodity Credit Corporation proceeds, the amount of State and local government agricultural program payments, and federal crop insurance payments(United States Department of Agriculture, 2012).

Stillwater County receives the largest amount of total government payment in this segment. However, the average per farm payments in all counties within Segment 4 is similar to payments in other counties along the River Corridor (Table 26).

Table 26. Government Payments in Segment 4, 2012

	Carbon	Stillwater	Sweet Grass	River Corridor Counties
Total ($)	1,696,000	2,997,000	689,000	32,789,000
Average per farm ($)	6,625	11,892	8,305	

Source: United States Dept. of Agriculture, 2012

Tax Revenue

Montana legislature determined 14 different classes of property for property taxes, agricultural land being one of the fourteen classifications. Each class of property is valued differently. For example, agricultural land is valued differently than railroads. However, properties within each class, such as grazing land and tillable irrigated land are valued the same. Agricultural land class is reappraised by the state every 6 years based on productivity of the land. The last valuation cycle took place in 2008. The phased-in productivity value is multiplied by the tax rate at 2.63 percent for 2012 to determine the taxable value. Non-productive mining claims and non-qualified agricultural land are also included in the agricultural land class. Non-qualified agricultural land is defined as parcels of land between 20 to 160 acres, not used primarily for agricultural purposes. These parcels are taxed at 18.41 percent in 2012. (Montana Department of Revenue, 2012).

Estimated 2012 tax revenues for each county in Segment 4 from agricultural land classifications are reported in Table 26. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue. Subtracting the average millage rate associated with the state revenue (0.101), from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

As shown in Table 27, Sweet Grass County receives a higher portion of property tax revenue from agricultural land than the other two counties in the Segment; with 11% of tax revenue coming from agricultural land and 7% of this from grazing lands. Agricultural property tax revenue received by Carbon and Stillwater counties is similar to that of the River Corridor at 6% and 5%, respectively (Montana Department of Revenue, 2012).

Table 27. Agricultural Property Tax Revenue, 2012

	Carbon		Stillwater		Sweet Grass		River Corridor Counties	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Agricultural Land	935,895	6%	889,663	5%	827,507	11%	12,607,835	5%
Tillable Irrigated	373,515	2%	90,635	1%	152,918	2%	2,247,812	1%
Tillable Non Irrigated	77,091	> 1%	190,647	1%	13,342	> 1%	3,363,055	1%
Grazing	294,010	2%	338,835	2%	522,653	7%	5,319,837	2%
Wild Hay	54,839	> 1%	135,891	1%	92,266	1%	616,523	> 1%
Non-Qualified Ag Land	136,440	1%	133,654	1%	46,328	1%	1,060,766	> 1%
Other	15,101,968	94%	15,763,875	95%	7,024,519	89%	259,597,39 3	95%
Total Property Revenue	16,037,863		16,653,538		7,852,026		272,205,22 8	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis all three counties in Segment 4, Carbon, Stillwater and Sweet Grass Counties, MT, were included as the region. The year 2012 IMPLAN v3 county-level data profiles for these three counties were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- <u>Employment</u> represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- <u>Labor Income</u> includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- <u>Value Added</u> measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of agriculture in the three-county area were estimated in IMPLAN using total output values for 19 agriculture-related sectors including grain farming, tree nut and fruit farming,

animal production and commercial logging. Economic contribution analyses address the importance or contribution of an existing industry to a local economy.

Table 28 summarizes the results of the contribution analysis. All results are presented in 2012 dollars. In 2012, agriculture in Segment 4 directly accounts for an estimated 2,600 jobs, $37.4 million in labor income, and $56.3 million in value added to the local economy. Secondary or multiplier effects of agriculture account for an additional estimated 300 jobs, $7.0 million in labor income, and $21.3 million in value added to the local economy. Accounting for both direct and secondary effects, agriculture in Segment 2 contributes an estimated total of 2,900 jobs, $44.4 million in labor income, and $77.6 million in value added to the local economy of the three counties in Segment 4. Segment 4 has the second highest employment contribution from agriculture across the segments in the River Corridor.

Table 28. Analysis of Agricultural Contribution, Segment 4

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	2,600	$37.4	$56.3
Secondary Effects	300	$7.0	$21.3
Total Effect	2,900	$44.4	$77.6

*Please note due to rounding, Total Effect reported may not be equal to the sum of Direct and Secondary Effects, as reported.

Segment 5

Historical Overview

Unlike other counties along the Yellowstone River Corridor, it was not just the prospect of agricultural development that attracted residents to Park County, MT. The expansion of the railroad promted the development of the city of Livingston, MT, the county seat of Park County (City of Livingston Montana, 2008). The proximity of Yellowstone National Park, just 55 miles between Livingston to the north entrance, also increased the popularity of Park County.

Current Agricultural Statistiscs

The agricultural data presented here are representative of county level statistics. The River Corridor Counties column demonstrates the representative statistic for all the 12 counties in which Yellowstone River is located. As the size of the counties varies, so does the length of the river stretch contained within those counties. Park County contains the second longest stretches of the Yellowstone River.

From 1950 to 2012, the number of farms in Park County remained the same, 564 farms. The land in farms decreased during this time. In 1950, 431 farms were under irrigation. By 2012, this number had decreased to 273 farms. Finally, total irrigated acreage has remained relatively constant during this time period, increasing slightly (see Tables 29 and 30).

Table 29. Agricultural Statistics for Segment 5, 1950

	Park	River Corridor
Number of Farms	564	8,593
Land in farms (acres)	841,104	15,261,807
Land in farms\ Average size of farm (acres)	1,491	1,776
Irrigated land (farms)	431	4,149
Irrigated land (acres)*	55,460	421,408

Source: United States Dept. of Agriculture, 1950
*1949 values

Table 30. Agricultural Statistics for Segment 5, 2012

	Park	River Corridor
Number of Farms	564	6,303
Land in farms (acres)	774,057	15,232,307
Land in farms\ Average size of farm (acres)	1,372	2,416
Irrigated land (farms)	273	2,326
Irrigated land (acres)	57,112	457,531

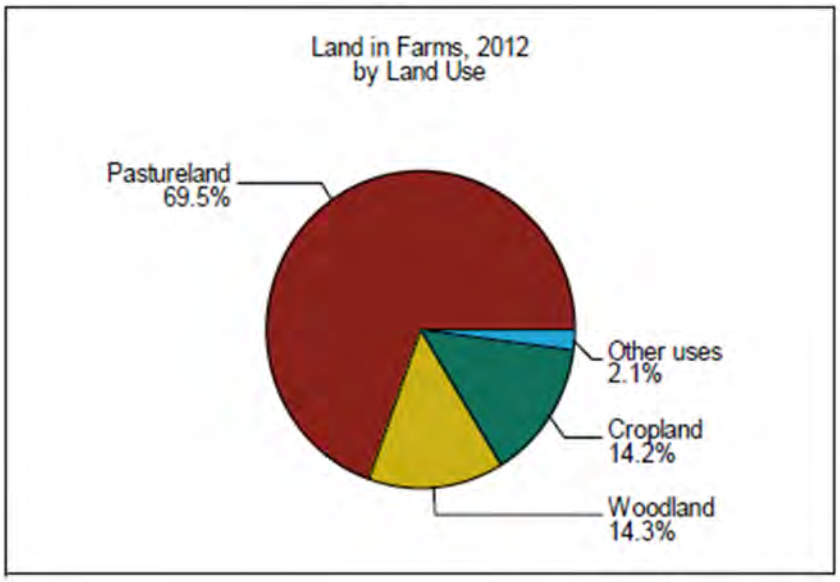
Source: United States Dept. of Agriculture, 2012

In 2012, majority of the land in farms in Park County was used as pastureland. However, 14.3% of the land in farms was classified as woodland, the highest percentage of woodland of any of the counties within the River Corridor (Figure 23). Pastureland is defined by the agricultural census as grazable land that does not qualify as woodland pasture or cropland pasture. Pastureland may be irrigated or dry land.

In some areas, it can be a high quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland. The Census of Argiculture defines woodland as planted woodlots or timer tracts, cutover and deforested land with young growth which has or will have value for wood products or woodland pastured. This category includes natural or woodland pasrture. The majority of farms in Park County are either 10-49 areas, or greater than 1,000 acres in size (see Figure 24).

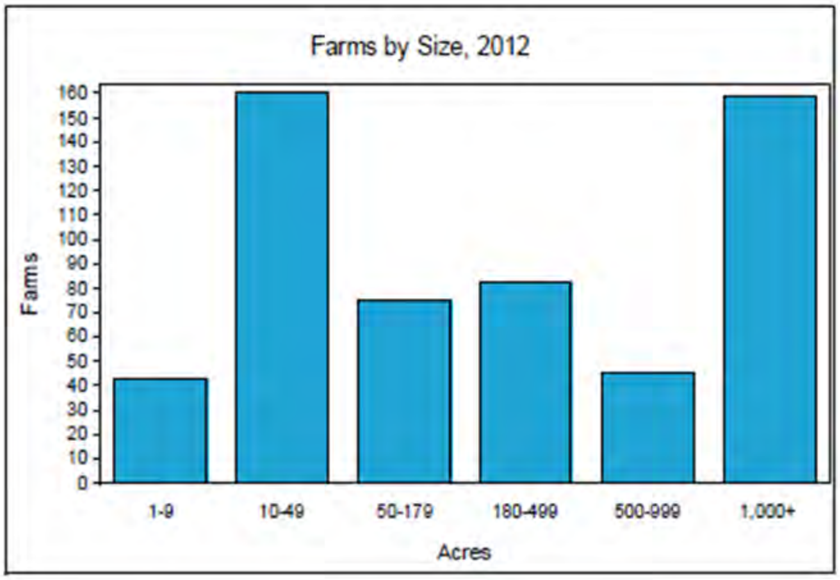
Figure 23. Park County Land in Farms by Land Use, 2012

Source: United States Dept. of Agriculture, 2012



Source: United States Dept. of Agriculture, 2012

Figure 24. Park County Farms by Size, 2012



Source: United States Dept. of Agriculture, 2012

Market Value of Farm Products and Capital/Farm Equity

The market value of products sold is a category that represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the place in 2012 (United States Department of Agriculture, 2012). The market value of products sold also does not infer that the value of the 2012 harvest. Values of products harvested in a previous year, held in storage and sold in 2012 are also included into this market value. "Market value of agricultural products sold does not include payments received for participation in other federal farm programs. Also, it does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources" (United States Department of Agriculture, 2012).

As compared to other counties within the River Corridor, the market value of agricultural products sold is relatively low in Park County. In 2012, the total value of agricultural products sold was slightly over $38 million. Contrarily, the average per farm market value of land and buildings in Park County is relatively high, valued at $3.5 million in 2012 (see Table 31 and 32, below) (United States Department of Agriculture, 2012).

Table 31. Market Value of Products Sold in Segment 5, 2012 ($1,000)

	Park	River Corridor Counties
Total value of ag products sold	38,487	1,035,226
value of crops including nursery and greenhouse	13,126	429,403
value of livestock, poultry and their products	25,361	605,823

Source: United States Dept. of Agriculture, 2012

Table 32. Market Value of Farm Capital In Segment 5, 2012

	Park
Market value of land and buildings \ Average per farm ($)	3,502,195

Estimated market value of all machinery and equipment \ Average per farm ($)	96,944

Source: United States Dept. of Agriculture, 2012

Government Payments

Government payments consist of "direct payments as defined by the 2008 Farm Bill; payments from Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), and Conservation Reserve Enhancement Program (CREP); loan deficiency payments; disaster payments; other conservation programs; and all other federal farm programs under which payments were made directly to farm operators" (United States Department of Agriculture, 2012). Government payments do not include Commodity Credit Corporation proceeds, the amount of State and local government agricultural program payments, and federal crop insurance payments (United States Department of Agriculture, 2012).

As shown in Table 33, total government payments in Park County, MT equaled $754 thousand, averaging $7,544 per farm in the County, in 2012.

Table 33. Government Payments in Segment 5, 2012

	Park	River Corridor Counties
Total ($)	754,000	32,789,000
Average per farm ($)	7,544	

Source: United States Dept. of Agriculture, 2012

Tax Revenue

Montana legislature determined 14 different classes of property for property taxes, agricultural land being one of the 14 classifications. Each class of property is valued differently. For example, agricultural land is valued differently than railroads. However, properties within each class, such as grazing land and tillable irrigated land are valued the same. Agricultural land class is reappraised by the state every 6 years based on productivity of the land. The last valuation cycle took place in 2008. The phased-in productivity value is multiplied by the tax rate at 2.63 percent for 2012 to determine the taxable value. Non-productive mining claims and non-qualified agricultural land are also included in the agricultural land class. Non-qualified agricultural land is defined as parcels of land between 20 to 160 acres, not used primarily for agricultural purposes. These parcels are taxed at 18.41 percent in 2012 (Montana Department of Revenue, 2012).

Estimated tax revenues for Park County in Segment 5 in 2012 from agricultural land class are reported in Table 34. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue. Subtracting the average millage rate associated with the state revenue (0.101), from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

In 2012, 5% of total revenue in Park County was derived from agricultural lands, with a majority of tax revenue from grazing lands. This is similar to what can be seen across the River Corridor.

Table 34. Agricultural Property Tax Revenue, 2012

	Park		River Corridor Counties*	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Agricultural Land	924,781	5%	12,607,835	5%
Tillable Irrigated	251,567	1%	2,247,812	1%
Tillable Non Irrigated	37,769	>1%	3,363,055	1%
Grazing	395,875	2%	5,319,837	2%
Wild Hay	24,301	>1%	616,523	>1%
Non-Qualified Ag Land	215,222	1%	1,060,766	>1%
Other	16,646,947	95%	259,597,393	95%
Total Property Revenue	17,571,729		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis, Park County, MT was included as the region. The year 2012 IMPLAN v3 county-level data profiles for the county were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- Employment represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- Labor Income includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- Value Added measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of agriculture in the one-county area were estimated in IMPLAN using total output values for 19 agriculture-related sectors including grain farming, tree nut and fruit farming,

animal production and commercial logging. Economic contribution analyses address the importance or contribution of an existing industry to a local economy.

Table 35 summarizes the results of the contribution analysis. All results are presented in 2012 dollars. In 2012, agriculture in Segment 5 directly accounts for an estimated 2,000 jobs, $37.6 million in labor income, and $41.3 million in value added to the local economy. Secondary or multiplier effects of agriculture account for an additional estimated 200 jobs, $6.6 million in labor income, and $15.8 million in value added to the local economy. Accounting for both direct and secondary effects, agriculture in Segment 2 contributes an estimated total of 2,200 jobs, $44.2 million in labor income, and $57.1 million in value added to the local economy of the three counties in Segment 5. Across the River Corridor, Segment 5 has the second fewest jobs contributed by agriculture, and the lowest contribution to labor income and value added.

Table 35. Analysis of Agricultural Contribution, Segment 5

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	2,000	$37.6	$41.3
Secondary Effects	200	$6.6	$15.8
Total Effect	2,200	$44.2	$57.1

*Please note due to rounding, Total Effect reported may not be equal to the sum of Direct and Secondary Effects, as reported.

Urban and Exurban Development

Historical Introduction

Much attention has been focused on urban and exurban development, defined as low density development of houses on 5-40 acres (Wildlife Conservation Society, Impacts of Low Density, Exurban Development). There is great concern over possible environmental damage and degradation that this type of development promotes (Vandenbosch and Erickson, 2007). In 1996 and 1997 two floods along the Yellowstone River brought this discussion to the forefront. Many homeowners had developed their homes along the riverbank and adjacent floodplain, subsequently losing some these homes following the floods. Debate began over how far back from the river homeowners should develop their lots and what type of riparian damage this type of development was causing to the river's ecosystem. In 2007, a bill was brought to state legislation requiring, "new construction to be at least 250 feet from the high-water mark of a major river and provide a vegetative buffer at least 100 feet wide" (Vandenbosch and Erickson, 2007). This bill did not pass, but the issues surrounding urban and ex-urban development continue to be analyzed and debated.

Current Housing

Representative housing statistics from the 2010 census are provided below. Though these statistics are county-wide and are not solely representative of development of land abutting the Yellowstone River Corridor, trends can be identified within the counties that make up the River Corridor. Tables 35 through 39 describe current housing data for counties within the River Corridor.

Yellowstone County, MT, which makes up Segment 3, accounted for over half of the total housing units, 63,943 units (see Table 37), while Treasure County had the fewest housing units, 422 units, in 2010 (see Table 36). Carbon County, MT had the highest percentage of housing units for seasonal or recreation use, with more than 1 of every 5 housing units used for seasonal or recreation use (see Table 38). In 2010, only 0.6% of the housing units in Yellowstone County are considered to be for seasonal or recreation use. Sweet Grass County, MT had the highest homeowner and rental vacancy rates, 3.8% and 15.0%, respectively (Table 38). Average household size remained fairly constant across the counties within the River Corridor, with all households having an average size of less than 3 individuals (United States Census Bureau, 2010).

Table 36. Housing Data for Segment 1, 2010

			Vacant Housing Units		Occupied Housing Units		
	Total Housing Units (2010)	% of Units For Seasonal/ Rec use	Homeowner Vacancy Rate	Rental Vacancy Rate	Owner Occupied	Renter Occupied	Average Household Size
McKenzie County, ND	3,090	7.5	0.5	8.5	2,410	729	2.58
Richland County, MT	4,550	1.6	0.7	2.7	2,904	1,263	2.33
Dawson County, MT	4,233	2.0	1.7	6.6	2,658	1,091	2.26
Prairie County, MT	673	8.9	2.0	3.4	438	113	2.10
Segment Total	12,546	3.6	1.2	5.3	8,410	3,196	2.32
River Corridor Total	109,295	4.4	1.9	8.9	68,269	30,037	2.29

Source: United States Census Bureau, 2010

Table 37. Housing Data for Segment 2, 2010

			Vacant Housing Units		Occupied Housing Units		
	Total Housing Units (2010)	% of Units For Seasonal/ Rec use	Homeowner Vacancy Rate	Rental Vacancy Rate	Owner Occupied	Renter Occupied	Average Household Size
Treasure County, MT	422	9.0	0.4	12.8	241	94	2.14
Rosebud County, MT	4,057	4.4	1.0	14.1	2,259	1,136	2.70
Custer County, MT	5,560	1.3	1.1	5.8	3,349	1,682	2.24
Segment Total	10,039	2.8	0.8	10.9	5,849	2,912	2.36
River Corridor Total	109,295	4.4	1.9	8.9	68,269	30,037	2.29

Source: United States Census Bureau, 2010

Table 38. Housing Data for Segment 4, 2010

			Vacant Housing Units		Occupied Housing Units		
Segment 4	Total Housing Units (2010)	% of Units For Seasonal/ Rec use	Homeowner Vacancy Rate	Rental Vacancy Rate	Owner Occupied	Renter Occupied	Average Household Size
Sweet Grass County, MT	2,148	16.2	3.8	15.0	1,112	478	2.27
Stillwater County, MT	4,803	13.6	2.0	10.1	2,960	836	2.37
Carbon County, MT	6,441	21.4	2.7	10.6	3,471	1,100	2.19
Segment Total	13,392	17.8	2.8	11.9	7,543	2,414	2.28
River Corridor Total	109,295	4.4	1.9	8.9	68,269	30,037	2.29

Source: United States Census Bureau, 2010

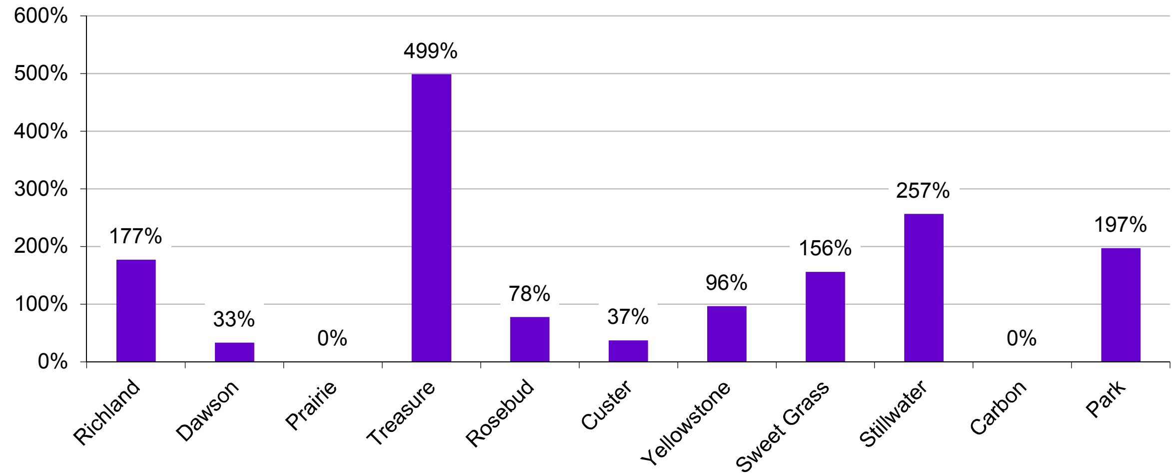
Table 39. Housing Data for Segment 5, 2010

			Vacant Housing Units		Occupied Housing Units		
	Total Housing Units (2010)	% of Units For Seasonal/ Rec use	Homeowner Vacancy Rate	Rental Vacancy Rate	Owner Occupied	Renter Occupied	Average Household Size
Park County, MT	9,375	14.0	3.0	10.3	4,938	2,372	2.12
River Corridor Total	109,295	4.4	1.9	8.9	68,269	30,037	2.29

Source: United States Census Bureau, 2010

Headwaters Economics developed an atlas for the counties in Montana, within the Yellowstone River Corridor. Figure 25 highlights the percent change in developed land along the Yellowstone River 100-Year Flood Zone from 1970 to 2008. Treasure County had nearly a 500% increase in land developed within the flood zone during this time period while Prairie and Carbon Counties did not experience a change. Stillwater County had a 257% increase in developed land and both Richland and Park Counties had an increase of nearly 200% in developed land within the flood zone (Headwaters Economics, 2014). This further highlights the concern over lands being developed in the flood plain, as mentioned previously.

Figure 25. Percent Change in Developed Land in Yellowstone River 100-Year Flood Zone, 1970 - 2008



Source: Headwaters Economics, 2014

Tax Revenue

Montana legislature determined 14 different classes of property for property taxes. Residential, commercial, and industrial (land and improvements) is one of the 14 classes. Each class of property is valued differently. For example, residential, commercial, and industrial (land and improvements) class is valued differently than the airlines and railroads class. Both residential and commercial properties are reappraised every 6 years by the Montana Department of Revenue. The most recent valuation cycle took place in 2011. Montana Department of Revenue reports that residential property had a 44 percent homestead exemption, so the residential taxable value was based on 56 percent of the market value. The tax rate of 2.63 percent is applied to the 56 percent of the market value to arrive at the taxable value. Commercial and industrial properties are taxed the same way except for the lower exemption rate of 19 percent, leaving 79 percent of market value being applied to the 2.63 percent tax rate to determine the taxable value (Montana Department of Revenue, 2012). Estimated tax revenues for each county in Segment 1 in 2012 from agricultural land class are reported in Table 40. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue. Subtracting the average millage rate associated with the state revenue (0.101), from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

The counties within the River Corridor as a whole received 28% of property tax revenue from residential property taxes. Park County is the only county that received over half of its property tax revenue from residential property, with 52% derived from residential property, Table 44. Following Park County, Carbon, Yellowstone and Custer Counties received a third or more of their property tax revenue from residential properties, 41%, 38% and 30%, respectively (Tables 41, 42, 43). For the remaining counties within the corridor, residential property taxes comprise less than 20% of county property tax revenue, with 5% of property tax revenue from residential property taxes in Prairie County, 2% in Rosebud County, and finally only 3% from residential property taxes in Treasure County (Montana Department of Revenue, 2012) (see tables 40-44, below).

Table 40. Land and Improvements Property Tax Revenue in 1, 2012

	Richland		Dawson		Prairie		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Land and Improvements	3,128,837	23%	2,275,730	26%	238,295	12%	126,192,430	46%
Residential	1,640,953	12%	1,426,609	16%	96,297	5%	77,522,483	28%
Commercial	1,089,932	8%	649,976	7%	129,657	7%	41,737,298	15%
Industrial	10,944	> 1%	4,220	> 1%	90	> 1%	901,461	> 1%
Other	10,596,471	77%	6,627,638	74%	1,668,666	88%	146,012,798	54%
Total Property Revenue	13,725,307		8,903,368		1,906,961		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 41. Land and Improvements Property Tax Revenue in Segment 2, 2012

	Custer		Rosebud		Treasure		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Land and Improvements	3,641,554	50%	1,991,062	4%	184,330	9%	126,192,430	46%
Residential	2,161,434	30%	910,972	2%	59,675	3%	77,522,483	28%
Commercial	1,291,783	18%	546,877	1%	109,668	5%	41,737,298	15%
Industrial	12,624	> 1%	74,903	> 1%	366	> 1%	901,461	> 1%
Other	3,664,365	50%	44,612,067	96%	1,868,718	91%	146,012,798	54%
Total Property Revenue	7,305,919		46,603,130		2,053,048		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 42. Land and Improvements Property Tax Revenue in Segment 3, 2012

	Yellowstone		River Corridor (MT only)	
	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated Property Tax Revenue	% Total Property Tax Revenue
Land and Improvements	84,682,235	63%	126,192,430	46%
Residential	50,745,316	38%	77,522,483	28%
Commercial	29,587,770	22%	41,737,298	15%
Industrial	728,156	1%	901,461	> 1%
Other	48,910,105	37%	146,012,798	54%
Total Property Revenue	133,592,340		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 43. Land and Improvements Property Tax Revenue in Segment 4, 2012

	Carbon		Stillwater		Sweet Grass		River Corridor (MT only)	
	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated County Property Tax Revenue	% Total County Property Tax Revenue	Estimated Property Tax Revenue	% Total Property Tax Revenue
Land and Improvements	8,852,575	55%	5,169,883	31%	2,545,369	32%	126,192,430	46%
Residential	6,616,179	41%	3,509,010	21%	1,221,999	16%	77,522,483	28%
Commercial	1,934,742	12%	1,248,973	7%	1,144,600	15%	41,737,298	15%
Industrial	16,473	> 1%	23,790	> 1%	16,658	> 1%	901,461	> 1%
Other	7,185,288	45%	11,483,655	69%	5,306,657	68%	146,012,798	54%
Total Property Revenue	16,037,863		16,653,538		7,852,026		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 44. Land and Improvements Property Tax Revenue in Segment 5, 2012

	Park		River Corridor	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Land and Improvements	13,482,559	77%	126,192,430	46%
Residential	9,134,039	52%	77,522,483	28%
Commercial	4,003,320	23%	41,737,298	15%
Industrial	13,237	> 1%	901,461	> 1%
Other	4,089,169	23%	146,012,798	54%
Total Property Revenue	17,571,729		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis, the counties within the Segments were included as the region. The year 2012 IMPLAN v3 county-level data profiles for the counties were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- <u>Employment</u> represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- <u>Labor Income</u> includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- <u>Value Added</u> measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of the housing sectors were estimated in IMPLAN using total output values for two housing-related sectors, construction of new residential permanent sight single- and multi-family structures and construction of other new residential structures. These sectors include industries such as residential housing general contractors (i.e., new construction, remodeling, or renovating existing residential structures), operative builders and remodelers of residential structures, residential project construction management firms, and residential design-build firms. Economic contribution analyses address the importance or contribution of an existing industry to a local economy.

The tables below summarize the results of the contribution analysis for housing across all five segments. All results are presented in 2012 dollars. In 2012, residential construction had the greatest contribution to Yellowstone County, Segment 3, with the construction of new residential permanent site single- and multi-family structures contributing 1,400 jobs and the construction of other new residential structures contributing 2,000 jobs, total. The construction of new residential permanent site single- and multi-family structures contributed over $100 million in labor income and value added in Segment 3 (see Tables 49 and 50). The two housing sectors contributed the least to Park County, with construction of new residential permanent site single- and multi-family structures and construction of other new residential structures contributing 110 and 170 total jobs, respectively (see Tables 53 and 54).

Table 45. Construction of new residential permanent site single- and multi-family structures in Segment 1

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	200	$19.2	$24.6
Secondary Effects	200	$6.9	$11.2
Total Effects	400	$26.1	$35.8

Table 46. Construction of other new residential structures in Segment 1

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	400	$28.2	$28.2
Secondary Effects	200	$9.2	$15.0
Total Effects	600	$37.4	$43.3

Table 47. Construction of new residential permanent site single- and multi-family structures in Segment 2

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	80	$4.1	$4.9
Secondary Effects	60	$1.9	$3.2
Total Effects	140	$6.0	$8.2

Table 48. Construction of other new residential structures in Segment 2

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	128	$6.2	$6.6
Secondary Effects	84	$2.6	$4.5
Total Effects	212	$8.8	$11.1

Table 49. Construction of new residential permanent site single- and multi-family structures in Segment 3

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	600	$36.8	$43.6
Secondary Effects	800	$31.6	$49.1
Total Effects	1400	$68.4	$92.6

Table 50. Construction of other new residential structures in Segment 3

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	1000	$57.2	$60.3
Secondary Effects	1000	$43.9	$68.2
Total Effects	2000	$101.0	$128.5

Table 51. Construction of new residential permanent site single- and multi-family structures in Segment 4

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	100	$3.1	$4.2
Secondary Effects	60	$1.5	$2.7
Total Effects	160	$4.6	$6.9

Table 52. Construction of other new residential structures in Segment 4

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	160	$5.3	$5.8
Secondary Effects	80	$2.1	$3.8
Total Effects	240	$7.4	$9.6

Table 53. Construction of new residential permanent site single- and multi-family structures in Segment 5

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	70	$2.0	$2.8
Secondary Effects	40	$1.2	$2.1
Total Effects	110	$3.3	$4.9

Table 54. Construction of other new residential structures in Segment 5

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	110	$3.4	$3.7
Secondary Effects	60	$1.7	$2.9
Total Effects	170	$5.1	$6.6

Transportation

Historical Introduction

In addition to the Enlarged Homestead Act, the railroads spurred population growth within the counties along the River Corridor. The Northern Pacific Railroad helped to ensure Miles City, located in Custer County, became an important cattle market for Southeastern Montana (Southeastern Montana, 2012b). In 1909, Billings Montana built a Depot to be used by three railroad companies, the Northern Pacific, Great Northern, and the Chicago, Burlington, and Quincy, all three of which would be combined with two additional railroads to form the Burlington Northern, and eventually the Burlington Northern Santa Fe Railway (Burlington Northern Santa Fe, 2013). Due to the number of homesteaders arriving, the railroads expanded and by 1931 more than 26 passenger trains went through the Depot daily (Billings Depot, 2014).

The railroads helped form the city of Livingston, MT in Park County, in 1882. Livingston served as an important stop for the Northern Pacific (NP), as it was a midway point between St. Paul, Minnesota and Tacoma, Washington. The proximity of Livingston to Yellowstone National Park also made it a choice location for the railroad as the NP carried visitors to the Park. Finally, the construction of repair shops in town solidified Livingston's importance to the railway. As automobiles increased in popularity, railroads shifted from transporting passenger to cargo (City of Livingston Montana, 2008).

Though the railroads are no longer important carriers for passengers, they serve as an important link to markets for rural communities. It is also important in the development of coal in eastern Montana. In Dawson County, the Burlington Northern Santa Fe Railway(BNSF) links agricultural producers with Billings and interstate markets. Additionally, the railway is a major employer within the county (Dawson County Economic Development Council). Billings, MT continues to serve as an important hub for the railroads, servicing both the BNSF and Montana Rail Link operating a port facility and two intermodal facilities (Montana Department of Transportation, 2013).

Current Transportation Description

In the state of Montana, between Livingston and Fairview, the railroad tracks stretch approximately 424 miles *(personal communication with Diane Myers of Montana Department of Transportation) in the Yellowstone Valley*. Two railroad companies currently operate within the Yellowstone River Corridor counties: the Burlington Northern Santa Fe and the Montana Rail Link. Information about these companies was collected via published reports and interviews with representatives of the companies.

BNSF has rail stretching through all the counties within the River Corridor and has yards located in Laurel, Forsyth, and Glendive. BNSF reports that there were, on average, 20 trains per day through Forsyth in 2013. Overall, BNSF handled 1.2 million carloads in the state of Montana in 2013. Out of 1.2 million car loads, 343,000 car loads originated in the state and 34,000 terminated in the state. Of the carloads that originated in Montana, 244,000 car loads carried coal, 53,000 car loads carried agricultural products and 45,000 car loads carried industrial products. Most of the car loads of coal likely originated in Southeastern Montana, as this is where many of the coal mines are located. Generally, a large volume of agricultural products originate in North Central Montana with some also originating in the southeastern part of the state. Industrial products include crushed stone, lumber, chemicals and crude oil-related shipments, which primarily originate in the northwestern section of the state, with some recent growth in Southeastern Montana and North Dakota *(personal communication with Matthew Jones of Burlington Northern Santa Fe Railway)*.

Montana Rail Link operates between Livingston and Huntley in the River Corridor, and reports that 40% of their payroll lives between Laurel and Livingston. The Laurel yard is utilized for car switching as well as train building *(personal communication with Jim Lewis of Montana Rail Link)*.

In addition to the railroads, semi-trucks serve as an important means of freight transportation. The recent oil development and oil transportation in the Bakken Oil Field is increasing the demand on the highways in eastern Montana (Dybing and others, 2013). According to a recent report, Highways 16 and 200 have between 625 and 1407 average annual trucks per day near the town of Sidney, MT. The same can be seen on Interstate 94, near the town of Glendive, in Dawson County (Dybingand others, 2013). Given its midpoint location between Minneapolis and Seattle, as well as Denver and Calgary, Billings serves as a hub for freight transportation via trucking. The portion of Interstate I-94 that runs through Billings has an annual average daily traffic rate between 9,000 and 27,500 vehicles, with an estimated 22% semi-trucks (Kittelson & Associates Inc. and DOWL HKM Inc., 2014). The transportation industry, both the railroads and trucking, provides economic activity across the counties in the River Corridor.

Tax Revenue from Railroads

Montana legislature determined 14 different classes of property for property taxes, with airlines and railroads being one of the fourteen classifications. This report focuses on revenue from railroad property taxes. Railroad properties are valued each year while the tax rate varies depending on the effective tax rate of all industrial property in the state that tax year (Montana Department of Revenue, 2012).

Estimated tax revenues for each of the segments in 2012 are reported in the tables below. These values are derived from a calculation of taxable value and the millage rate and therefore are estimates of revenue received by the counties. The millage rate used is a calculation of the average millage rate for the state of Montana (0.54883). This includes the state and county level revenue. Subtracting the average millage rate associated with the state revenue (0.101), from 0.54883 results in a millage rate of 0.44783 which represents the county revenue. The River Corridor counties revenue estimate is the sum of all revenues across categories for all Montana counties. North Dakota is excluded from that summation. Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Two counties in the River Corridor, Prairie and Treasure, receive more than 25% of their property tax revenue from the railroad (see Tables 55 and 56). Most counties receive around 10% or less. Across the River Corridor counties in Montana, 3% of total property tax revenue comes from the railroad, compared to 28% coming from residential property and 5% from agricultural land (Montana Department of Revenue, 2012).

Table 55. Tax Revenue from Railroads in Segment 1, 2012

	Richland		Dawson		Prairie		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Railroad	85,699	1%	1,142,571	13%	597,408	31%	8,373,172	3%
Other	13,639,608	99%	7,760,797	87%	1,309,553	69%	263,832,056	97%
Total Property Revenue	13,725,307		8,903,368		1,906,961		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 56. Tax Revenue from Railroads in Segment 2, 2012

	Custer		Rosebud		Treasure		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Railroad	599,543	8%	835,301	2%	526,573	26%	8,373,172	3%
Other	6,706,377	92%	45,767,829	98%	1,526,475	74%	263,832,056	97%
Total Property Revenue	7,305,919		46,603,130		2,053,048		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 57. Tax Revenue from Railroads in Segment 3, 2012

	Yellowstone		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Railroad	3,385,938	3%	8,373,172	3%
Other	130,206,402	97%	263,832,056	97%
Total Property Revenue	133,592,340		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 58. Tax Revenue from Railroads in Segment 4, 2012

	Carbon		Stillwater		Sweet Grass		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated County Property Tax Revenue**	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Railroad	375,009	2%	231,306	1%	231,643	3%	8,373,172	3%
Other	15,662,854	98%	16,422,232	99%	7,620,382	97%	263,832,056	97%
Total Property Revenue	16,037,863		16,653,538		7,852,026		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Table 59. Tax Revenue from Railroads in Segment 5, 2012

	Park		River Corridor (MT only)	
	Estimated County Property Tax Revenue	**% Total County Property Tax Revenue**	**Estimated Property Tax Revenue**	**% Total Property Tax Revenue**
Railroad	362,181	2%	8,373,172	3%
Other	17,209,548	98%	263,832,056	97%
Total Property Revenue	17,571,729		272,205,228	

*River Corridor, in this case, excludes McKenzie County, North Dakota

**Complete and comparable tax data from North Dakota was unavailable at the time this report was produced and is therefore not included in the analysis.

Source: Montana Department of Revenue, 2012

Contribution Analysis

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The analyses presented in this report were estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis, the counties within the Segments were included as the region. The year 2012 IMPLAN v3 county-level data profiles for the counties were used in this study. Regional economic contributions from the IMPLAN model are reported for the following categories:

- Employment represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- Labor Income includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- Value Added measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Current economic contributions of the railroad sectors were estimated in IMPLAN using total output values for two railroad-related sectors, railroad transportation and scenic and sightseeing transportation and support activities. Railroad Transportation includes industries that provide rail transportation of passengers and/or cargo using railroad rolling stock. Scenic and sightseeing transportation and support activities include transportation equipment to provide recreation and entertainment as well as support activities for rail transport. Economic contribution analyses address the importance or contribution of an existing industry to a local economy. Economic contributions of trucking were estimated in IMPLAN using the total output value for the sector transport by truck. Though outside the scope of this analysis, it should be noted that these transportation sectors support other industries within the River Corridor, including but not limited to, agriculture, energy development and mining industries.

The tables below summarize the results of the contribution analysis for railroad and trucking across all five segments. All results as presented are in 2012 dollars. In 2012, both railroad-related sectors contributed the most to the economy of Yellowstone County, MT, Segment 3. Railroad transportation contributed 1,400 jobs $88.0 million in labor income and nearly $208 million in value added while scenic and sightseeing transportation and rail support activities contributed 2,700 jobs, $115.0 million in labor income and nearly $144 million in value added (see Tables 64 and 65). This is not surprising as Yellowstone County has three rail lines that pass through, Burlington Northern Santa Fe, Montana Rail Link and Signal Peak Energy. Yellowstone County also houses one port facility and three intermodal facilities (Montana Department of Transportation, 2013). Railroads contributed the least in Segment 4 with both sectors contributing 5 jobs, total and less than $1 million in labor income or value added (see Tables 66 and 67). In Segment 4, the BNSF (Burling Northern Santa Fe Railway) operates through Carbon County and the Montana Rail Link operates through Sweet Grass and Stillwater Counties, but there are not any port or intermodal facilities in any of the counties (Montana Department of Transportation, 2013).

Trucking also contributed the most to the economy of Yellowstone County, MT (see Table 72). In 2012, transport by trucking contributed an estimated 3,200 jobs, $163.3 million in labor income and $228.3 million in value added. Trucking also contributed to the economy of the counties in Segment 1. This is not surprising given the recent increase in trucking activity that can be attributed to the Bakken Oil Fields, located in close proximity to the counties in Segment 1. Transport by truck contributed an estimated 2,700 jobs, $218.9 million in labor income and $300.8 million in value added to the economy of Segment 1 (see Table 70). Transport by truck contributed the least to Segment 5, Park County, contributing an estimated 60 jobs, $2.3 million in labor income and $3.3 million in value added (see Table 74).

Table 60. Contribution of Railroad Transportation in Segment 1

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	300	$28.1	$91.8
Secondary Effects	300	$15.7	$24.3
Total Effects	600	$43.8	$116.1

Table 61. Contribution of Scenic and sightseeing transportation and support activities in Segment 1

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	15	$1.1	$1.1
Secondary Effects	5	$0.2	$0.4
Total Effects	20	$1.3	$1.4

Table 62. Contribution of Railroad Transportation in Segment 2

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	130	$13.5	$44.1
Secondary Effects	170	$5.7	$9.5
Total Effects	300	$19.2	$53.6

Table 63. Contribution of Scenic and sightseeing transportation and support activities in Segment 2

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	14	$0.1	$0.1
Secondary Effects	4	$0.1	$0.2
Total Effects	18	$0.2	$0.3

Table 64. Contribution of Railroad Transportation in Segment 3

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	400	$43.3	$141.2
Secondary Effects	1000	$44.7	$66.6
Total Effects	1400	$88.0	$207.8

Table 65. Contribution of Scenic and sightseeing transportation and support activities in Segment 3

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	1500	$69.3	$73.3
Secondary Effects	1200	$45.7	$70.5
Total Effects	2700	$115.0	$143.8

Table 66. Contribution of Railroad Transportation in Segment 4

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	2	$0.22	$0.73
Secondary Effects	3	$0.07	$0.12
Total Effects	5	$0.29	$0.85

Table 67. Contribution of Scenic and sightseeing transportation and support activities in Segment 4

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	4	$0.02	$0.03
Secondary Effects	< 1	$0.02	$0.04
Total Effects	5	$0.05	$0.07

Table 68. Contribution of Railroad Transportation in Segment 5

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	52	$5.5	$18.1
Secondary Effects	86	$2.2	$3.9
Total Effects	138	$7.8	$22.0

Table 69. Contribution of Scenic and sightseeing transportation and support activities in Segment 5

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	13	$0.2	$0.3
Secondary Effects	5	$0.1	$0.2
Total Effects	18	$0.4	$0.5

Table 70. Contribution of Transport by truck in Segment 1

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	1900	$183.4	$239.1
Secondary Effects	800	$35.5	$61.6
Total Effects	2700	$218.9	$300.8

Table 71. Contribution of Transport by truck in Segment 2

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	200	$10.8	$14.6
Secondary Effects	100	$3.6	$6.5
Total Effects	300	$14.5	$21.1

Table 72. Contribution of Transport by truck in Segment 3

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	1600	$99.6	$128.2
Secondary Effects	1600	$63.7	$100.1
Total Effects	3200	$163.3	$228.3

Table 73. Contribution of Transport by truck in Segment 4

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	110	$5.3	$7.3
Secondary Effects	40	$1.2	$2.2
Total Effects	150	$6.4	$9.5

Table 74. Contribution of Transport by truck in Segment 5

Impact Type	Employment	Labor Income (in millions)	Value Added (in millions)
Direct Effect	40	$1.7	$2.4
Secondary Effects	20	$0.5	$0.9
Total Effects	60	$2.3	$3.3

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SOCIOECONOMIC REPORT

Analysis of Ecosystem Services in the Yellowstone River Corridor and Economic Impacts of Tourism and Yellowtail Dam

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Part 1

Ecosystems are integrated natural communities stemming from the interactions among and between humans, animals, and the physical environment. The natural functions maintained by a healthy ecosystem provide ecological goods and services which preserve the natural capital required to maintain biodiversity and provide for the social, cultural, and economic needs of humans. The beneficial outcomes of these ecological processes provide “provisioning services” such as food, water and timber; “regulating services” such as flood and disease regulation; “cultural services” including recreational and spiritual services; and “supporting services” such as soil formation and nutrient cycling (Millennium Ecosystem Service Assessment, 2005).

The worth of natural ecosystems stem from their explicit market values (when applicable) and their implicit non-market values, which are often overlooked in private decision making processes. Since the economic value of ecosystem services is equal to the total social benefits they provide, it is important to account for both the market and non-market values of these resources (Freeman, 1993). Undervaluation of ecosystem resources is known to cause an inadequate provision of natural capital; thus, conservation and restoration efforts usually stem from the coordination of government agencies and public trusts. Conservation easements and fee-title acquisitions can protect non-market values associated with biodiversity and wildlife abundance, maintain aesthetic beauty, and protect social and culturally significant features of landscapes and livelihoods (Ehrlich and Ehrlich, 1992; Daily, 1997; Millennium Ecosystem Service Assessment, 2005). Ecosystem services, such as flood mitigation, water purification, oxygen production, pollination, and waste breakdown, are also maintained and/or enhanced through land preservation (Millennium Ecosystem Service Assessment, 2005). These services can have significant impacts on the welfare of those living in the area and beyond.

Land use decisions within the Yellowstone River Corridor, both on private and public lands, impact the quality of ecosystem services which in turn have economic implications throughout the corridor. In the following sections, the economic impacts associated with changes in relevant ecosystem services caused by development along the Yellowstone River Corridor will be discussed in detail. The nature of this report is qualitative, not quantitative. That is to say, no analytical modelling was done to estimate economic impacts within the corridor. Rather, economic impacts discussed in the following sections draw upon economic theory and as well as empirical evidence from peer-reviewed quantitative studies and other working documents.

A term used by economists – and frequently mentioned in this analysis – that portrays the economic value of something is willingness to pay. Someone’s willingness to pay for a good is the maximum amount that individual is willing to sacrifice to procure said good (Loomis et al., 2000). Although some ecosystem services are traded on the open market, namely raw materials, many ecosystem services are not. Thus, those services that are not traded on the open market do not have prices explicitly associated with them. However, prices are helpful with decision-making processes because they translate the values of different goods into one commensurate unit. Therefore, economists estimate individuals’ willingness to pay for different ecosystem services to better understand how to manage ecosystem services in order to optimize social welfare. There are many methods used to estimate willingness to pay for ecosystem services, some of which are mentioned throughout this analysis in regard to referencing outside studies. The reader should note that regardless of the type of method used by a referenced study, the concept of “willingness to pay” remains unchanged. As an example of estimating individuals’ willingness to pay for ecosystem services that are not traded on an open market, see Loomis et al. (2000), where it is estimated that households in a given area were willing to pay an average of $21 per month to have five ecosystem services restored along a 45-mile stretch of river.

The ecosystem services provided by the Yellowstone River Corridor are classified by three distinct categories: Provisioning Services, Regulating Services, and Cultural Services. Provisioning services describe the products obtained from ecosystems. Regulating Services describe the benefits obtained from an ecosystem when components of the natural environment help to control other naturally occurring components or byproducts of the ecosystem. Cultural Services describe the benefits people acquire through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (Millennium Ecosystem Service Assessment, 2005).

Provisioning Services

Provisioning services describe the products obtained from the ecosystem. For example, the Yellowstone River Corridor provides fresh water to users throughout the region. Those users include native and nonnative animal species and habitats, as well as humans in the agricultural, municipal, and industrial sectors. Furthermore, the corridor provides other raw materials to the region, such as timber.

Fresh Water

Fresh Water provides vast benefits to human well-being and is becoming increasingly scarce as demand for it grows. The Yellowstone River Corridor – which provides fresh water to many uses/users – is no exception. Beyond providing fresh water to the natural environment, the corridor also supplies fresh water to agricultural, municipal, recreational, and industrial users. Thus, it is important to understand the caveats of estimating the value of fresh water in order to best understand the importance of fresh water within the Yellowstone River Corridor.

The value of water varies across industry (i.e., use), space, and time (Gibbons, 1986). Consider a farmer using fresh water for irrigation and a household using fresh water for indoor use. The residential user pays a higher per unit price than does the farmer, and the farmer is using considerably more water. Furthermore, the farmer has little to no need for water in the winter and fall months, and therefore values water even less during the winter; compared to a residential user whose demand for indoor water changes very little from month to month, maintaining a relatively constant value of water year-round. To portray how the value of water varies across space, consider how a farmer in water-scarce Colorado will value water compared to a farmer in Ohio, where it is common practice to install drainage tile to drain excess rain water from fields.

Fresh Water having economic value is not just an abstract idea – values of water can and have been estimated according to what individuals/entities are willing to pay for water. For example, the value of water in agriculture in the Missouri River region was estimated to be $138 per acre-foot (in 2015 dollars; Frederick, et. al. 1996). However, the average price of municipally-supplied water in the U.S. is $2 per 1,000 gallons (U.S. Environmental Protection Agency, 2009). Using like units, the average willingness to pay for water for agricultural use in the Missouri River Basin was $138 per acre-foot, while the nation's average cost for municipally-supplied water was $709 per acre-foot. Of course, the previous statement is only a rough approximation of a comparison. For example, the price of municipal water incorporates an implicit cost for water treatment that the agricultural measure does not. Also, the price of municipal water only represents a lower-bound of willingness to pay – it is assumed that residential users would be willing to pay relatively higher prices for water (Dalhuisen, et. al., 2003). Therefore, it should be noted that even though the value of fresh water varies across industry, space, and time, comparing values originating from different estimation techniques can be difficult and/or problematic (see Young and Loomis, 2014, for a more in-depth discussion).

As is the case with most ecosystem services, the consumption decisions made by one individual will affect other's consumption decisions. That is to say, suppose there is an industrial user upstream that diverts a given quantity of instream flows, and whose consumption patterns are the same from day to day. If river flow levels were relatively unchanged over the long-run, then downstream users would presumably adjust to the constant level of flows experienced at their place on the river. Now, suppose stream flows were drastically reduced by a drought and the industrial user did not change the quantity of fresh water they used. If the industrial user consumes the same quantity it consumes during non-drought periods, then everyone downstream would have proportionately less water. However, each user would have the same proportion of water if the industrial user consumed the same percentage of in-stream flows as they had before, during non-drought periods. This action would have very adverse consequences for downstream users. Although legislation is in place to prevent occurrences as drastic as this illustration, the aggregation of individual decisions across the river corridor can have adverse effects on downstream users.

The doctrine of prior appropriations determines water rights within the region, meaning that whichever user was the first to put the water to beneficial use maintains the right to use that water. Upstream users cannot deny downstream water rights holders from their legal share. In this regard, downstream non-consumptive uses can prohibit upstream consumptive uses, but upstream non-consumptive uses do not affect downstream uses for either consumptive or non-consumptive uses.

Most of the water in the region is already appropriated, and many uses are tied to junior water rights. Junior water rights can only be exercised during high-flow years, thereby being unreliable from year to year. Any new uses of water require either a transfer of water rights, increases in water supply through reservoir storage, or mining of ground water.

When considering the allocation of fresh water within the Yellowstone River Corridor, it is essential to take into account all the different users of fresh water within the region, and the ways in which space and time impact their value of fresh water, as well as how one user's consumption habits affect other users within the region. Each type of user has different preferences and needs regarding fresh water consumption. Thus, it is important to know how much fresh water a type of user demands in order to allocate fresh water efficiently throughout the river corridor. For anthropocentric uses, allocation can be determined by the amount a typical user is willing to pay and the number of users within a certain area. For example, a town of 500 people will demand a different amount of water than a town of 5,000 people. For fisheries and wildlife uses, however, the amount of fresh water required is typically based on a biological threshold. Thus, it is important to know how different users' dependency on water and demand for water vary in order to understand the value of the ecosystem service.

Raw Materials

Ecosystems generate benefits through providing raw materials for food, manufacturing, construction and fuels. Specific examples would be timber stands which can be used for building materials and manufacturing, as well as biofuels. Economically, a capital stock could be considered the market value of a stand of timber at a given time. But the ecosystem provides further services that generate economic benefits: a suitable environment for such materials to grow. A steady flow of economic benefits from raw materials is possible through sustainable extraction and management practices. For example, clear-cutting an acre of timber and developing that acre for residential use will result in a one-time payoff of that timber, and benefits from only the residential use thereafter. However, implementing a harvest rotation and leaving that acre in its otherwise natural state will allow multiple market-value payoffs from the timber. Additionally, a properly implemented timber harvest rotation allows for some forest habitat to remain in existence, and for forest regeneration. This is typically not the case where that area of timber is clear-cut in order to be developed.

Cottonwood forests regenerate on the Yellowstone through a complex and lengthy process of forest senescence, channel erosion of forests, recruitment of new seedlings and growth cycles covering a century or more (Report: Riparian Systems). Although no data are readily available, it is thought that a significant portion of the cottonwood forest along the riparian corridor was removed for fuel and to develop agriculture prior to 1950. Presently, changes in historic flows caused by regulating dam releases are impairing natural recruitment of seedlings and growth of new forests due to reduced moisture reaching the riparian areas (Reports: Hydrology; Riparian Systems). Thus, the economic value of raw materials has been negatively impacted by development and flow regulation within the corridor.

Regulating Services

Regulating Services describe the benefits obtained from the ways in which an ecosystem helps to regulate environmental events. That is, it is the benefits generated by the ways an ecosystem helps control things like water flow, flooding, erosion, etc. The Yellowstone River Corridor provides services that regulate water flows, soil erosion, and water quality. Beneficiaries from these services include human users and animal and plant species.

Water Regulation

The ecosystem service Water Regulation is the ways in which “land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas [impacts] the timing and magnitude of runoff, flooding, and aquifer recharge” (Millennium Ecosystem Assessment, 2003). Development in the Yellowstone River Corridor has created barriers within the corridor, resulting in isolated floodplain area – some portion of the floodplain that is no longer accessible to flood waters – along the river. Thus, the economic benefits provided by the floodplain is, to a degree, lost when some type of development/land use causes floodplain isolation. Along the YRC the largest cause of 100-year floodplain isolation is agriculture (9,090 acres of 100-year floodplain isolated), with railroads (active and abandoned, 3,526 acres and 2,303 acres, respectively), hydrologic alteration (3,234 acres), transportation (2,054 acres), and general urban development (1,230 acres) also causing floodplain isolation (Report: Hydraulic Assessment). Collectively, 12.4% of the 100-year floodplain has been isolated (21,437 acres out of 172,419). Generally, approximately 5-20% of the 100-year floodplain has been isolated in any given reach of the river; and approximately 20-50% of the 5-year floodplain has been isolated in any given reach. The dominant water use in the basin is irrigation for agriculture.

A specific type of landscape – wetlands – play a particularly significant role in water regulation. Wetlands hold and slowly release flood water and snow melt. A single acre of wetlands can store somewhere between 1 and 1.5 million gallons of floodwater (3 to 4.5 acre-feet). There are approximately 7,750 acres of wetlands habitat in the Yellowstone River Corridor; nearly 2,500 acres fall within the 100-year floodplain, of which around 500 have been isolated (Report: Hydraulic Assessment).

Although the land uses contributing to floodplain isolation create benefits to society, there is an economic cost associated with the forgone benefits of the isolated floodplains. That is, a certain degree of flood control and mitigation has been traded off for the benefits generated by the above land uses. One way to conceptualize the opportunity cost of the forgone benefits of flood prevention (as a result of floodplain isolation) is to consider the cost of some alternative methods of controlling floods: although not entirely accurate, the costs of flood insurance and flood cleanup offer some insight into the forgone benefits of floodplains after they have become isolated. For example, the average flood insurance policy in Montana in 2011 was $572, annually (Montana Commissioner of Securities and Insurance, 2014). This figure, while not providing a direct estimation of a per unit value of the ecosystem service water regulation, does clearly indicate a willingness to pay for services that reduce the risk of experiencing damages from a flood. Thus, it can be inferred that development resulting in a reduction in water regulating services would cause an increase in the average flood insurance premium observed within the corridor, since the severity of damage caused by a flood would increase in probability.

Erosion Control

An ecosystem provides Erosion Control when vegetative cover helps to retain soil and prevent erosion and maintain or improve soil fertility. Soil provides a physical support system for plants and retains and delivers nutrients to them. Soil fertility is essential for plant growth and agriculture, and well-functioning ecosystems supply the soil with nutrients required to support plant growth. Furthermore, soil can hold and release water flexibly, providing flood control and water purification benefits (U.S. Environmental Protection Agency, 2001). Thus, removal of vegetation from an ecosystem generally has a negative impact on soil retention and fertility. From 1950 to 2001 there was an estimated 1 percent decrease in riparian cover across the entire Yellowstone River Corridor, going from 22% to 21% (Report: Riparian Systems). Even though the removal of riparian vegetation might result in the generation of benefits because of development, it comes at a cost: the depletion of erosion-prevention services and soil fertility. For example, consider a plot of land that was covered in cottonwood in its natural state. Soil erosion on that plot would be moderated by the cottonwood stand. Suppose that the plot of land is cleared and put into irrigated agriculture. The erosion control services once provided by the ecosystem would no longer exist, and the plot of land would experience higher levels of erosion thereafter.

The previous example illustrates the economic tradeoffs of development and erosion control. A plot of land could generate new sources of revenue for the land owner by developing it, but it might come at a cost which is borne by downstream users or society, in general. In the above example, agricultural land likely sees higher financial returns than does a stand of Cottonwoods, but erosion control becomes a forgone benefit once the development takes place. In a scenario like that, the land owner is not the only individual bearing the cost of soil erosion: downstream users would also bear the economic cost as they would be subjected to higher levels of sediment.

A study conducted from 2002 to 2005 of homes near lakes in Prescott, Arizona shows that individuals are willing to pay for erosion control (Yoo, et. al., 2014). More specifically, households were willing to pay between $145 and $334 per ton of decreased sedimentation load into neighboring lake(s). Although these values are likely not representative of the Yellowstone River Corridor, they illustrate how individuals are willing to pay for the ecosystem service erosion control.

Water Purification

An ecosystem provides Water Purification by processing and/or filtering out pollutants such as metals, viruses, oils, excess nutrients, and sediment as water moves through wetland areas, forests, and riparian zones (Daily, 1997). This purification process provides water suitable for industrial uses, recreation, and wildlife habitat, as well as decreasing treatment costs to public utilities. Thus, any development along the river corridor would likely have a negative impact on water purification. Although changes in riparian extent across individual reaches were different (i.e., some reaches saw little to no change in riparian vegetation, while others experienced relatively high degrees of change), Regions A and C saw net losses from 1950 to 2001 (Report: Riparian Systems). It should be noted, however, that large-scale conversions of riparian areas are assumed to have taken place prior to the 1950 study time (i.e., the early 1800's) by way of early agricultural development and timber harvesting for fuel and construction. Wetlands – another natural landscape that helps to purify water – are very dynamic, thereby created and removed by high flow events. The Yellowtail Dam has decreased the river's high flow events, causing less dramatic peaks in the spring and summer. The reduction in channel-forming flows will negatively affect the long-term viability of the riparian and wetland communities (Report: Wetland Systems), and therefore decrease water purification potential. There are no precise measurements of temporal change in wetlands in the corridor, but estimates of losses ranging from 25-33% of the historic extent due to development (Report: Wetland Systems).

Although the land uses negatively impacting water purification create benefits to society, there is an economic cost associated with the forgone benefits of water purification. Consider an acre of riparian vegetation cleared for urban uses: that acre would generate benefits to society by way of said urban development, but then would result in less purified water downstream. For example, developing a natural area into a residential area would not only provide additional space to live, but also generate property taxes. However, once that area had been developed for residential use it would no longer offer the same degree of water purification services – a cost that would be borne by users downstream, such as fish species or another municipality subject to more pollutants. One way to conceptualize the opportunity cost of the forgone benefits of water purification as a result of land use changes is to consider the cost of some alternative methods: although not entirely accurate, the costs of municipal water treatment and removal of pollutants from surface water offer some insight into the forgone benefits of water purification. For example, a study done in Louisiana showed that wastewater treatment by way of natural wetland was 6 times more cost-effective than the conventional sand-treatment method (Jae-Young, et. al., 2004). That is, from a benefit-cost perspective, the wetlands method was 6 times more efficient than the conventional method. Of course, such a metric admittedly disregards other benefits generated by wetlands, like recreation, habitat support, water regulation, etc. Therefore, the depletion of water purification ecosystem services as a result of development generates a loss of economic benefits to the region.

Cultural Service

Cultural Services describe the benefits people acquire through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. The Yellowstone River Corridor provides individuals with the opportunity to experience unique things and the opportunity to conduct research on and within a unique natural environment.

Opportunity to Experience

Ecosystems provide enjoyment and happiness to people in two distinct ways. The first type of enjoyment/happiness occurs when an individual interacts with the ecosystem. This includes enjoyment experienced from some type of recreation, like fishing, rafting, or bird watching and also includes residents who experience enjoyment from living within the ecosystem region or nearby some specific feature of the ecosystem. Economists commonly refer to this first type of enjoyment as use value. The second type of enjoyment/happiness that ecosystems provide occur when an individual finds contentment in just knowing that the ecosystem exists and/or finds contentment in knowing that future generations will have the opportunity to enjoy that ecosystem. Economists refer to the latter types of values as existence and bequest values, respectively; but generally those types of values are known as nonuse values.

Use values are measured by someone's willingness to pay for an environmental good on/in which to recreate or enjoy firsthand. Numerous studies have been conducted to estimate how much an individual values a single day of hiking, fishing, and so on. For example, a study done in Montana, Colorado, and Wyoming found that backpackers were willing to pay $63 (in 2015 dollars) for each day of backpacking (Bhat, et. al., 1998). A U.S. Fish and Wildlife Service study estimated that users were willing to pay $23 for each day of wildlife viewing in Montana (Aiken and la Rouche, 2003).

Nonuse values are measured by an individual's willingness to pay for an environmental good even if they do not intend on using it. The Yellowstone River Corridor provides nonuse values to individuals, within the region. For example, the Crow Nation states they have existence and bequest values for the Yellowstone River Corridor ecosystem (Gilbertz et. al., 2006). Furthermore, nonuse values can – and oftentimes do – exist outside the region, as well. As an illustration, consider an individual living in the Midwest who is willing to pay to protect a fish species in the Yellowstone River, even if they never intend on visiting the region. An often-cited example is the Exxon Valdez Oil Spill that occurred in Alaska in 1989, where a nation-wide study found an aggregate loss of nonuse value to be $4.8 billion (Carson et. al., 2003).

The idea of nonuse values has been a part of the environmental economics field for decades (Krutilla, 1967) and has become extremely prevalent in the literature and federal agency economic analysis procedures (U.S. Environmental Protection Agency, 2000). It is essential to consider how individuals' opportunities to experience are affected by land use decisions and development along the Yellowstone River Corridor in order to best understand the economic impacts of development.

Opportunity to do Research

Another ecosystem service provided by the region is the Opportunity to do Research. This service provides scientists the opportunity to conduct research on species, biological processes, geological processes, etc. Given the fact that some species and biological/geological processes can be region-specific, the opportunity to do research in that particular region is essential to understanding said species traits/characteristics and biological/geological processes. In most instances, the findings from research done in one region can be generalized to other regions across the globe. For example, a land-grant university would perform hydrologic studies on a river within its state and share the findings via professional papers and meetings or extension in other parts of the state, other parts of the country, or other parts of the world, particularly in developing countries. As a general rule, being able to conduct research will result in improved management decisions and increased flows of benefits to society from an ecosystem.

The quality of research opportunities provided by an ecosystem are determined by the end goal. That is, if the research question is 'what are soil-erosion rates given moderated peak flows caused by a dam in a river basin where 20-40% of the 5-year floodplain has been isolated due to development?', then it would be essential to perform the research in a river basin which had experienced comparable anthropogenic impacts. However, if the research question is 'what are the natural mating habits of a native fish species?', then the ecosystem service would be depleted and less rich had the ecosystem experienced anthropogenic impacts. That said, the opportunity to do research provided by an ecosystem is generally regarded as being more valuable the less developed it is. The reason is because natural or undeveloped areas are becoming increasingly scarce. In this way the Yellowstone River is very unique, as it is the longest undammed river in the contiguous United States.

To illustrate the point that undeveloped areas are rare and provide valuable opportunities to study ecosystems: there are very few fresh water ecosystems on earth, relative to saltwater ecosystems. Since fresh water ecosystems attract human settlement and development, particularly irrigated agriculture, virtually all of them have experienced some degree of anthropocentric development. Thus, fresh water ecosystems that are relatively undeveloped are rare, and the opportunity to conduct research in such ecosystems are scarce.

The Yellowstone River Corridor provides many opportunities to do hydrogeological research (e.g. hydrology, geomorphology, hydraulics, etc.). However, the corridor also provides unique opportunities to do biological research on many types of fish and avian species. Although every native species in an ecosystem plays a role in that ecosystem, the value of a given species generally comes from recreation, the opportunity to experience and the opportunity to do research.

The ecosystem service opportunity to do research has economic value. Numerous grants are handed out every year for the sole purpose of conducting research so that the findings might contribute to the overall wellbeing of the general public. Consider the National Science Foundation, who financially backs roughly 24% of all federally-funded research (National Science Foundation, 2015). The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare." The agency states, "no single factor is more important to the intellectual and economic progress of society, and to the enhanced well-being of its citizens, than the continuous acquisition of new knowledge." A study done in 1998 estimated that North Carolina households were willing to pay between $251 and $698 million annually for water quality research and extension programs (Whitehead, et. al., 2001). Although these figures cannot be directly applied to the Yellowstone River Corridor, they do indicate that there is economic value for the opportunity to do research.

Part 2

The following analysis is a departure from ecosystem services and the explicit and implicit values associated with ecosystem services provided within the corridor. Rather, this section analyzes and discusses the economic impacts of tourism and recreation within the Yellowstone river corridor, as well as the economic impacts of the Yellowtail Dam.

Economic Impact of Nonresident Tourism and Recreation in Yellowstone River Corridor Counties

Along the Yellowstone River, Montana's landscape encompasses wide open vistas, mountains and valleys, unique Rimrock landscape and badlands. A number of natural sites include Gallatin National Forest, Makoshika State Park, Pompey's Pillar National Historic Landmark, entrance points to Yellowstone National Park in Gardiner and Cooke City, Absoroka and Beartooth mountain ranges as well as the Paradise Valley outside of Livingston. These sites of natural, cultural and historic significance draw visitors outside of the state for tourism and recreation each year. According to the Statewide Comprehensive Outdoor Recreation Plan of 2014, visitors to Montana counties along the Yellowstone River enjoy scenic driving, photography, wildlife watching, visiting historical sites and day hiking. During the stay, visitors spend money on gasoline and diesel, retail purchases—particularly those associated with fishing, restaurants and bars and hotels and motels, groceries and snacks and other services like fishing or river guides. These nonresident expenditures generate economic activity in the local economy which can be estimated.

The economic impact result from the visitor spending, shown in Table 1 have been estimated by the Institute for Tourism and Recreation at the University of Montana for years 2012-2013 by using IMPLAN, an economic input-output model. (Grau, K., 2014) (Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government). Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. The estimates include direct, secondary and combined impacts in industry output and employment.

Employment represents the number of jobs generated in the region from a sector in the economy. Estimates for employment include *full time, part time, and temporary jobs.* Economic impact of industry output refers to the value of goods and service produced by an industry which nonresidents purchase. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. “Multipliers” (or “response coefficients”) capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

Rosebud, Prairie, Treasure and Sweet Grass counties were omitted from the analysis and the report due to particularly low visitor spending estimates in those counties.

Table 1 shows the economic impacts for nonresident travel between years 2012 and 2013. Yellowstone County sees the largest number of direct impacts on industry output and employment at $288,550,000 and 3,400 respectively. Park County is the second with direct impacts of $142,360,000 in industry outputs and 2,060 in employment.

Table 1: Economic Impact of Nonresident Travel 2012-2013

	Industry Output ($)			**Employment (# of jobs)**		
	Direct	Secondary	Combined	Direct	Secondary	Combined
Richland	$31,990,000	$9,100,000	$41,090,000	390	90	480
Dawson	$26,410,000	$9,140,000	$35,550,000	310	90	400
Custer	$61,230,000	$25,790,000	$87,020,000	800	260	1,060
Yellowstone	$288,550,000	$158,280,000	$446,820,000	3,400	1,450	4,850
Carbon	$49,190,000	$18,380,000	$67,570,000	740	180	920
Stillwater	$29,850,000	$6,570,000	$36,420,000	370	70	440
Park	$142,360,000	$52,950,000	$195,320,000	2,060	580	2,640

Source: Grau, K., 2014, Institute for Tourism and Recreation Research, University of Montana

Yellowtail Dam

Yellowtail Dam is located in Southcentral Montana. It was built between 1963 and 1966 as a part of the Pick-Sloan Missouri Basin Program. The dam serves multiple purposes; providing irrigation water, flood control, recreation and power generation. (Bureau of Reclamation, 2015) As a result of the Dam, it has been estimated that flood damage was reduced by $113 million between the years of 1965 and 2007. (National Park Service, 2015) The power produced by the Yellowtail Power plant supplies electrical energy to the surrounding area. The electricity produced is owned and managed by the Western Area Power Administration (WAPA). The irrigation water supplied by the dam travels northeast along the Yellowstone River, helping provide water to over one hundred thousand acres of agricultural land. Canyon views, boating, hiking, camping and fishing recreational opportunities attract local and non-local users to experience the Bighorn Canyon National Recreation Area which resulted from construction of the Yellowtail Dam.

Power Generation

Yellowtail Power plant has an installed capacity of 250,000 kilowatts. The production of power at the dam supplies electricity for residential and commercial use in the surrounding area. (Bureau of Reclamation)

Table 2 displays the average generation of power at the Yellowtail dam as a percentage of the average total generation for Pick-Sloan over a five year period. The average generation is equivalent to marketed energy for Pick-Sloan power. (Gierard, J. and Radecki, M., written commun.) Figure 1 shows the geographic area of Pick-Sloan as a whole, the Eastern Division, the Western Division, and the Missouri River Basin watershed. While Yellowtail dam produces 21.2% of total load in the Western division, it only produces 4.3% of the total load in the Eastern Division. This averages to 7.1% of total load generation for Pick-Sloan from the Yellowtail dam. The percentage of population served by the Western Division, where the Yellowtail Dam power generation is at 21.2%, varies by state and is highest in rural South Dakota and lowest in urban Colorado.

Table 2: Average Generation of power at Yellowtail Dam, Courtesy of WAPA

	Yellowtail Generation (GWh)	**Total Generation (GWh)**	**% of Yellowtail Dam Generation/Load**
Western Division plus Mt. Elbert Plant	401	1,888	21.2%
Eastern Division	401	9,382	4.3%
Total Pick-Sloan	802	11,270	7.1%

Source: Western Area Power Administration

Figure 1: Pick-Sloan Service Area. Courtesy of Western Area Power Administration

Bighorn Canyon National Recreation Area

The construction of the Yellowtail Dam increased recreational opportunities for local and non-local residents. The cold water flows into the Bighorn River from the dam created a world class trout fishery which has become the most fished stream in the state of Montana. Yellowtail Dam also led to the designation of Bighorn Canyon National Recreation Area in 1968. (National Park Service) Each year Bighorn Canyon National Recreation Area welcomes over 200,000 visitors who are seeking fishing, wild life viewing, hiking, bird watching, boating and camping. These visitors contribute to the economic activity of the region through their spending. Local and non-local visitor spending is captured by National Park Service through surveys. This information is then used in an input-output model to estimate the economic impact and economic contribution of non-local and local visitors to the recreation area.

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The results presented here are published in the 2013 National Park Service Visitor Spending Effects report and are estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The

IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic impact and contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis, Stillwater, Big Horn, Carbon, Yellowstone, Musselshell, Rosebud, and Treasure Counties of Montana as well as Sheridan, Big Horn, Hot Springs, Johnson, Park and Washakie Counties of Wyoming were included as the region. Regional economic contributions from the IMPLAN model are reported for the following categories:

- <u>Employment</u> represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- <u>Labor Income</u> includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- <u>Value Added</u> measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Tables 3 and 4 show Non-local recreation visits and associated economic impacts as well as total recreation visits and associated economic contribution from visitor spending. Total recreation visit for 2013 to the Bighorn Canyon National Recreation Area was slightly over 241 thousand people. These visitors contributed close to $11 million dollars in total output from which almost $10 million dollars was generated from non-local visitor spending. A total of 140 jobs were created through recreation visits and visitor spending, while 126 of those jobs were created due to non-local visitor spending.

Table 3: Impacts of Non-local Visitor Spending, 2013

Park Unit	Non-Local Recreation Visits	Non-Local Visitor Spending ($ Thousands)	Impact of Non-Local Visitor Spending			
			Jobs	Labor Income ($ Thousands)	Value Added ($ Thousands)	Output ($ Thousands)
Bighorn Canyon National Recreation Area	166,325	$8,756.2	126	$3,298.5	$5,479.2	$9,926.8

Source: Cullinane Thomas, C., 2013 National Parks Visitor Spending Effects

Table 4: Contribution of all Visitor Spending, 2013

Park Unit	Total Recreation Visits	Total Visitor Spending ($ Thousands)	Contribution of all Visitor Spending			
			Jobs	Labor Income ($ Thousands)	Value Added ($ Thousands)	Output ($ Thousands)
Bighorn Canyon National Recreation Area	241,528	$9,893.5	140	$3,646.6	$6,026.7	$10,850.1

Source: Cullinane Thomas, C., 2013 National Parks Visitor Spending Effects

Conclusion

The Yellowstone River Corridor's natural environment provides benefits to human users and animal and plant species through ecosystem services. The ecosystem services provided by the river corridor can be classified as Provisioning, Regulating, or Cultural Services. These ecosystem services are typically valued using non-market valuation techniques, since they do not have market prices explicitly associated with them.

The Yellowstone River Cumulative Effects Analysis was generated by a need to know the status of the river's water flows and floods (hydrology and hydraulics) and their relationship with the geomorphology of the river channel and environment. It further looked at the long term effects on the biology of the river corridor to determine if there were cumulative impacts to the biology from social and economic efforts to control river flooding, bank erosion, and other changes to the river channel.

It is essential to account for the ecosystem services provided by the Yellowstone River Corridor during land use decision-making processes to place in context ecology, land use decisions, and economic interactions. Furthermore, it is necessary to understand how different types of development impact the corridor's ecosystem services, and in turn, how different types of development impact human users, wildlife species, and plant species within the region and outside of the region. In better understanding these interactions, decision-makers can be better informed with designing and implementing best management practices.

This evaluation has offered a qualitative analysis on the impacts of development on ecosystem services within the Yellowstone River Corridor. Thus, the analysis was grounded in theory and drew upon outside research and empirical evidence, offering examples from the Yellowstone River where appropriate. In order to more accurately estimate the impacts of development on ecosystem services within the river corridor as well as understand the benefits and costs of land use changes, a quantitative analysis on the Yellowstone River Corridor should be conducted in order to help form best management practices. More specifically, data on individuals' willingness to pay to maintain current levels of ecosystem services or reestablish natural levels of ecosystem services could be used to estimate the value of those ecosystem services. In turn, those values could be compared to market values typically earned as a result of development. Such data are typically collected through a survey and the estimation process referred to by economists as contingent valuation. Another estimation technique, referred to as the hedonic property method, uses property and home sales data to estimate the value of ecosystem services. Regardless of the method, a quantitative analysis on the Yellowstone River Corridor and its ecosystem services would allow land owners, utilities directors, and industrial managers to more accurately understand the impacts of their decisions. Furthermore, a quantitative analysis would provide pertinent information with which policy-makers might use to form policy.

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Yellowstone River Reach Narratives

County	Sweetgrass	**Upstream River Mile**	478.8
Classification	PCB: Partially confined braided	**Downstream River Mile**	475.4
General Location	Springdale	**Length**	3.40 mi (5.47 km)

Narrative Summary

Reach A1 is located just downstream of the Springdale Bridge in western-most Sweet Grass County. It is a Partially Confined Braided (PCB) reach type, indicating some influence of the valley wall on river geomorphology, as well as abundant un-vegetated mid-channel bars. The reach is 3.4 miles long. This reach is most prominently characterized by a large meander located at RM 478 that has been very dynamic over recent years. The meander bend has repeatedly migrated to the north and then cut off, leaving broad open gravel bars and a wide active channel corridor. The bendway has been heavily armored on its apex, and partially armored on its downstream limb. With all of the changes at this meander, there has been a net gain of total channel area in the reach of about 50 acres since 1950.

There are about 6,800 feet of rock riprap in the reach, over 1,500 feet of which was constructed since 2001. Several flow deflectors have been eroded out in Reach A1 since 2001. About 25% of the bankline in Reach A1 was armored as of 2011. There are also over 6,800 feet of mapped transportation encroachment in the river corridor, most of which is the rail line that follows the south bank.

Although the rail line runs along the edge of the river, it is situated on higher terraces and as such has not isolated any 100-year historic floodplain area. However, about 9% of the total Channel Migration Zone (CMZ) footprint has become restricted, and these restrictions are due to armoring against both the rail line and irrigated fields. This demonstrates how terraces that may be out of the 100-year floodplain can still be prone to erosion and thus within the CMZ.

The primary land use in the reach is non-irrigated agriculture (~1,100 acres), although there are about 650 acres under some form of irrigation. Pivot irrigation has expanded from 0 acres in 1950 to 302 acres in 2011. Similarly, sprinkler irrigation has expanded from 0 to 250 acres during the same time frame, and the extent of flood irrigated lands dropped from 803 to 123 acres over those 61 years. About 46 acres of land under sprinkler and 10 acres of land under pivot are located within the CMZ.

About 120 acres of wetland have been mapped in the reach, with most of that (84 acres) emergent wetland marsh that is located primarily in the active stream corridor. About 20 acres of wetland have been isolated from the corridor by the rail line near RM 477.8. About 0.7 acres of Russian olive have been mapped in the reach, and these trees are dispersed throughout the corridor.

Hydraulic modeling of the reach shows an extensive network of floodplain channels on the floodplain in Reach A1 that creates some avulsion risk north of the river. Much of the armoring on the large meander at RM 478 has reduced the risk of an avulsion and potential bypass of the Prather Mayborn Westfall Ditch Diversion. In addition, one of the overflow channels has been allowed to activate, which has reduced the potential for additional avulsions. The strategic allowance of channel migration and secondary channel activation has prevented the creation of a severe pinch point at RM 477.4 that may have created long-term instability in the reach.

A large dike at RM 476.7 blocks a ~3,000ft long side channel and focuses the river towards the south bank and the Prather Mayborn Westfall Ditch Diversion. Although the dike blocks the head of the channel, it is still seasonally accessed by other overflow points from the main river.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,750cfs to 1,570cfs with human development, a reduction of 10.3%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A1 include:
- Strategic allowance of side channel activation to reduce overall avulsion risk
- Isolation of emergent wetlands by transportation infrastructure
- Blockage of a 3,000ft long side channel to focus flows to a diversion structure.

Recommended Practices for Reach A1 include:
- CMZ management due to level of restriction and avulsion risks on north floodplain
- Channel Bank Stabilization Recommended Practices due to current extent of bank armoring (25% of total bankline)
- Irrigation diversion structure management at Prather Mayborn Westfall
- Wetland management/restoration due to high wetland concentrations

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	23,300	22,900	-1.7%
100 Year (cfs)	43,400	43,200	-0.5%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
189.9	216.9	242.7	256.3	66.4

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	6,838	19.2%	1,678
Concrete Riprap	0	0.0%	0
Flow Deflectors	2,092	5.9%	-309
Total	**8,930**	**25.1%**	**1,369**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	2,970

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	44.0	62.6
Acres/Year	1.7	2.5
Acres/Year/Valley Mile	0.5	0.8

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

-45.46 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	13.2	7%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
65.8	9%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	1,992.8	1,789.8
Ag. Infrastructure (Ac)	52.1	109.4
Exurban (Ac)	5.4	5.4
Urban (Ac)	0.0	0.0
Transportation (Ac)	47.6	81.5

	1950	2011
Flood (Ac)	803.4	122.6
Sprinkler (Ac)	0.0	254.2
Pivot (Ac)	0.0	301.6

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
3.7	0.0	3.7	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	7.4	2.3
Emergent	84.3	26.0
Scrub/Shrub	38.0	11.7

Total Wetland Acres **129.8**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
0.7	0.2%

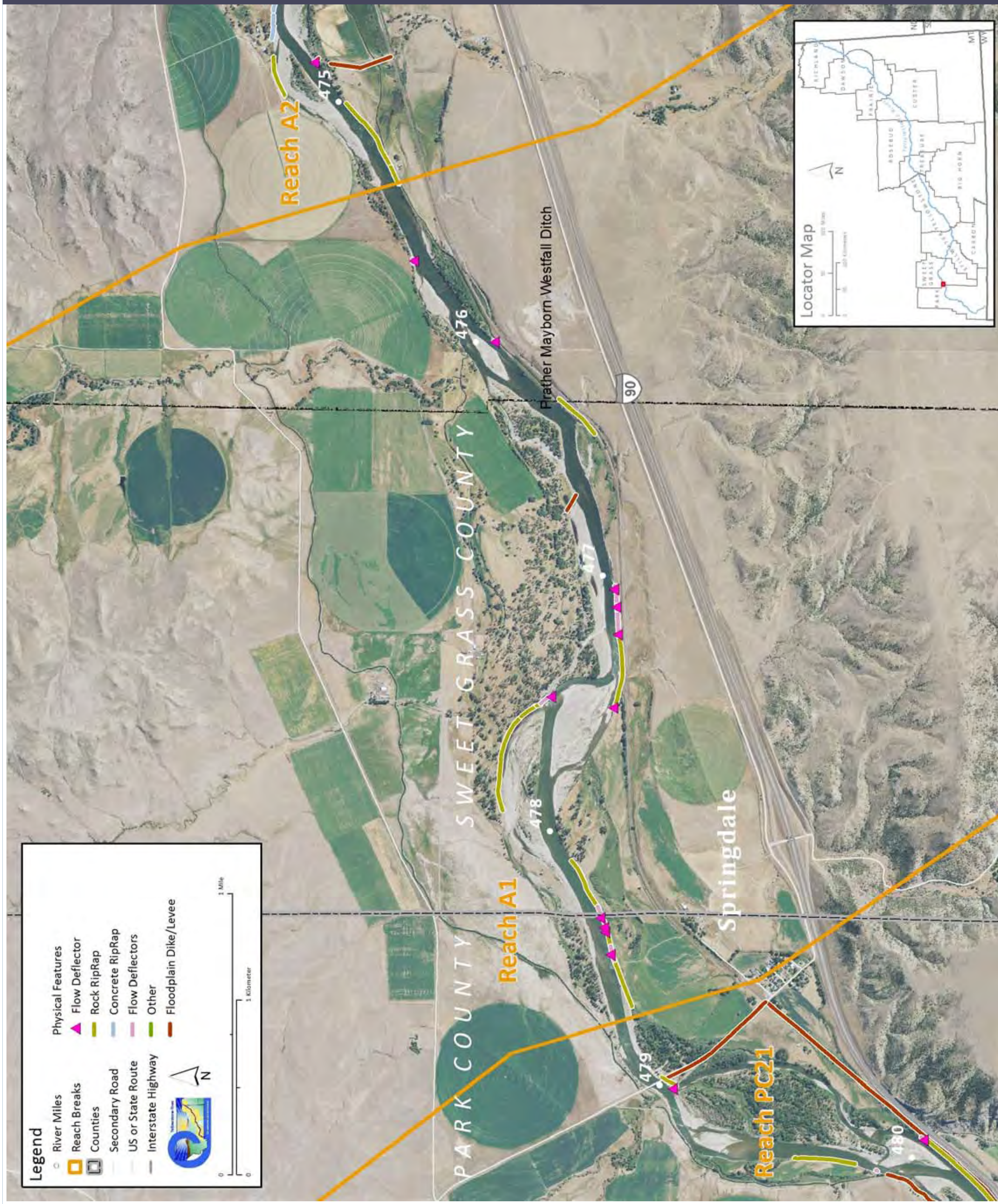
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

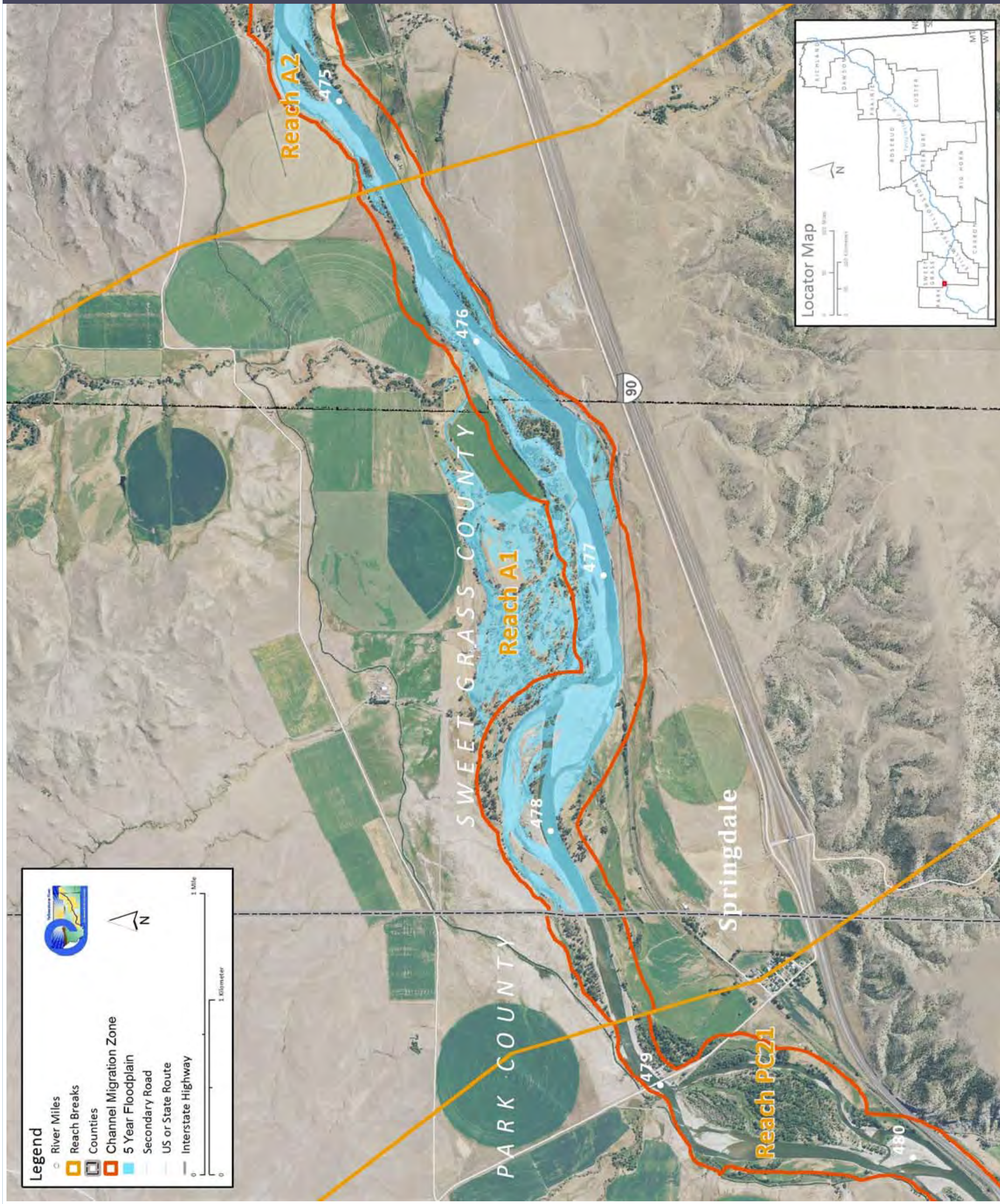
1950	1976	2001	Change 1950-2011
0.0	0.0	0.0	0.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	475.4
Classification	UB: Unconfined braided	**Downstream River Mile**	468.5
General Location	Grey Bear fishing access	**Length**	6.90 mi (11.10 km)

Narrative Summary

Reach A2 is 6.9 miles long and extends from about one mile below the Prather Mayborn Westfall Ditch Diversion to about a mile below the Grey Bear fishing access. Reach A2 is classified as Unconfined Braided (UB), indicating a relatively small influence of the valley wall on reach geomorphology as well as a preponderance of open gravel bars in the channel. Reach A2 has changed markedly since the 1950s due to loss of riparian forest and side channel length.

As a consequence of its unconfined and dynamic nature, there are over two miles of rock riprap in the reach that cover almost 18% of the total bankline. Of those 10,633 feet of rock riprap, 1,673 feet was constructed since 2001. The physical features mapping also indicated 945 feet of tree revetments in the reach in 2001, however these were not identified in the 2011 mapping. This is the most upstream-reach with mapped concrete rubble riprap; there are over 1,000 feet of concrete riprap on the left bank at RM 474.6.

Sometime prior to 1950, one 3,125 foot long channel was blocked at RM 473. In 1950, there were still over 6 miles of active anabranching channels, but by 2011 that side channel length had dropped to 4 miles, resulting in a 15% reduction of braiding parameter in the reach.

There is also intermittent transportation encroachment by the railroad on the south side of the river. The transportation encroachment, which is due to the rail line, extends over two miles along the south bank and isolates 23 acres of historic floodplain. Similarly, 140 acres of the natural Channel Migration Zone (CMZ) area has been restricted by bank armor and the railroad prism.

Floodplain turnover values show that turnover rates have dropped from 4.5 acres per year to 3.7 acres per year since 1976. The channel has also enlarged by over 30 acres as anabranching channels have consolidated into a larger single thread. About 23 acres of 100-year floodplain area has been isolated by dikes.

Land uses in Reach A2 are primarily agriculture, with about ½ of the total agricultural land in some form of irrigation. About 26 acres of the existing 5-year floodplain are currently under irrigation, most of which is in flood.

Over 300 acres of wetland have mapped in the reach, most of which is emergent marsh-type areas. About 40 acres of emergent wetland are in an area of historic floodplain isolated by the railroad at RM 471.2. Approximately ½ of an acre of Russian olive was mapped in Reach A2.

Reach A2 has had extensive riparian clearing over the last century. In 1950, there were 431 acres of closed timber in the reach, and that footprint had contracted to 275 acres by 2001. Almost 12 acres of riparian forest in the reach per valley mile have been identified as being at low risk of cowbird parasitism due to the distance of those areas from agricultural infrastructure.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,760cfs to 1,580cfs with human development, a reduction of 10.2%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A2 include:
•Blockage of over 3,000 feet of side channel prior to 1950
•Passive abandonment of over two additional miles of side channel since 1950.
•Loss of over 150 acres of closed timber since 1950, most of which is in the 5-year floodplain.

Recommended Practices for Reach A2 include:
•Side Channel Restoration (RM473)
•CMZ management due to extent of encroachment (140acres restricted)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	23,300	22,900	-1.7%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	43,400	43,200	-0.5%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	442.3	474.7	464.9	480.2	37.9	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	12,305	16.9%	1,673	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	1,015	1.4%	1,015	
Flow Deflectors	154	0.2%	154	
Total	**13,475**	**18.5%**	**2,842**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	3,125	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	117.5	93.0	-30.58 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	4.5	3.7		
Acres/Year/Valley Mile	0.7	0.6		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	16.1	4%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	23.4	3%	

Restricted Migration Area	Acres	% of CMZ	
	140.5	11%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,713.3	3,548.8	Flood (Ac)	2,014.7	1,213.3	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	141.0	217.9	Sprinkler (Ac)	0.0	93.9	
Exurban (Ac)	0.0	13.4	Pivot (Ac)	0.0	737.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	91.6	150.5				

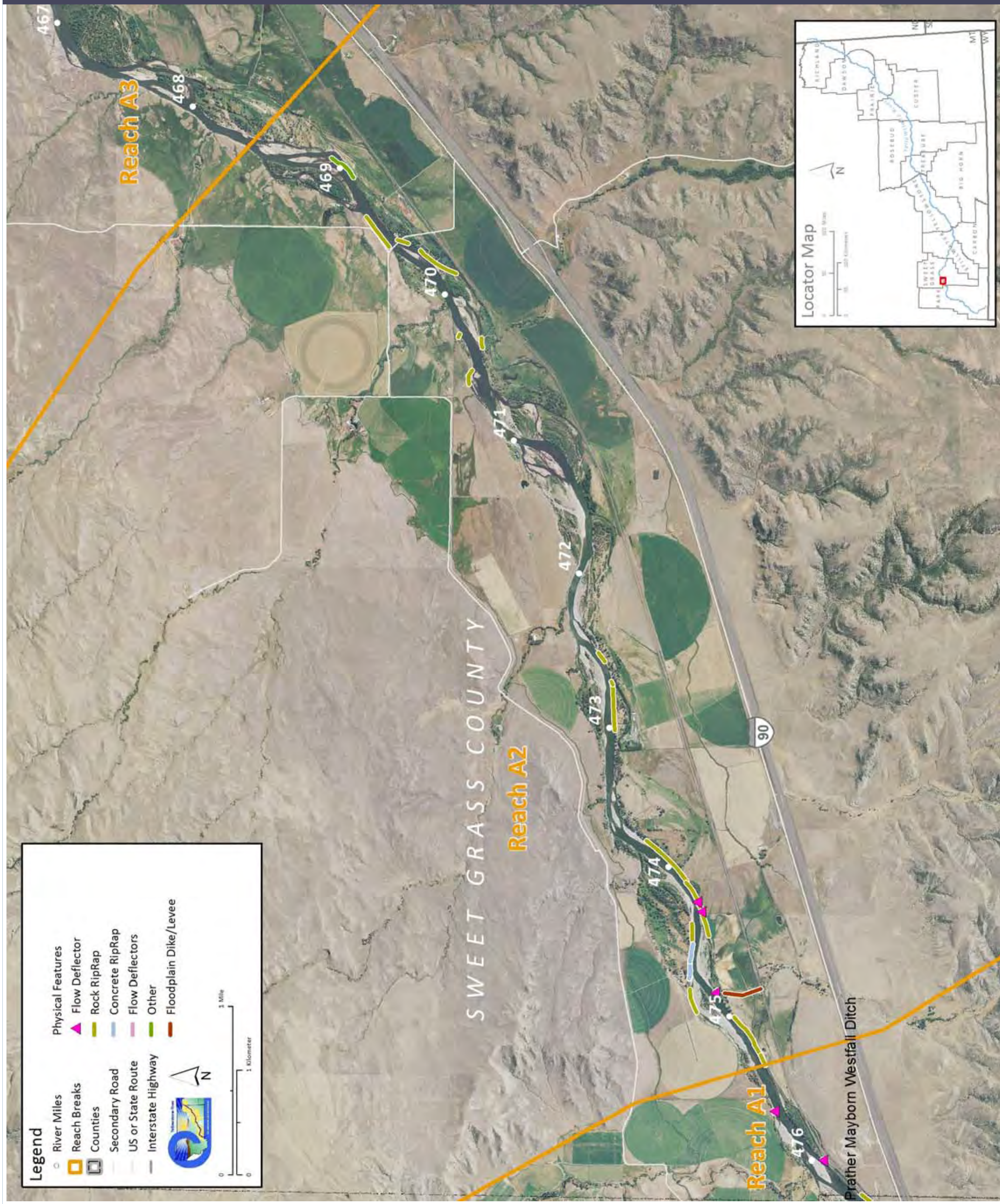
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	4.3	0.8	5.1	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	17.0	2.6	**355.7**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	257.8	39.9		
Scrub/Shrub	80.9	12.5		

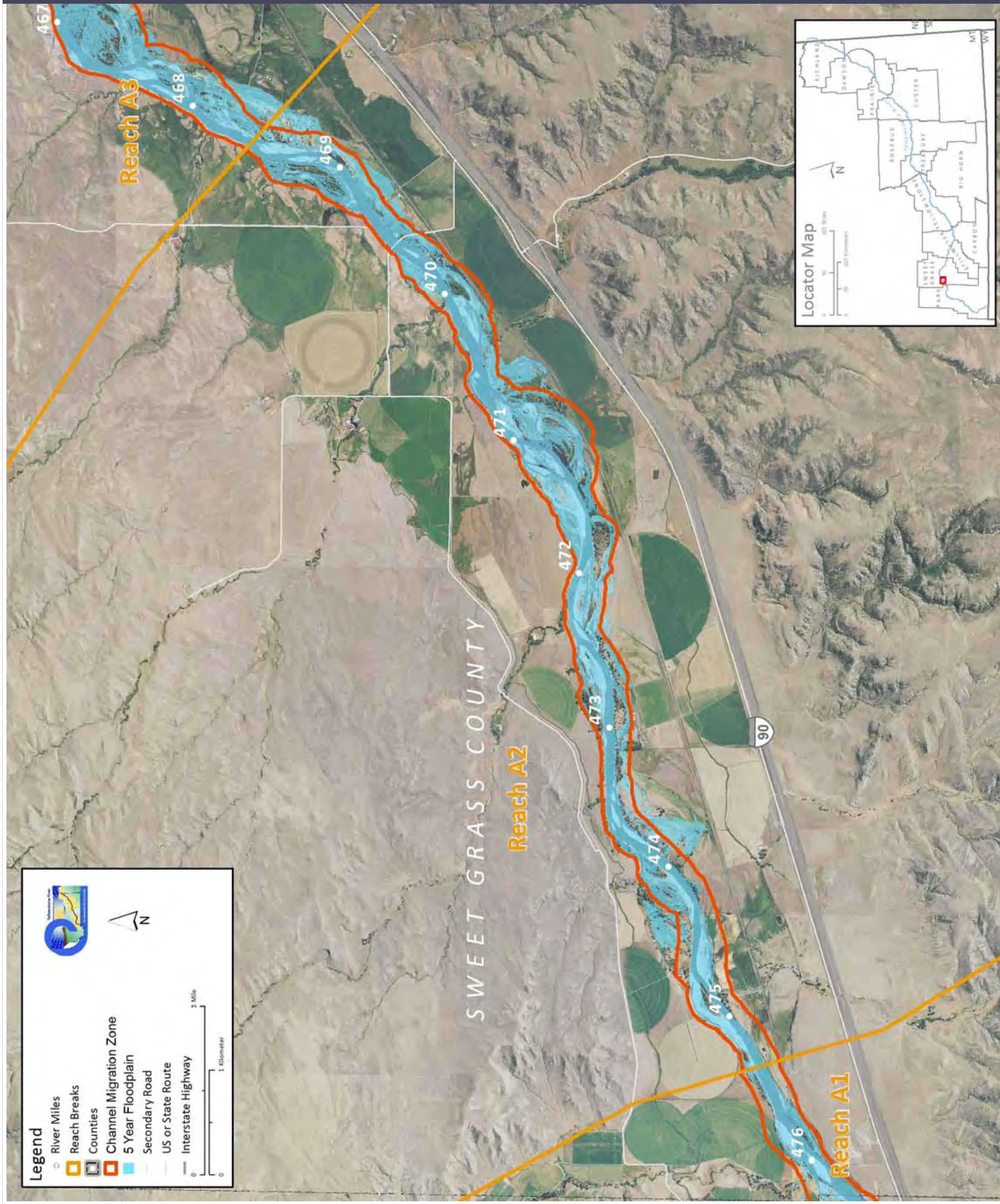
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	0.4	0.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	11.6	11.4	6.9	-4.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	468.5
Classification	PCB: Partially confined braided	**Downstream River Mile**	463
General Location	Upstream of Big Timber	**Length**	5.50 mi (8.85 km)

Narrative Summary

Reach A3 is 5.5 miles long and is just located upstream of the town of Big Timber. It is classified as a Partially Confined Braided (PCB) reach type indicating some valley wall influence and relative extensive open gravel bars and low flow secondary channels. This reach shows the passive loss of miles of anabranching channel length since 1950, similar to Reach A2 just upstream. The river has converted from having more than one primary channel to having a dominant main thread with intermittent side channels.

About 12.5 % of the banks in Reach A3 are armored, with the majority of that armor being rock riprap. Between 2001 and 2011, about 1,700 feet of new bank armor, of which 277 feet are flow deflectors, were installed. There are about 2,000 feet of floodplain dikes in the reach.

Similar to Reach A2 just upstream, this reach has experienced extensive loss of anabranching channel length since 1950. In 1950, the total length of anabranching channels was 6.7 miles, and by 2001 that length had dropped to 4.7 miles, resulting in a reduction in braiding parameter of 17%.

Reach A3 shows a reduction in floodplain turnover rates since 1976; prior to that time, average rates of turnover were 103 acres per year, and since that time the average rate of floodplain erosion by the river has been reduced to 65.4 acres per year.

Land use in Reach A3 is predominantly agricultural, with about ½ of all agricultural acreage in flood irrigation. Approximately 13% of the 5-year floodplain has been isolated in the reach. This isolation reflects the slight reduction in the magnitude flows in this reach due primarily to irrigation-related withdrawals upstream.

Over 600 acres of wetland have been mapped in Reach A3, most of which is emergent marshes and wet meadows on the south side of the river. The 4.6 acres of Russian olive mapped is dispersed throughout the riparian corridor.

Almost 50 acres of riparian forest per valley mile is considered at low risk of cowbird infestation due to its relative distance from agricultural infrastructure that provides cowbird foraging habitat.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 11,900cfs to 11,500 cfs, a drop of about 3.4%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,770cfs to 1,580cfs with human development, a reduction of 11%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A3 include:
•Passive abandonment of over two miles of side channel since 1950.
•Conversion from a river channel with multiple large primary channels to a single main thread with small anabranches.
•Reduced floodplain turnover rates.

Recommended Practices for Reach A3 include:
•Russian olive removal
•Wetland management/restoration due to high density of mapped emergent wetland

Yellowstone River Reach Narratives

Reach A3

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	23,300	22,900	-1.7%
100 Year (cfs)	43,400	43,200	-0.5%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	343.5	379.6	366.8	376.5	33.0

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	6,765	12.0%	1,291
Concrete Riprap	0	0.0%	0
Flow Deflectors	277	0.5%	277
Total	**7,042**	**12.5%**	**1,568**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	103.0	65.4
Acres/Year	4.0	2.6
Acres/Year/Valley Mile	0.9	0.6

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

-7.98 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	13.2	3%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	99.5	9%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	3,050.1	2,981.2
Ag. Infrastructure (Ac)	7.3	22.0
Exurban (Ac)	0.0	0.0
Urban (Ac)	0.0	0.0
Transportation (Ac)	3.3	6.3

	1950	2011
Flood (Ac)	1,492.4	1,670.4
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	3.6	0.0	3.6	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	5.1	1.1
Emergent	558.7	120.5
Scrub/Shrub	86.5	18.7

Total Wetland Acres **650.3**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

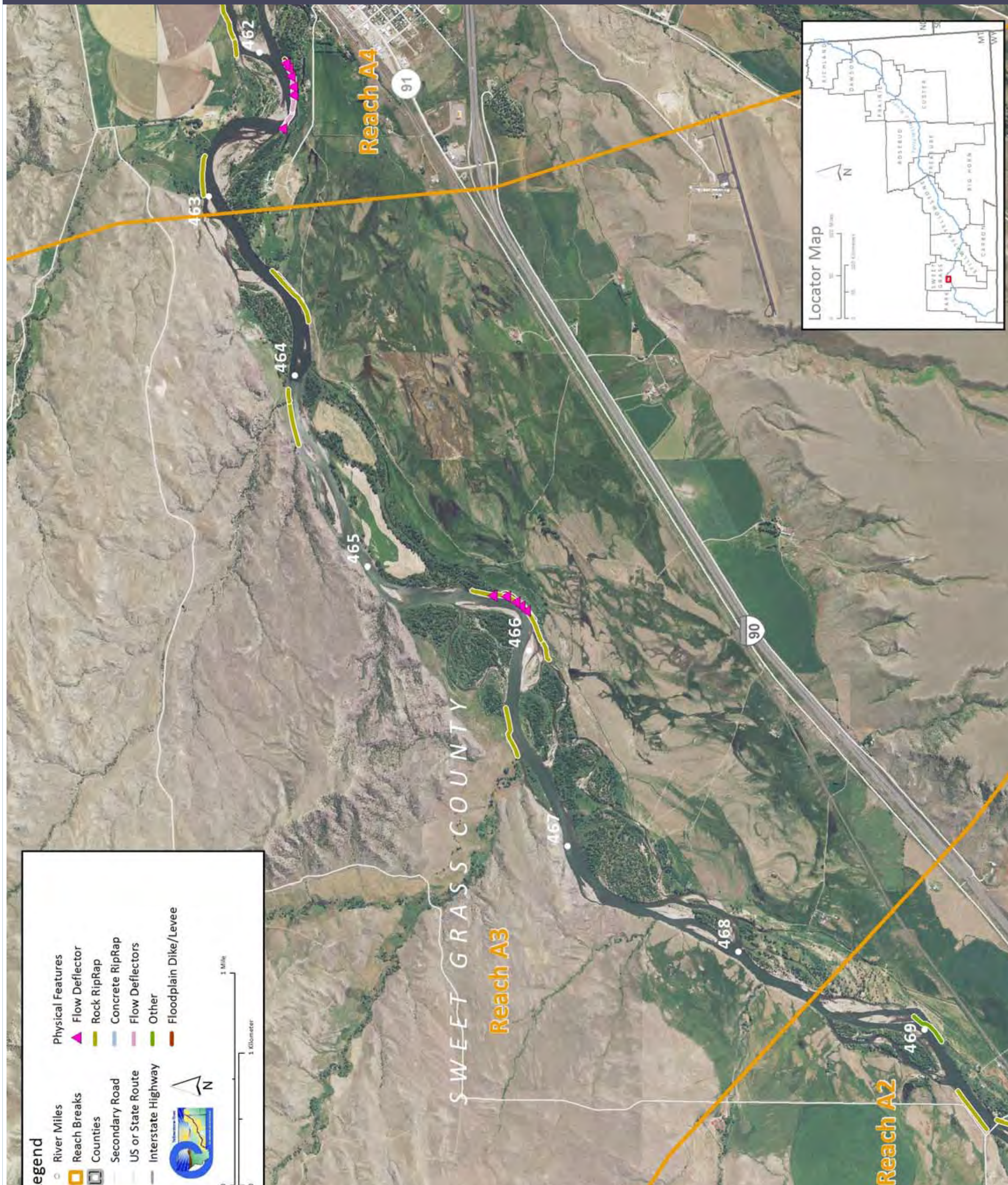
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	4.6	0.3%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

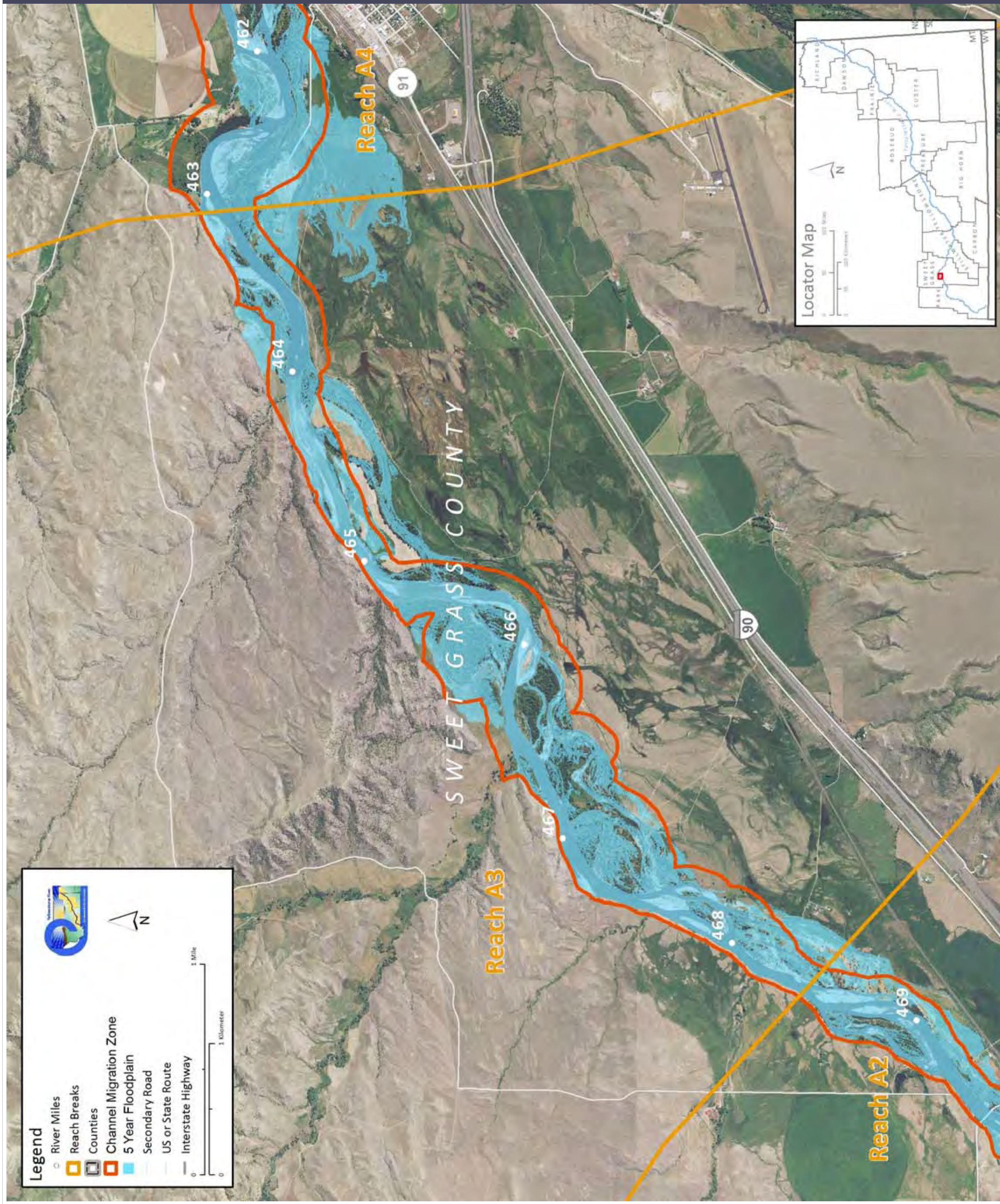
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	46.4	60.5	49.5	3.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	463
Classification	UB: Unconfined braided	**Downstream River Mile**	459.7
General Location	Big Timber	**Length**	3.30 mi (5.31 km)

Narrative Summary

Reach A4 is approximately 3.3 miles long, extending from near the Sweet Grass County Fairgrounds downstream to the Boulder River confluence. Reach A4 is very dynamic with active channel migration, threats to infrastructure, bank armor, flanked barbs, and active riparian recruitment on raw gravel bars. The most dynamic portion of the reach is upstream of the Highway 191 Bridge; in spring of 2013 a large meander formed a 1,500 foot long chute cutoff near the fairgrounds which abandoned about 3,500 feet of channel to the south.

About 19 % of the banks in Reach A4 are armored, with the majority of that armor being rock riprap. Between 2001 and 2011, there was a loss of about 1,000 feet of armor in the reach. Over 800 feet of that lost bank protection was flow deflectors; flanked barbs are visible in the middle of the channel downstream of the fairgrounds. With the avulsion of 2013, those flanked barbs are now sitting in the abandoned channel. Similar to reaches upstream, the river channel in Reach A4 has increased in size since 1950 by about 19 acres, and the channel expansion has been at the expense of riparian cover. Almost a quarter of the Channel Migration Zone (CMZ) has been restricted by physical features, and the restrictions are primarily due to bank armor that is protecting agricultural land.

Since 1950, over 7,500 feet of side channels in Reach A4 have been blocked by berms, which have caused a 25% drop in braiding parameter for the reach. Russian olive has colonized these historic channels. Like many other reaches the loss of active side channels in this reach has been accompanied by a lengthening of the main thread. Between 1950 and 2001, the main channel lengthened by about 1,000 feet through the 3.3 mile reach.

Land use in Reach A4 is predominantly agricultural, although there are several hundred acres of urban/exurban development associated with the town of Big Timber. Most of the agricultural land is non-irrigated; however there are hundreds of acres of flood, sprinkler, and pivot irrigation in the reach. Almost 150 acres of irrigated ground are within the 5-year floodplain in Reach A4, and most of that commonly flooded ground is south of the fairgrounds. This area also has most of the 160 acres of mapped wetlands in the reach.

There is one mapped dump site in Reach A4, which is on the high terrace edge at Big Timber. There is also one major petroleum product pipeline in the reach that runs parallel to the river on its north side. The pipeline is owned by ConocoPhillips, and passes under both Big Timber Creek and Otter Creek within 1,500 feet of the Yellowstone River.

Almost 200 acres of land in Reach A4 are within the mapped Channel Migration Zone. This includes 83 acres of flood, 42 acres of sprinkler, and 37 acres of pivot. A total of 21 acres of land in the CMZ has been developed to urban/exurban use.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 11,900cfs to 11,500 cfs, a drop of about 3.4%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,880cfs to 1,620cfs with human development, a reduction of 14%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A4 include:
•Restriction of the Historic Migration Zone (HMZ) isolating side channels and reducing riparian turnover.
•Primary channel lengthening in association with loss of side channels.
•Rapid migration and channel realignment resulting in barb flanking and abandonment of rock in channel.
•Isolation of historic channels (over 7,500 feet) by berms.
•Russian olive colonization within isolated side channels.
•Riparian recruitment (cottonwood establishment) on islands created by channel migration.

Recommended Practices for Reach A4 include:
•Removal of flanked armor at RM 462.3
•Side channel restoration/management (RM 461.2, RM 462)
•CMZ management due to encroachment (200 acres restricted)
•Russian olive removal (2.7 acres)
•Solid waste removal from dump on right bank at RM 461
•Pipeline management at Big Timber Creek and Otter Creek tributary crossings just north of Yellowstone River.

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	23,300	22,900	-1.7%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	43,400	43,200	-0.5%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	203.9	238.6	235.7	257.2	53.3	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	6,143	16.8%	-168	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	932	2.5%	-854	
Total	**7,075**	**19.3%**	**-1,022**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	7,575	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	64.1	58.2	-35.78 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	2.5	2.3		
Acres/Year/Valley Mile	0.8	0.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	8.5	3%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	0.0	0%	

Restricted Migration Area	Acres	% of CMZ	
	183.0	23%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011	
Agricultural Land (Ac)	2,380.8	2,154.9	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	112.7	138.6	
Exurban (Ac)	22.3	105.2	
Urban (Ac)	176.6	268.6	
Transportation (Ac)	60.8	64.4	

Irrigated	1950	2011
Flood (Ac)	1,161.8	385.3
Sprinkler (Ac)	0.0	194.7
Pivot (Ac)	0.0	301.5

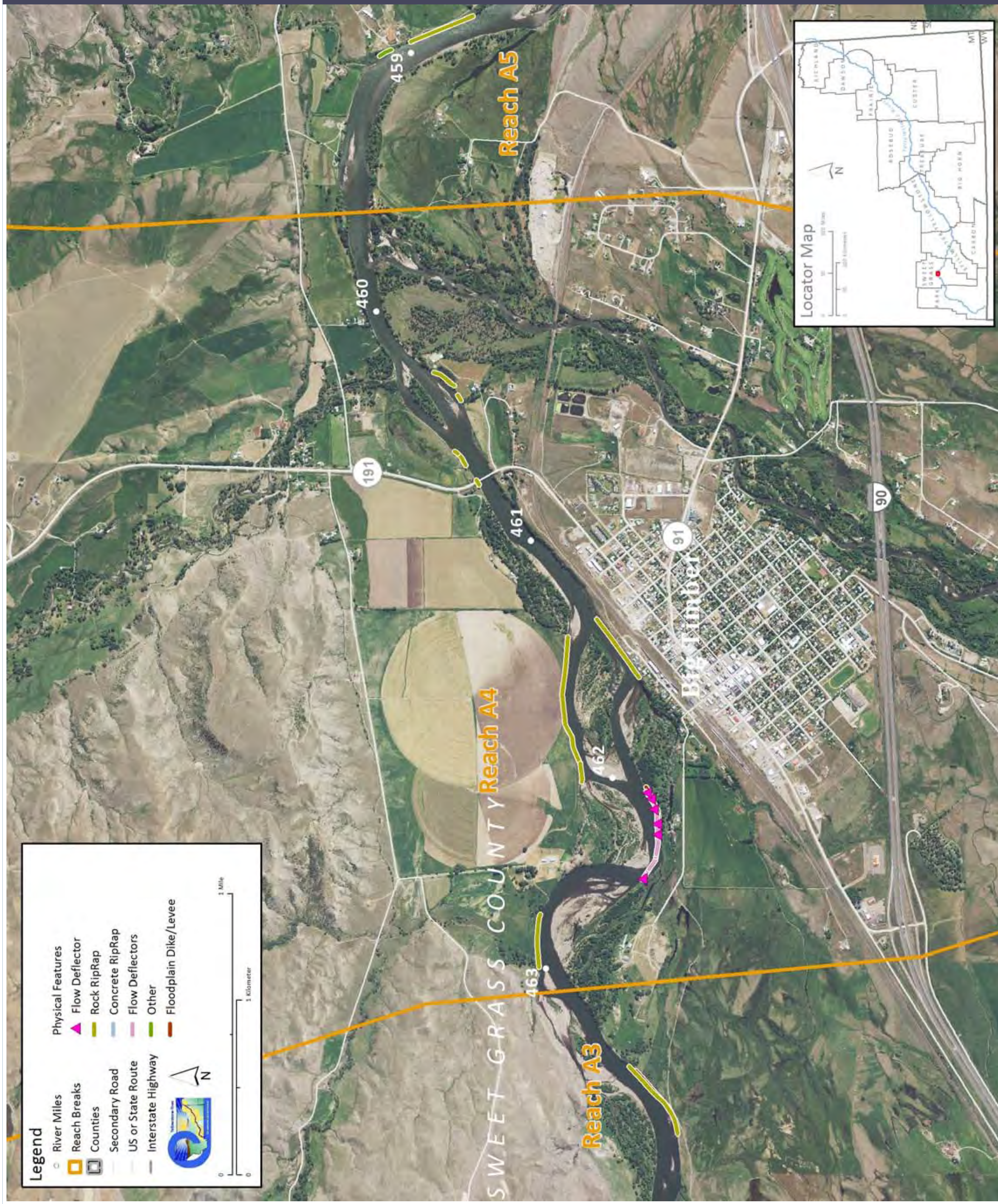
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	2.4	8.2	10.6	3.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	3.7	1.3	**164.1**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	140.0	47.6		
Scrub/Shrub	20.5	7.0		

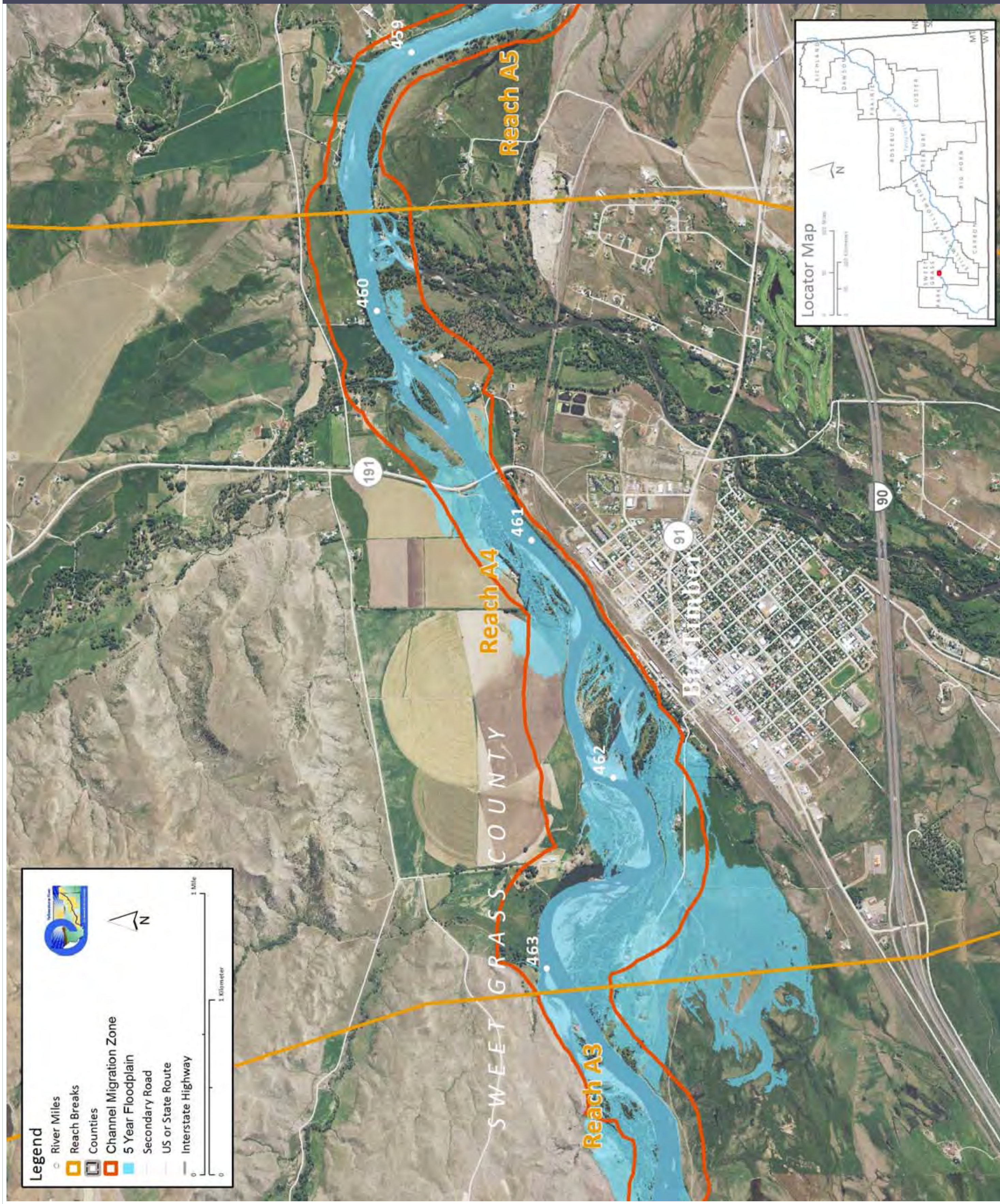
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	2.7	0.3%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	0.0	0.0	0.0	0.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives Reach A5

County	Sweetgrass	**Upstream River Mile**	459.7
Classification	UB: Unconfined braided	**Downstream River Mile**	456.4
General Location	Big Timber Creek	**Length**	3.30 mi (5.31 km)

Narrative Summary

Reach A5 is approximately 3.3 miles long, and is located just below Big Timber near the Otter Creek Fishing Access Site starting just below the mouth of the Boulder River. Reach A5 is shows low migration rates and has a relatively narrow CMZ as a result. Similar to other reaches in Region A, the channel footprint has enlarged since 1950; in this reach the channel shows continual expansion from 1950 to 2001 of about 24 acres. This has been accompanied by a loss of 16 acres of riparian area in the main river corridor.

About 7 % of the banks in Reach A5 are armored by rock riprap. Another 250 feet of bank is protected by tree revetments which are unusual on the Yellowstone River.

Land use in Reach A5 is predominantly agricultural, although there over 60 acres of urban/exurban development on the outskirts of Big Timber. Most of the agricultural land is non-irrigated, although there are almost 400 acres of ground under flood irrigation and another 150 acres under pivot. There are corrals associated with an Animal Holding Facility on the left bank of the river at RM 459.

Reach A5 has substantial irrigated land in the Channel Migration Zone. Land use mapping for 2011 conditions show 62 acres of flood, 2 acres of sprinkler, and 9 acres of pivot irrigated land within the CMZ boundary.

Reach A5 has seen almost a quarter (18 acres) of its riparian corridor converted to developed land uses since 1950. Most of that (17 acres) was conversion to irrigation.

Over 170 acres of wetland have been mapped in Reach A5. Most of the wetland area is on the eastern portion of the large alluvial fan formed at the mouth of the Boulder River, where there are open water wetlands and wet marsh areas.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 12,600 to 12,100 cfs, a drop of about 4%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,910cfs to 1,630cfs with human development, a reduction of 15%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A5 include:
•Riparian clearing in support of irrigation.
•Presence of corrals on the edge of the corridor at RM 459.
•Extensive wetland complex on low alluvial ground at the toe of a terrace.
•Encroachment of irrigated land into Channel Migration Zone.

Recommended Practices for Reach A5 include:
•Nutrient management at corrals at RM 459
•Wetland management/restoration due to extent of emergent marsh (>170 acres)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	24,500	24,000	-2.0%
100 Year (cfs)	45,500	45,200	-0.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
188.3	195.7	203.1	219.2	30.9

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	2,117	6.2%	851
Concrete Riprap	0	0.0%	0
Flow Deflectors	0	0.0%	
Total	**2,117**	**6.2%**	

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	24.7	29.3
Acres/Year	0.9	1.2
Acres/Year/Valley Mile	0.3	0.4

1950-2001 In-channel riparian encroachment (negative number indicates retreat)
-15.9 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	1.2	0%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
16.1	4%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	1,580.8	1,447.0
Ag. Infrastructure (Ac)	18.0	62.8
Exurban (Ac)	0.8	64.2
Urban (Ac)	0.0	0.0
Transportation (Ac)	7.1	7.1

	1950	2011
Flood (Ac)	733.8	391.5
Sprinkler (Ac)	0.0	8.3
Pivot (Ac)	0.0	154.4

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
16.6	1.4	18.0	24.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	6.3	2.1
Emergent	157.3	52.8
Scrub/Shrub	9.5	3.2

Total Wetland Acres
173.2

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
0.2	0.1%

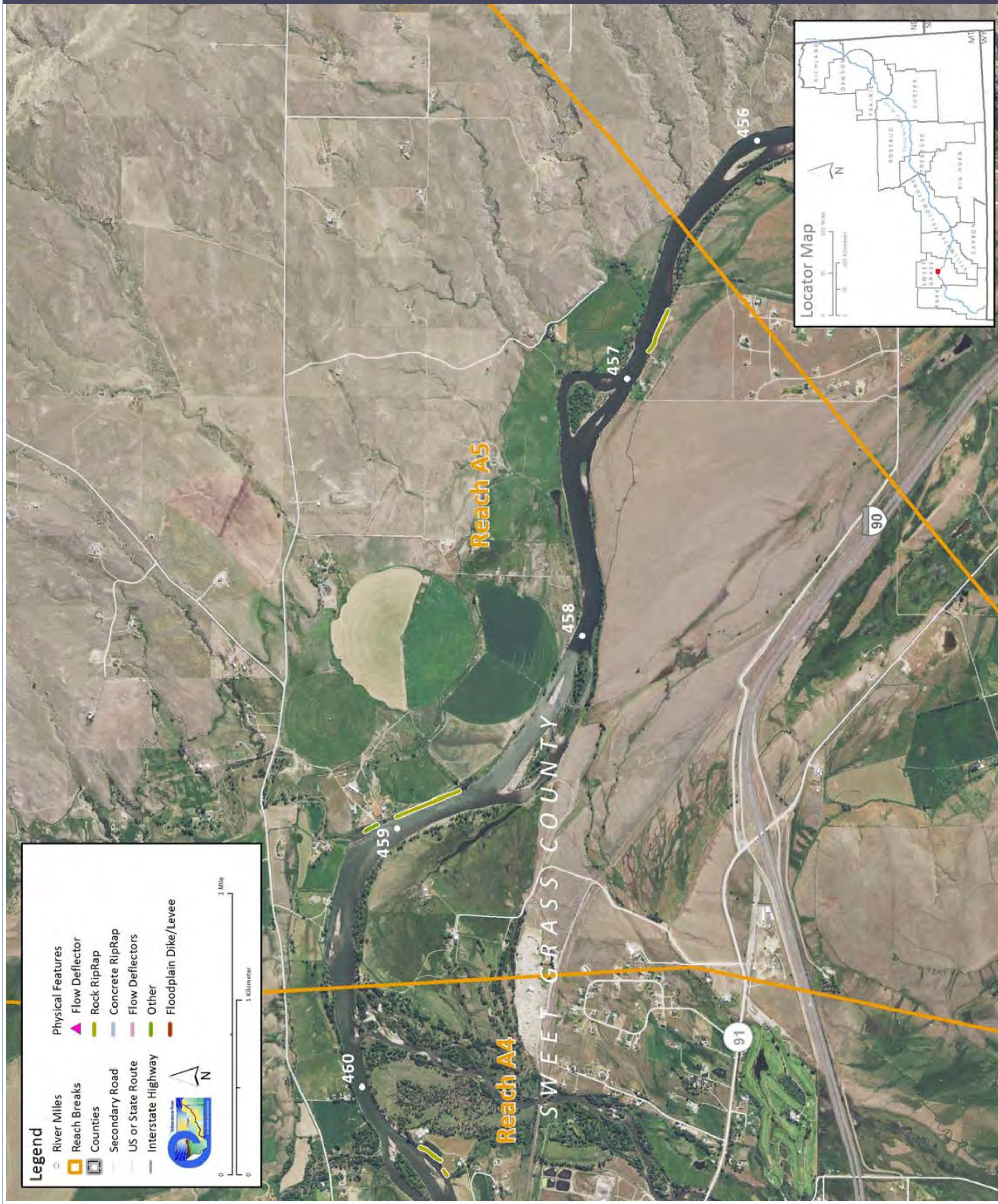
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

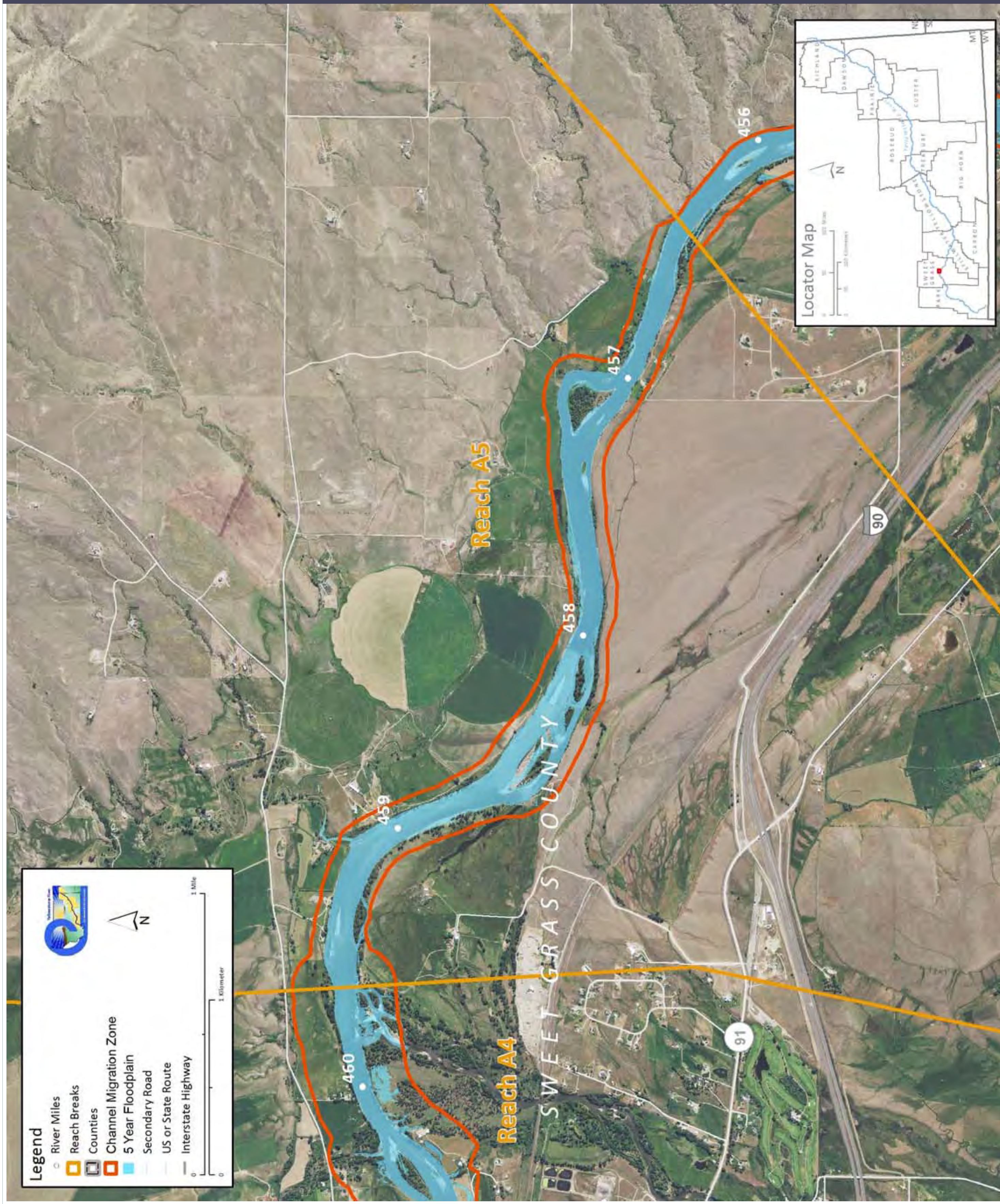
1950	1976	2001	Change 1950-2011
3.6	3.3	2.3	-1.3

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	456.4
Classification	PCS: Partially confined straight	**Downstream River Mile**	453.3
General Location	Below Big Timber	**Length**	3.10 mi (4.99 km)

Narrative Summary

Reach A6 is approximately 3.1 miles long, and is located below Big Timber. The reach is classified as Partially Confined Straight (PCS), which indicates some valley wall influences on river form and minimal meandering. Within this reach, the river consistently follows the northern bluff line of the river valley which is comprised of Cretaceous-age Hell Creek Formation sandstones and mudstones. The other side of the river consists of low floodplain and terrace deposits. Because of the valley wall confinement, migration rates are low in the reach and the Channel Migration Zone (CMZ) is narrow.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 161 acres but by 2001 it had expanded to 202 acres.

About 7 % of the banks in Reach A6 are armored, and most of that bank protection is flow deflectors (2,165 ft). There is another 650 feet of rock riprap, all of which was constructed between 2001 and 2011.

One side channel in Reach A6 was blocked prior to 1950. It is about 2,700 feet long and is blocked by a dike as well as flow deflectors along the bank. The side channel currently hosts riverine and emergent wetland areas.

Land use in Reach A6 is predominantly agricultural, although there almost 200 acres of exurban development on the low terraces between the river and I-90. Most of the agricultural land is non-irrigated, although there are 760 acres of ground under flood irrigation and another 64 acres under pivot. A total of 35 acres of flood irrigated land are in the Channel Migration Zone.

Reach A6 has seen 28 percent (18 acres) of its riparian corridor converted to developed land uses since 1950. Most of that (17 acres) was conversion to irrigation.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 12,600 to 12,100 cfs, a drop of about 4%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,910cfs to 1,630cfs with human development, a reduction of 15%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

The reduction in flows is evident by the contraction of the 5-year floodplain area in Reach A6 by 4.8 acres, or 30%.

CEA-Related observations in Reach A6 include:
•Riparian clearing in support of irrigation.
•Side Channel Blockage
•Contraction of 5-year floodplain due to flow alterations.

Recommended Practices for Reach A6 include:
•Side channel restoration at RM 454.5

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	24,500	24,000	-2.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	45,500	45,200	-0.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	160.9	160.3	176.7	201.9	41.0	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	648	2.1%	648	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	2,165	6.9%	42	
Total	**2,814**	**9.0%**	**690**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	2,691	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	11.5	22.6	-6.51 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	0.4	0.9		
Acres/Year/Valley Mile	0.2	0.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	4.8	30%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	0.0	0%	

Restricted Migration Area	Acres	% of CMZ	
	20.1	6%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011	
Agricultural Land (Ac)	1,821.9	1,538.8	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	16.8	6.4	
Exurban (Ac)	0.0	198.5	
Urban (Ac)	0.0	0.0	
Transportation (Ac)	19.1	77.4	

	1950	2011
Flood (Ac)	936.4	761.1
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	64.1

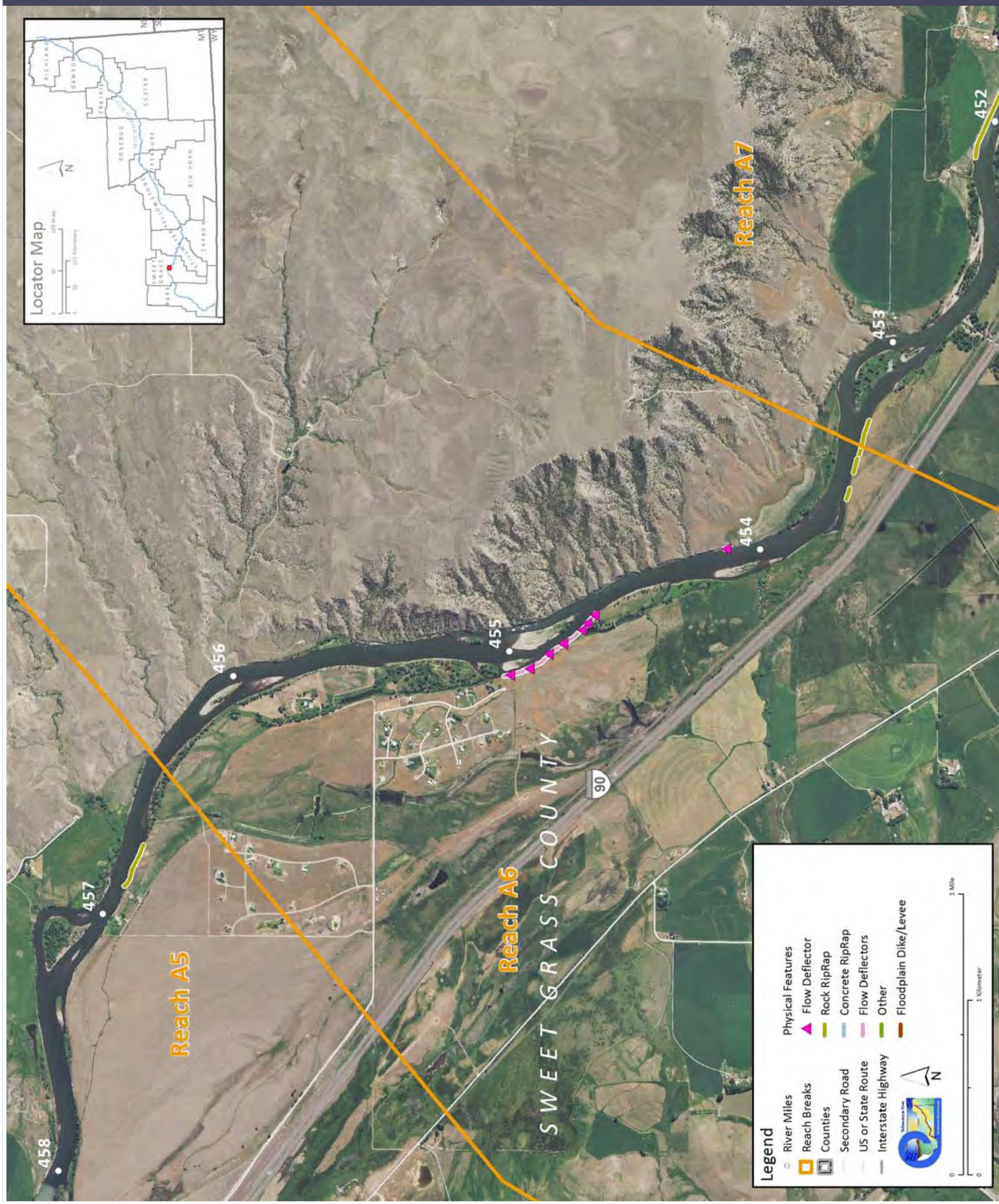
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	16.9	0.8	17.7	28.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	14.3	5.1	**38.6**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	23.3	8.3		
Scrub/Shrub	1.1	0.4		

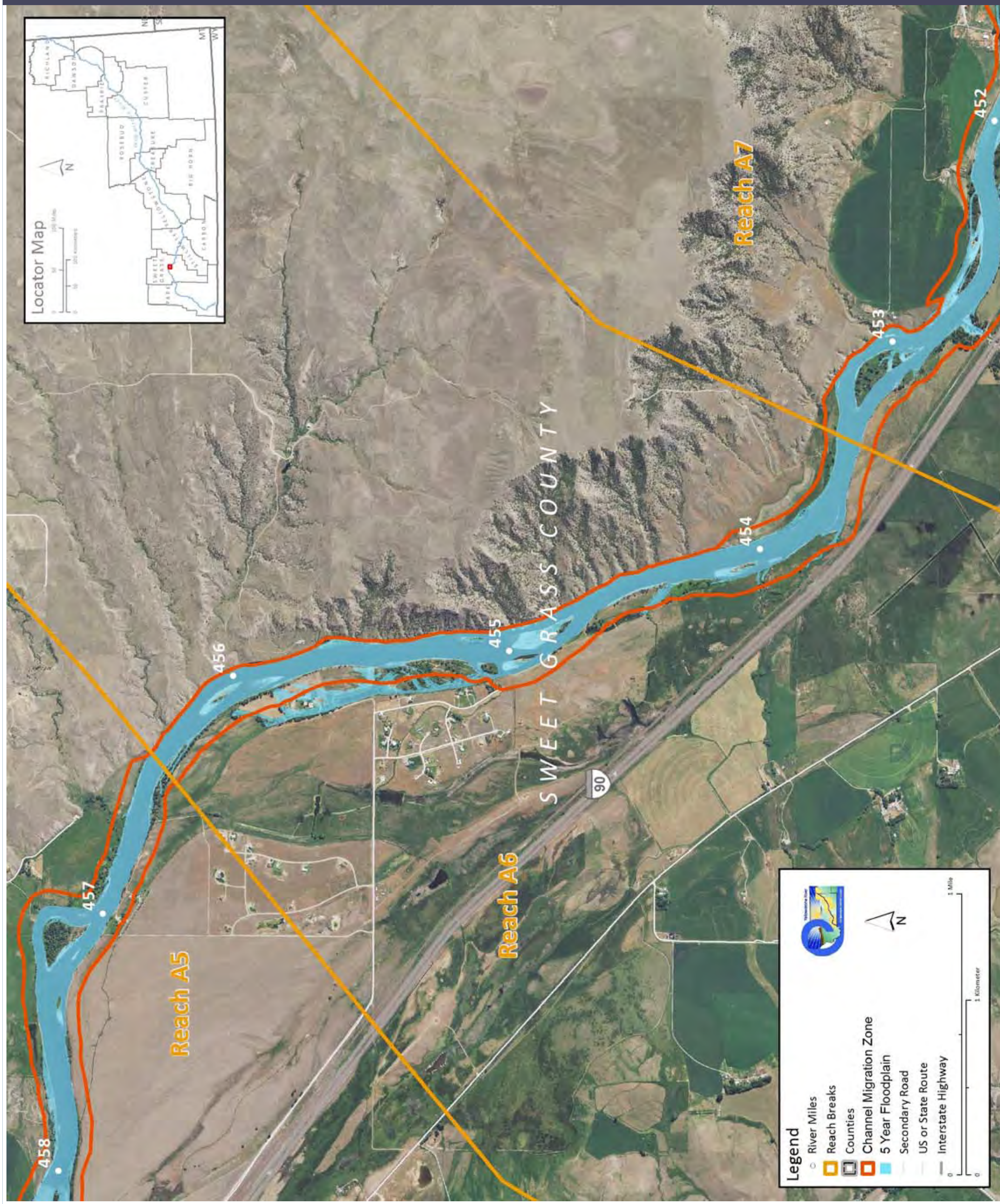
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	0.1	0.0%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	0.8	0.0	0.7	-0.1	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	453.3
Classification	PCB: Partially confined braided	**Downstream River Mile**	443.6
General Location	Greycliff	**Length**	9.70 mi (15.61 km)

Narrative Summary

Reach A7 is approximately 9.7 miles long, and is at Greycliff. The reach is classified as Partially Confined Braided (PCB), which indicates some valley wall influences on river form and relatively extensive gravel bars and low flow channel complexity. Within this reach, the river intermittently follows the northern bluff line of the river valley which is comprised of Cretaceous-age Hell Creek Formation sandstones and mudstones. The other side of the river valley consists of low floodplain and terrace deposits. In several places, such as at Greycliff Bridge, the terrace toe is sandstone. Several tributaries enter the river in this reach, including Sweet Grass Creek and Deer Creek.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 613 acres but by 2001 it had expanded to 723 acres.

As of 2011, about 12 % of the banks in Reach A7 were armored, and most of that bank protection is rock riprap (11,254 feet). There are also 1,500 feet of flow deflectors in the reach. Between 2001 and 2011, about 2,400 feet of riprap and 230 feet of flow deflectors were constructed. There are also minor amounts of gabions and steel retaining wall in the reach.

Reach A7 has experienced the loss of thousands of feet of side channels both pre- and post- 1950. Prior the collection of the 1950s imagery, a channel that was almost a mile long was blocked in multiple places. The land that this blocked side channel is about ½ mile downstream of the Greycliff Bridge on the right bank and is part of the Pelican Fishing Access Site. Currently, only the downstream portion of this channel has good definition; the upper end has largely decayed. Since 1950, side channels have been blocked at RM445 and RM452. Both of these side channels were relatively small features that flowed on the south side of the river corridor. In total, 4,600 feet of channel were blocked post-1950. Since 1950 there has been a net loss of about 9,000 feet of side channel in the reach, indicating some passive loss as well as loss due to blockages.

In contrast to the general trend on the river, floodplain turnover rates in Reach A7 have increased since 1976. From 1950-1976 the average floodplain turnover rate in this reach was 3.4 acres per year, and from 1976-2001, that rate had increased to 5.5 acres per year.

Land use in Reach A7 is predominantly agricultural, although there almost 140 acres of exurban development on the low terraces between the river and I-90. Transportation infrastructure also comprises almost 300 acres of the mapping footprint. Most of the agricultural land is non-irrigated, although there are 1,500 acres of ground under flood irrigation, 225 acres under sprinkler and another 914 acres under pivot. A total of 267 acres of developed land are in the Channel Migration Zone. Most of that is in flood irrigation (196 acres), but 51 acres are in pivot. At RM 450, pivots extend to the active streambank on both sides of the river. About 10% of the CMZ is restricted by physical features.

Reach A7 has seen 5 percent (33 acres) of its riparian corridor converted to developed land uses since 1950. Most of that (23 acres) was conversion to irrigation. Currently, there are about 26 acres of land under pivot irrigation within the mapped 5-year floodplain.

Reach A7was sampled as part of the avian study. The average species richness in Reach A7 was 9.9, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. One bird species of concern (SOC), the Bobolink, was identified in the reach. Three bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, including the Chimney Swift, Dickcissel, and Ovenbird.

On area in Reach A7 that has become persistently problematic is the Greycliff Bridge at RM448.5. Bank migration upstream of the bridge has approached 1,000 feet of lateral movement since 1950. Bank armor has been flanked and now sits In the middle of the river. The county road that lies in the CMZ has been threatened; it was treated with buried revetment that has become exposed in recent years. Efforts are ongoing to develop an optimal strategy to funnel the river meanderbelt through the bridge without disrupting sediment transport patterns and causing accelerated erosion.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 13,200cfs to 12,700 cfs, a drop of about 4%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,000cfs to 1,670cfs with human development, a reduction of 17%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

The reduction in flows is evident by the contraction of the 5-year floodplain area in Reach A7 by 62 acres, or 25%.

CEA-Related observations in Reach A7 include:
•Flanking of armor and accelerated erosion behind.
•Side Channel Blockage
•Contraction of 5-year floodplain due to flow alterations.

Recommended Practices for Reach A7 include:
•Side channel restoration RM452, RM447.9, RM445
•Bank armor removal upstream of Greycliff Bridge

•CMZ management due to encroachment of pivots

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	25,600	25,100	-2.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	47,400	47,100	-0.6%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	613.3	627.0	632.6	722.7	109.3	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	11,254	10.8%	2,338	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	1,507	1.4%	226	
Total	**12,761**	**12.2%**	**2,564**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	4,756	4,610	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	89.2	138.5	-3.83 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	3.4	5.5		
Acres/Year/Valley Mile	0.4	0.6		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	62.2	25%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	12.6	2%	

Restricted Migration Area	Acres	% of CMZ	
	164.2	10%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	5,652.9	5,154.6	Flood (Ac)	2,027.4	1,465.8	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	77.6	167.7	Sprinkler (Ac)	0.0	224.5	
Exurban (Ac)	17.2	138.4	Pivot (Ac)	0.0	913.8	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	110.1	295.9				

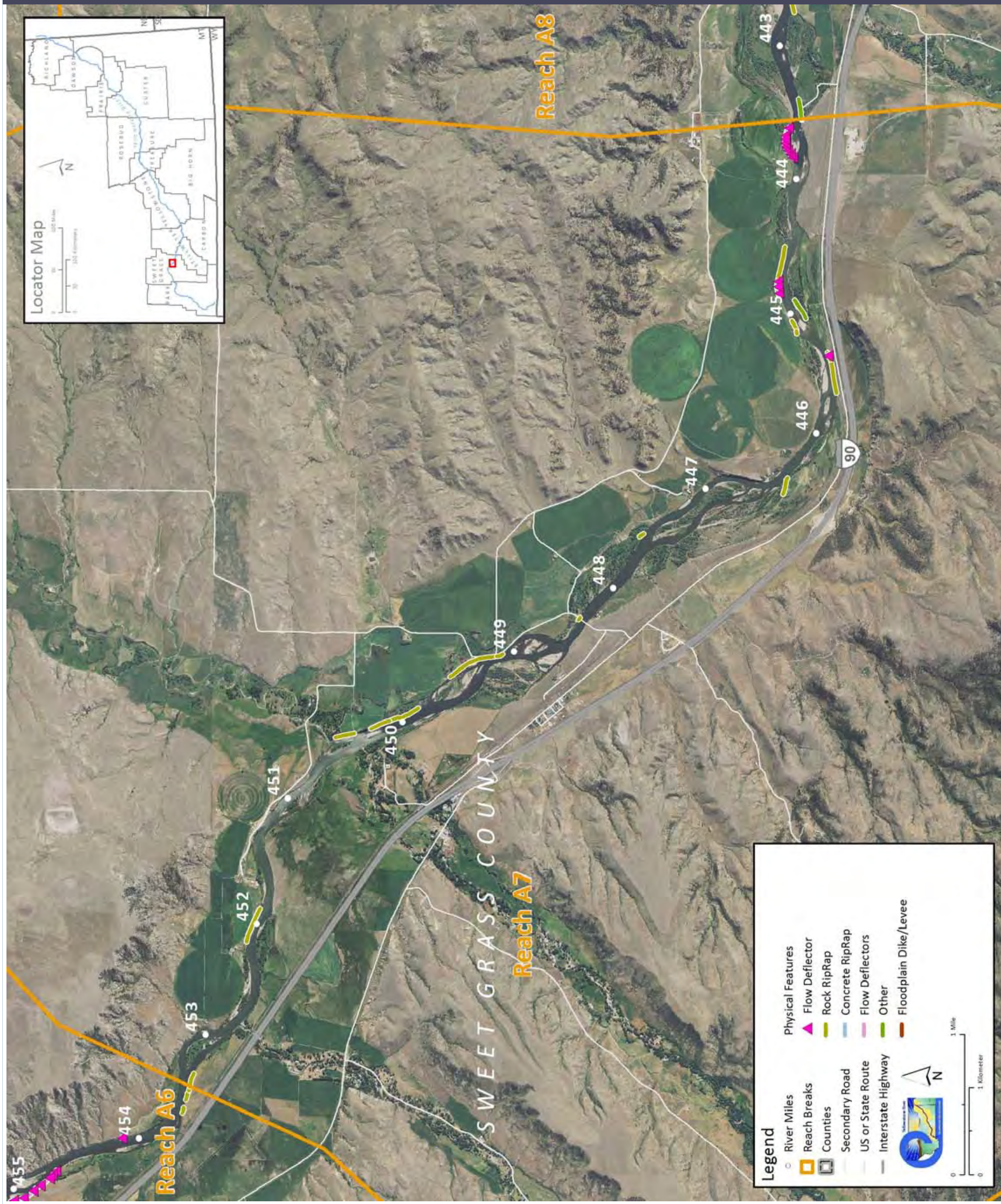
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	22.8	9.7	32.5	5.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	14.1	1.6	**113.2**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	56.6	6.2		
Scrub/Shrub	42.5	4.7		

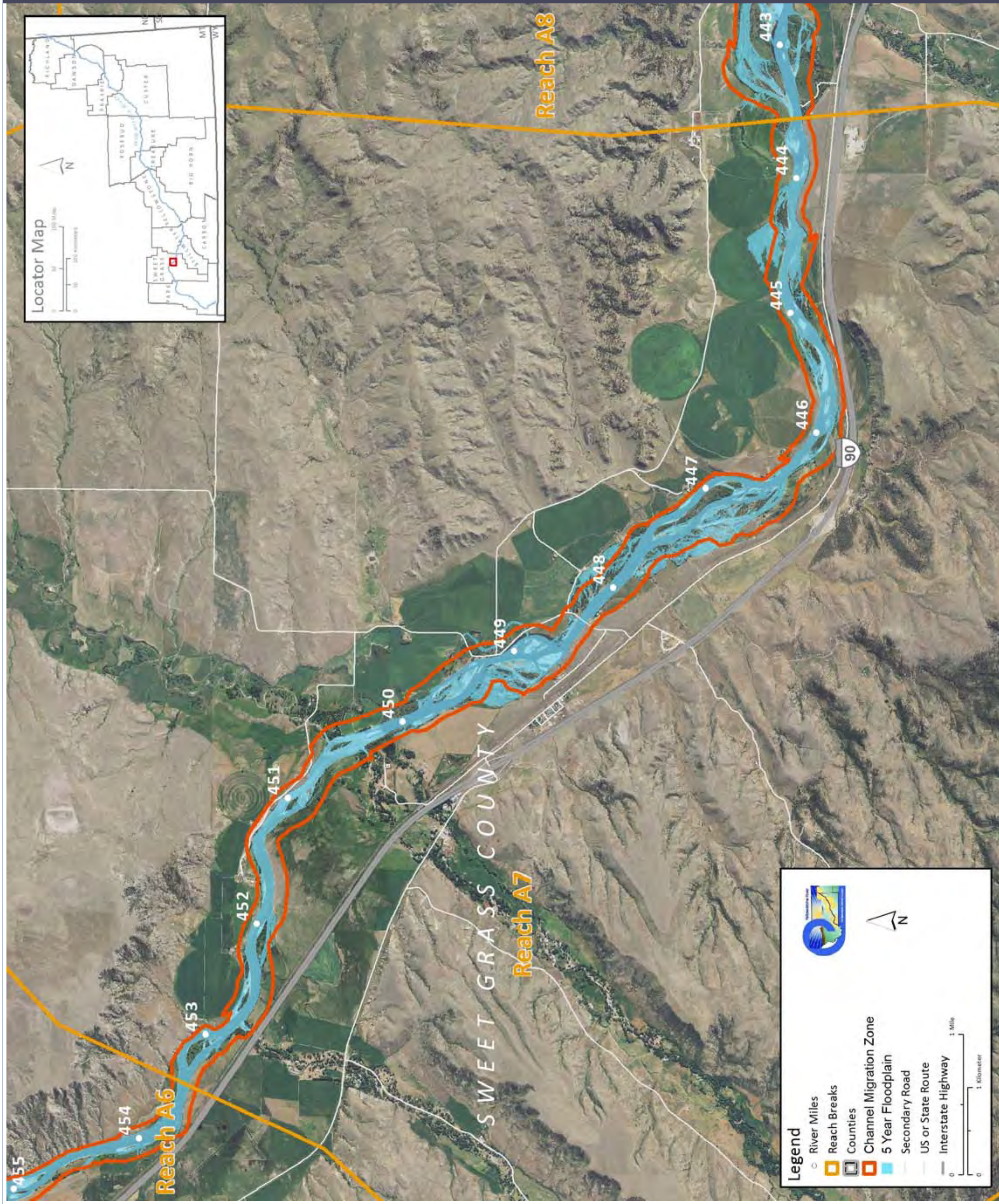
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	0.5	0.0%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	9.0	1.3	0.0	-9.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	443.6
Classification	PCB: Partially confined braided	**Downstream River Mile**	438.5
General Location	Bridger Creek	**Length**	5.10 mi (8.21 km)

Narrative Summary

Reach A8 is 5.1 miles long, and is at Bridger Creek. The reach is classified as Partially Confined Braided (PCB), which indicates some valley wall influences on river form and relatively extensive gravel bars and low flow channel complexity. Within this reach, the river intermittently follows the northern bluff line of the river valley which is comprised of Cretaceous-age Hell Creek Formation sandstones and mudstones. The other side of the river valley consists of low floodplain and terrace deposits. The Bratten fishing access site is located in the lower end of the reach.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 436 acres but by 2001 it had expanded to 482 acres.

As of 2011, about 10 % of the banks in Reach A8 were armored by almost 4,000 feet of rock riprap and 1,400 feet of flow deflectors. There is also a ~760 ft retaining wall on the right bank at the very upstream most end of the reach that protects several structures. At Rm 441.1, rock riprap on both sides of the river has constricted the channel corridor to essentially the width of the active channel, which is about 550 feet. Physical features also occupy the floodplain; over three miles of transportation encroachment and 1,800 feet of floodplain dikes have been mapped in the reach. Transportation infrastructure and agriculture-related dikes have isolated 25% of the historic 100-year floodplain in the reach.

Reach A8 has experienced the loss of almost a mile of side channel since the 1950s due to dike construction. All of the side channel loss is from one project at the mouth of Bridger Creek, where the lower portion of the creek was channelized downstream of the I-90 Bridge. This channelization included re-routing the creek through a channelized section to an active side channel of the Yellowstone River. The channelization included construction of a dike that guides Bridger Creek into the side channel, and blocks the side channel at the intersection, essentially turning the lower portion of the side channel into lowermost Bridger Creek. The channelization of lower Bridger Creek occurred between 1950 and 1976.

Even though Reach A8 has experienced some side channel loss, it still supports extensive side channel length. As of 2001 there were 6.6 miles of active side channel in the 5.1 mile long reach.

Land use in Reach A8 is predominantly agricultural, although there almost 230 acres of transportation-related development in the mapping footprint. Most of the agricultural land is non-irrigated, although there are 900 acres of ground under flood irrigation and 56 acres under pivot. A total of 236 acres of developed land are in the Channel Migration Zone. Most of that is in flood irrigation (211 acres), but 8 acres are in pivot and 4 are in exurban development. About 16% of the CMZ is restricted by physical features.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 13,700cfs to 13,000 cfs, a drop of about 5%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,020cfs to 1,670cfs with human development, a reduction of 17%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

The reduction in flows is evident by the contraction of the 5-year floodplain area in Reach A8 by 24 acres, or 11%.

CEA-Related observations in Reach A8 include:
•Side channel loss as part of tributary channelization
•Isolation of 25% of historic 100-year floodplain primary due to transportation infrastructure
•Contraction of 5-year floodplain due to flow alterations.

Recommended Practices for Reach A8 include:
•Side channel restoration at RM442
•Floodplain restoration/reconnection on south side of interstate at RM 439.5
•CMZ management due to extent of CMZ restriction (16%)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	26,600	25,800	-3.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	49,000	48,500	-1.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	436.3	445.2	460.7	482.4	46.1	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	3,970	7.4%	274	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	1,415	2.6%	-134	
Total	**5,386**	**10.1%**	**140**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	4,657	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	107.8	106.2	33.22 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	4.1	4.2		
Acres/Year/Valley Mile	0.9	0.9		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	23.6	11%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	197.0	25%	

Restricted Migration Area	Acres	% of CMZ	
	195.8	16%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,285.3	3,019.8	Flood (Ac)	1,161.0	903.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	63.0	128.0	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	10.2	Pivot (Ac)	0.0	55.9	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	54.6	228.8				

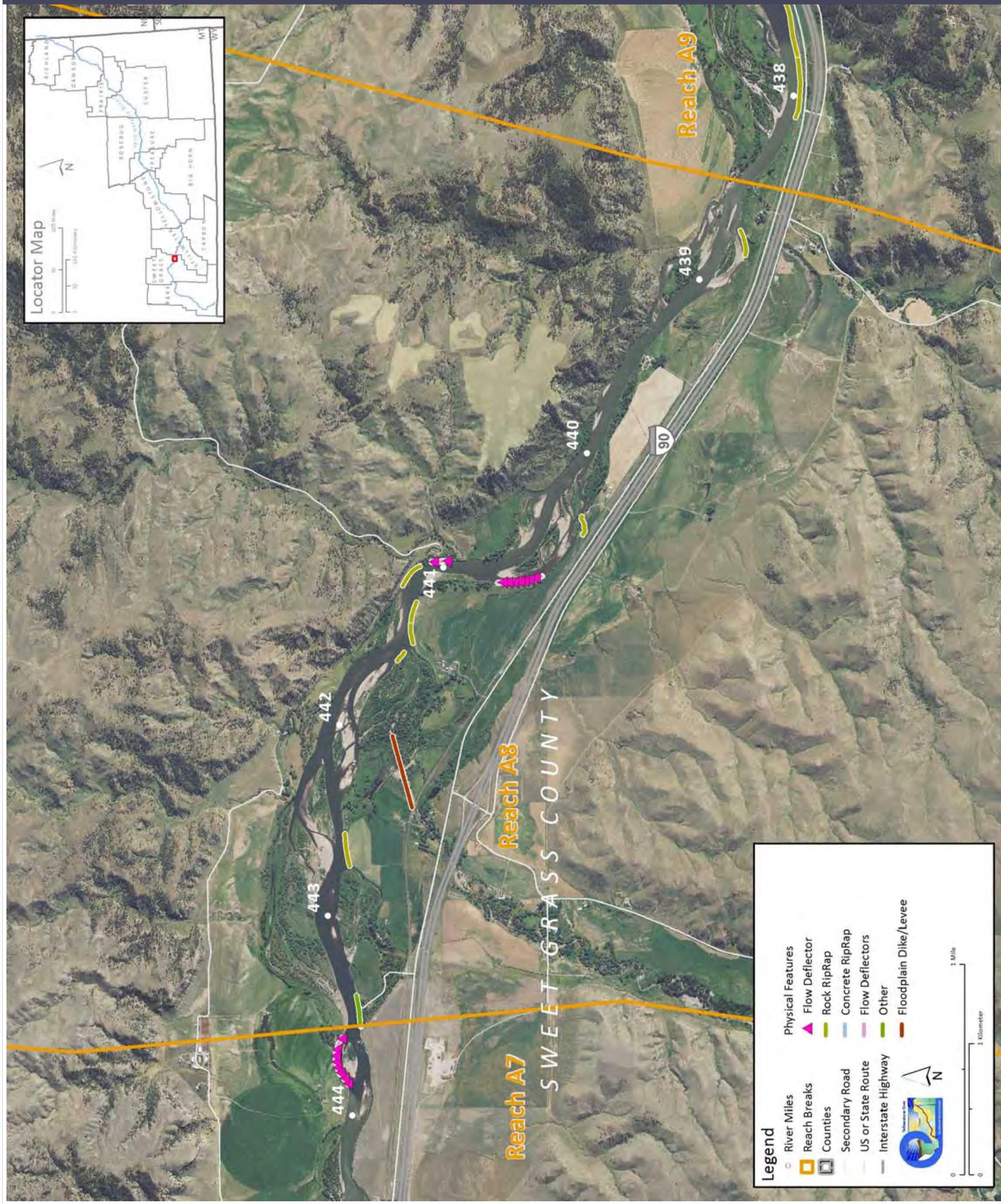
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	1.1	3.6	4.7	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	14.8	3.2	**112.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	73.1	15.7		
Scrub/Shrub	24.6	5.3		

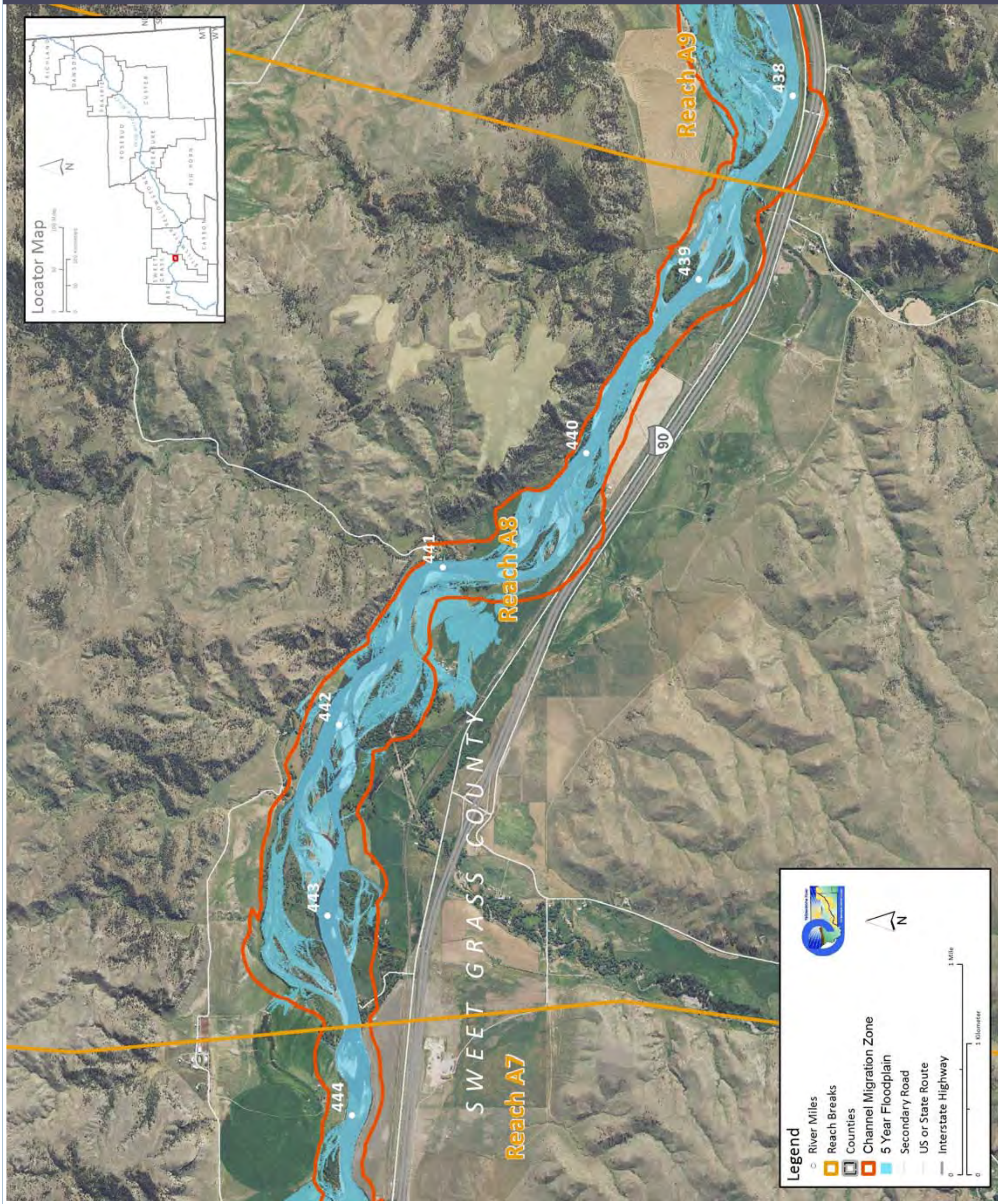
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	0.4	0.0%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	0.0	2.2	0.0	0.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Sweetgrass	**Upstream River Mile**	438.5
Classification	UA: Unconfined anabranching	**Downstream River Mile**	434.7
General Location	Reed Point	**Length**	3.80 mi (6.12 km)

Narrative Summary

Reach A9 is located in lowermost Sweet Grass County, just upstream of the Sweet Grass/Stillwater county line near Reed Point. The reach is an Unconfined Anabranching reach type. The reach is 3.8 miles long, extending from RM 434.7 to RM 438.5. The lower reach break is the bridge crossing just north of Reed Point. This bridge was originally constructed in 1911 and rebuilt in 2000.

Reach A9 provides an excellent example of a dynamic, largely unmodified Unconfined Anabranching reach type. The stream corridor is typically one half mile wide through the reach, with significant narrowing of that corridor in the downstream direction as the river approaches the bridge at Reed Point. In the uppermost portion of the Reach (RM 437-438.5), the northern valley margin consists of an alluvial fan deposit that is currently irrigated with center pivots. Downstream, the river abuts Cretaceous-age Hell Creek Formation on the northern valley wall, which contains sandstones that tend to form steep cliffs. The reach is characterized by high displacement ratios, extensive split flow and islands, and riparian turnover. Although riparian turnover is evident, the rates of that turnover have gone down in the reach since 1976. Prior to that time (1950-1976), average turnover rates were 5.9 acres per year; from 1976 to 2001 that average rate dropped to 3.6 acres of riparian turnover per year.

Bank armor in Reach A9 consists primarily of 10,000 linear feet of riprap which drapes about 24% of the stream bank. About 2,000 feet of that armor was constructed since 2001. This new armor is on the right bank at RM 437.8 where the river was rapidly migrating southward toward the rail line. By the time the bank was armored, the river was within 60 feet of the tracks.

Much of the riprap in Reach A9 is located along the south bank of the river on lower end of the reach where the Yellowstone River approaches the bridge near Reed Point. This bridge marks a major narrowing of the river corridor from about 2,000 feet ½ mile upstream of the bridge to 360 feet at the bridge itself. The narrowing is achieved by a ~mile long section of bank armor on the right bank that on its lower end runs due north/south, which is perpendicular to the overall east/west trend of the river. This has caused the river to consolidate into a main thread and abandon an historic side channel just upstream of the bridge at the Indian Fort Fishing Access Site.

Reach A9 has experienced the loss of almost about 3,700 feet of side channel since the 1950s due to dike construction. All of the side channel loss is from one project at the upstream end of the reach, where a side channel was blocked on the north side of the river at RM 438.5.

Even though Reach A9 has experienced some side channel loss, it still supports extensive side channel length. As of 2001 there were 5.1 miles of active side channel in the 3.8 mile long reach. Large islands have persisted in the reach since 1950.

Land use in Reach A9 is predominantly agricultural, although there several hundred acres of non-agricultural uses due to the proximity of the transportation corridor as well as the town of Reed Point. Since 1950, 160 acres of agricultural land have been converted to pivot. A total of 300 acres of developed land are in the Channel Migration Zone. Most of that is in flood irrigation (250 acres), but 40 acres are in transportation. About 13% of the CMZ is restricted by physical features.

There is natural gas one pipeline that crosses under the Yellowstone River in Reach A9. It crosses at the upper most end of the reach at RM 438.5 and is consists of a 6 inch pipeline that is owned by Northwestern Energy.

Since 1950, Reach A9 has lost most of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 17 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to 2.5 acres due to development within the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 14,000cfs to 13,300 cfs, a drop of about 5%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,030cfs to 1,680cfs with human development, a reduction of 17%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

The reduction in flows is evident by the contraction of the 5-year floodplain area in Reach A8 by 15 acres, or 6%.

CEA-Related observations in Reach A9 include:
•Reduced floodplain turnover rates since 1976
•Approximately 3,700 feet of side channel has been lost due to channel plugging between 1950 and 2011
•Meander belt encroachment at bridge crossing
•Side channel loss as part of armoring at bridge approach\

Recommended Practices for Reach A9 include:
•Side channel restoration at RM438.5
•CMZ management due to extent of CMZ restriction (13%)
•Pipeline management for 6-inch natural gas pipeline that crosses under the river at RM438.5

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	27,100	26,300	-3.0%
100 Year (cfs)	49,900	49,400	-1.0%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	351.0	420.9	364.2	403.1	52.1

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	9,898	24.2%	2,012
Concrete Riprap	0	0.0%	0
Flow Deflectors	107	0.3%	107
Total	**10,005**	**24.4%**	**2,119**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	3,717

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	154.6	90.0
Acres/Year	5.9	3.6
Acres/Year/Valley Mile	1.8	1.1

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

45.11 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	14.9	6%
100 Year	19.0	4%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	150.9	13%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	2,009.3	1,760.1
Ag. Infrastructure (Ac)	27.7	26.9
Exurban (Ac)	0.0	67.4
Urban (Ac)	15.6	48.0
Transportation (Ac)	54.4	169.1

	1950	2011
Flood (Ac)	462.8	450.6
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	163.4

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	16.2	0.0	16.2	5.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	9.8	2.9
Emergent	32.5	9.7
Scrub/Shrub	30.9	9.2

Total Wetland Acres **73.2**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

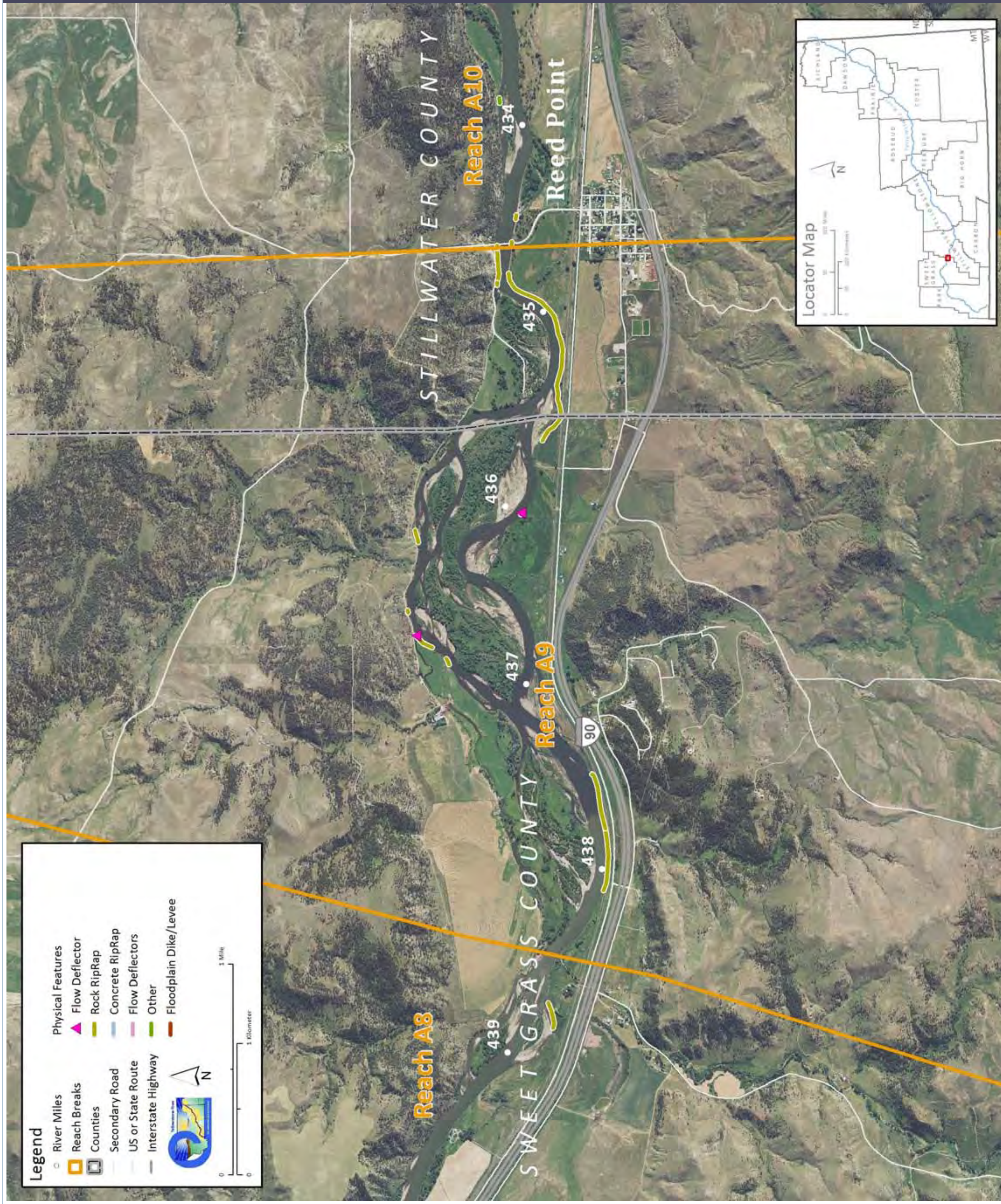
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	0.1	0.0%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

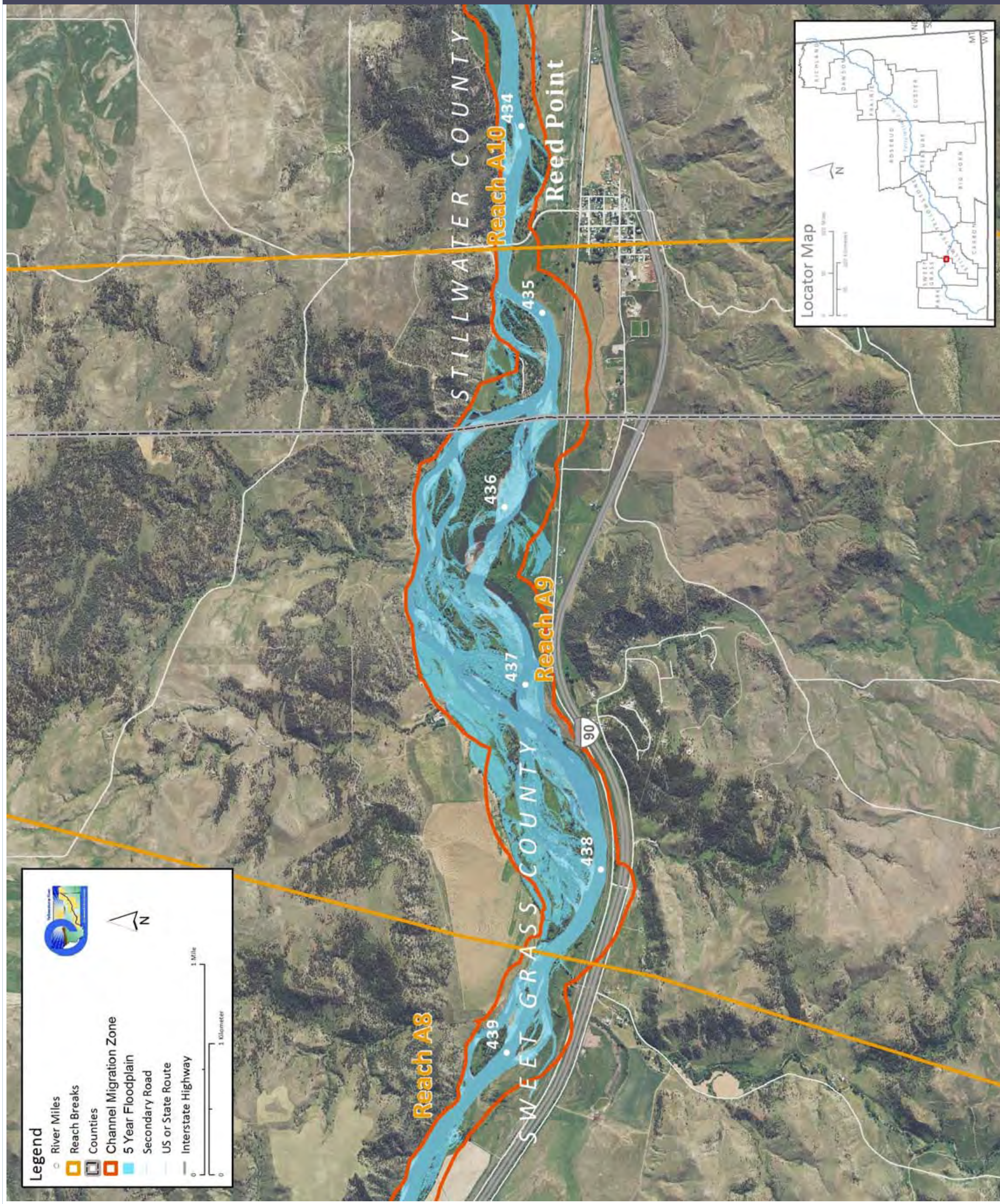
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	16.6	2.1	2.5	-14.2

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Stillwater	**Upstream River Mile**	434.7
Classification	PCS: Partially confined straight	**Downstream River Mile**	430.3
General Location	Reed Point	**Length**	4.40 mi (7.08 km)

Narrative Summary

Reach A10 is 4.4 miles long and begins at Reed Point. The reach is a Partially Confined Straight (PCS) reach type, indicating valley wall influences and minimal meandering. The river flows closely along the north valley wall sandstones of the Hell Creek Formation. Migration activity to the south off of the valley wall has been limited and relatively slow, resulting in a fairly narrow Channel Migration Zone and relatively little bank armor. There is only 500 feet of bank armor in the reach, which protects less than 2% of the bankline.
No side channels have been physically blocked in Reach A10, however there still has been a net loss of almost 2 miles of side channel length since 1950. This is in part due to the loss of a several thousand foot side channel on the south side of the corridor at RM 431. The entrance to the side channel is just downstream of a series of flow deflectors that appear to have contributed to aggradation at the entrance to the side channel.

Riparian mapping in Reach A10 shows a reduction in total acreage of closed timber from 222 acres in 1950 to 155 acres in 2001.

One of the most evident impacts in Reach A10 is floodplain isolation. Due to the transportation encroachment into the reach by the rail line, approximately 30% of the 100 year floodplain has become isolated from the river.

Land use in Reach A9 is predominantly agricultural, although there several hundred acres of non-agricultural uses due to the proximity of the transportation corridor as well as the town of Reed Point. All of the irrigated land is in flood. A total of 163 acres of developed land are in the Channel Migration Zone. Almost all of that ground is in flood irrigation Less than 1% of the CMZ is restricted by physical features.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 14,000cfs to 13,300 cfs, a drop of about 5%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,060cfs to 1,690cfs with human development, a reduction of 18%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A10 include:
•Passive loss of anabranching channels, some potentially correlated to flow deflectors
•Floodplain isolation by active rail line.

Recommended Practices for Reach A10 include:
•Floodplain restoration/reconnection behind rail line at RM 430.1
•Side channel restoration at RM431

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	27,100	26,300	-3.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	49,900	49,400	-1.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	255.8	268.7	286.2	290.6	34.8	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	270	0.6%	82	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	255	0.6%	255	
Total	**525**	**1.2%**	**338**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	44.4	45.1	-2.51 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	1.7	1.8		
Acres/Year/Valley Mile	0.4	0.4		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	8.4	22%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	191.5	30%	

Restricted Migration Area	Acres	% of CMZ	
	6.1	1%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	2,550.7	2,370.7	Flood (Ac)	636.2	597.4	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	23.4	27.9	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	30.0	Pivot (Ac)	0.0	0.0	
Urban (Ac)	46.2	56.4				
Transportation (Ac)	55.1	158.2				

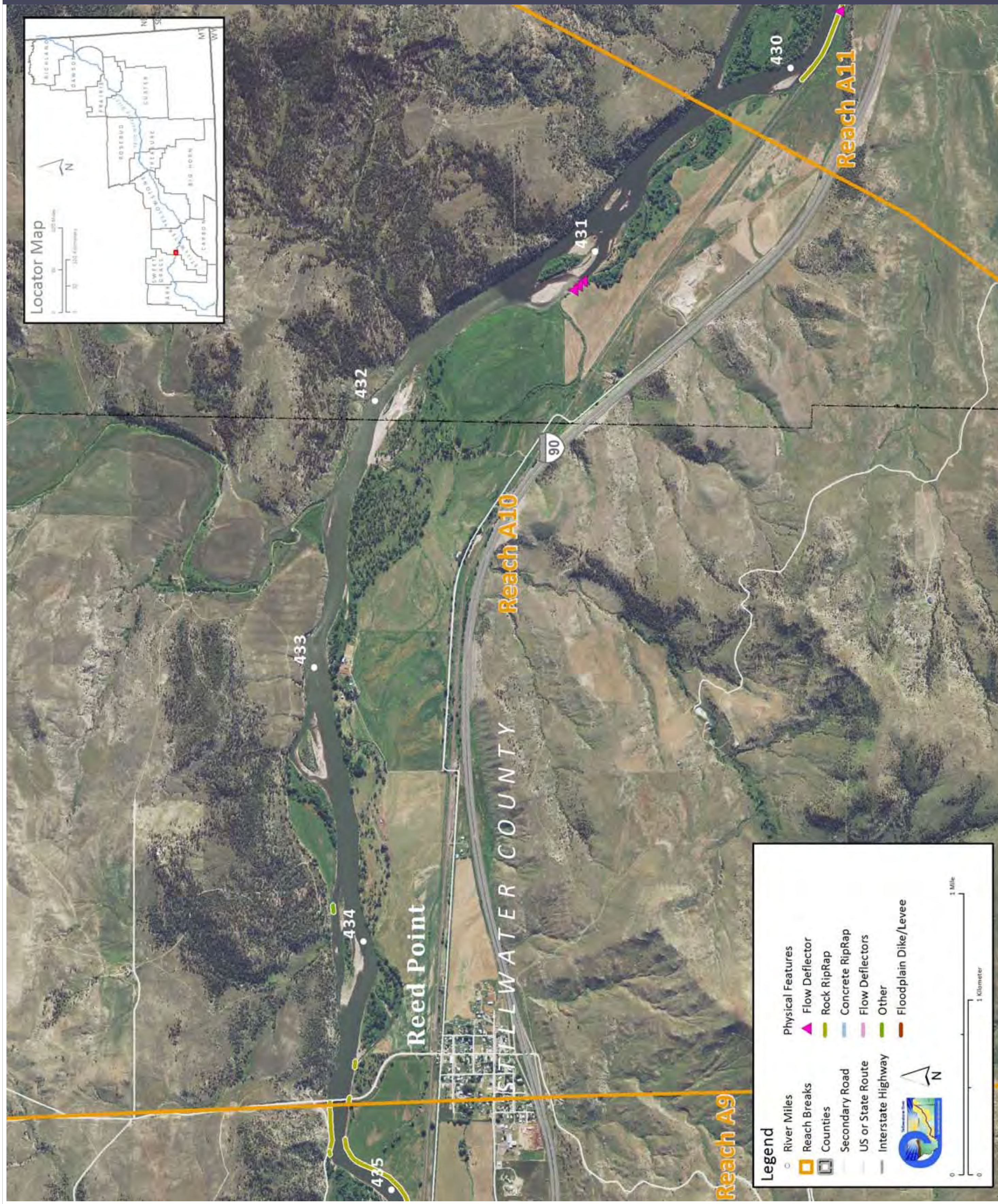
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	4.3	1.1	5.4	2.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	0.3	0.1	**22.6**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	15.9	3.9		
Scrub/Shrub	6.4	1.6		

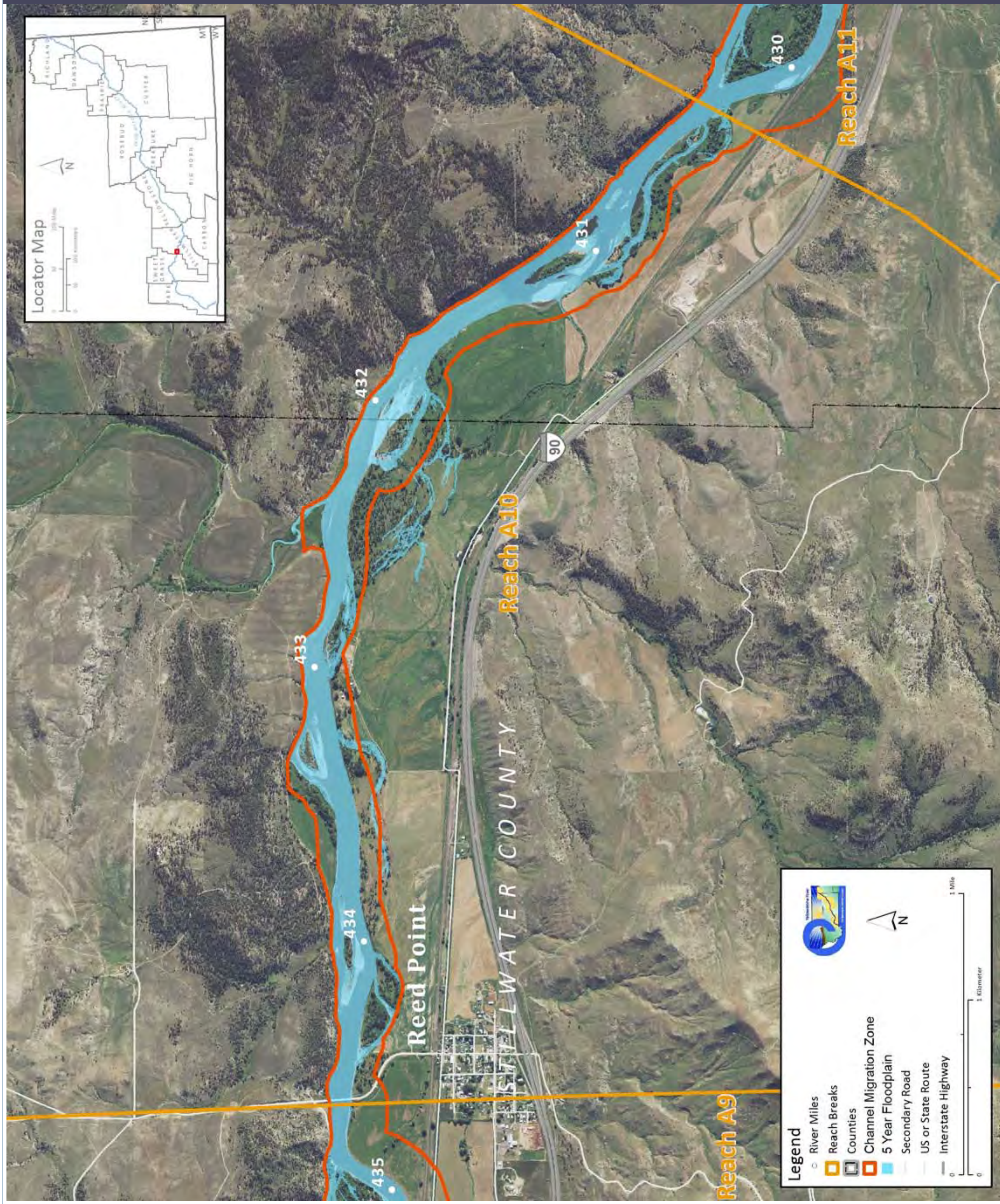
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	0.0	0.0%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	3.9	2.6	2.7	-1.3	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Stillwater	**Upstream River Mile**	430.3
Classification	PCB: Partially confined braided	**Downstream River Mile**	423.3
General Location	I-90 bridge crossing	**Length**	7.00 mi (11.27 km)

Narrative Summary

Reach A11 is 7 miles long and is located at the I-90 Bridge crossing below Reed Point. The reach is a Partially Confined Braided (PCB) reach type, indicating valley wall influences and relatively extensive open gravel bars and small islands. The valley is relatively narrow in this reach, and the river swings from the north valley wall upstream of the bridge to the south valley wall downstream. The valley wall consists of erosion-resistant sandstone cliffs of the Hell Creek Formation. The river has been extremely dynamic in this reach, and over a thousand feet of bank armor has been flanked since 2001. Since 1950, numerous areas have experienced over 500 feet of bank movement.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 451 acres but by 2001 it had expanded to 567 acres.

About 13 % of the banks in Reach A11 are armored, with the majority of that armor being rock riprap. Between 2001 and 2011, there was a loss of about 1,200 feet of armor in the reach. Rock riprap was eroded out from the left (north) bank at RM 424.5, where the river flanked about a thousand feet of rock between 2005 and 2011. Since that time, the river has migrated at least 250 feet behind the armor. At least one flow deflector was lost on the same bankline just upstream. About 320 feet of the lost bank protection was flow deflectors.

Over a mile of side channels have been physically blocked in Reach A11 since 1950. The loss has occurred at RM 424, where a road/field dike crosses the old side channel at two locations.

Land use in Reach A11 is predominantly agricultural, although there several hundred acres of transportation-related use associated with I-90 and the rail line. All of the irrigated land is in under flood irrigation. A total of 210 acres of developed land are in the Channel Migration Zone. Almost all of that ground is in flood irrigation, and about 50 acres of the transportation corridor are within the CMZ. About 17% of the CMZ is isolated by physical features.

There is one diversion structure on the right bank at RM 428.3 that feeds the Merrill Columbus Ditch. The diversion is located just downstream of the railroad and county road bridges, which are about 2,100 feet upstream of the I-90 Bridge.

There is one dump site mapped in Reach A11 at RM 425.8.

Riparian mapping in Reach A11 shows a reduction in total acreage of closed timber from 400 acres in 1950 to 230 acres in 2001. Similarly, the extent of mapped shrubs dropped from 170 acres to 82 acres for the same timeframe.

Reach A11 was sampled as part of the avian study. The average species richness in Reach A11 was 9.6, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. One bird species of concern (SOC), the Bobokink, was identified in the reach. One bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC), the Ovenbird, was also found.

Since 1950, Reach A11 has lost most of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 35 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to 13 acres due to development within the reach.

Reach A11 marks a distinct jump in the extent of Russian olive present in the river corridor. The reach has approximately 2.3 acres of mapped Russian olive, which is most concentrated in the vicinity of the bridges.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 14,200cfs to 13,400 cfs, a drop of about 6%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,070cfs to 1,690cfs with human development, a reduction of 18%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A11 include:
•Accelerated erosion behind 1,000 feet of flanked rock riprap.
•Blockage of several thousand feet of side channel
•At least one flanked barb
•Expansion of Russian olive infestation relative to upstream.
•Reduction in both closed timber and shrub riparian extent.

Recommended Practices for Reach A11 include:
•Floodplain restoration/reconnection behind rail line at RM 430
•Side channel restoration at RM424

- Bank armor removal at RM 424.5
- CMA management due to extent of CMZ restriction (17%)
- Russian olive removal—this is the most upstream reach of major Russian olive colonization
- Solid waste removal from right (south) bank area at RM 425.8
- Irrigation diversion structure management at Merrill Columbus Ditch Diversion at RM 428.3

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	27,500	26,700	-2.9%
100 Year (cfs)	50,600	50,100	-1.0%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	451.0	492.6	532.9	568.8	117.9

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	9,701	13.2%	-956
Concrete Riprap	0	0.0%	0
Flow Deflectors	286	0.4%	-321
Total	**9,987**	**13.6%**	**-1,277**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	6,747

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	135.3	121.7
Acres/Year	5.2	4.9
Acres/Year/Valley Mile	0.8	0.8

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

-65.23 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	49.7	21%
100 Year	38.7	5%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	235.8	16%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	2,872.2	2,357.0
Ag. Infrastructure (Ac)	49.4	107.7
Exurban (Ac)	0.0	70.6
Urban (Ac)	0.0	0.0
Transportation (Ac)	94.4	326.5

	1950	2011
Flood (Ac)	351.2	530.6
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	26.6	14.9	41.5	7.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	20.2	3.2
Emergent	28.3	4.6
Scrub/Shrub	30.2	4.9

Total Wetland Acres **78.7**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

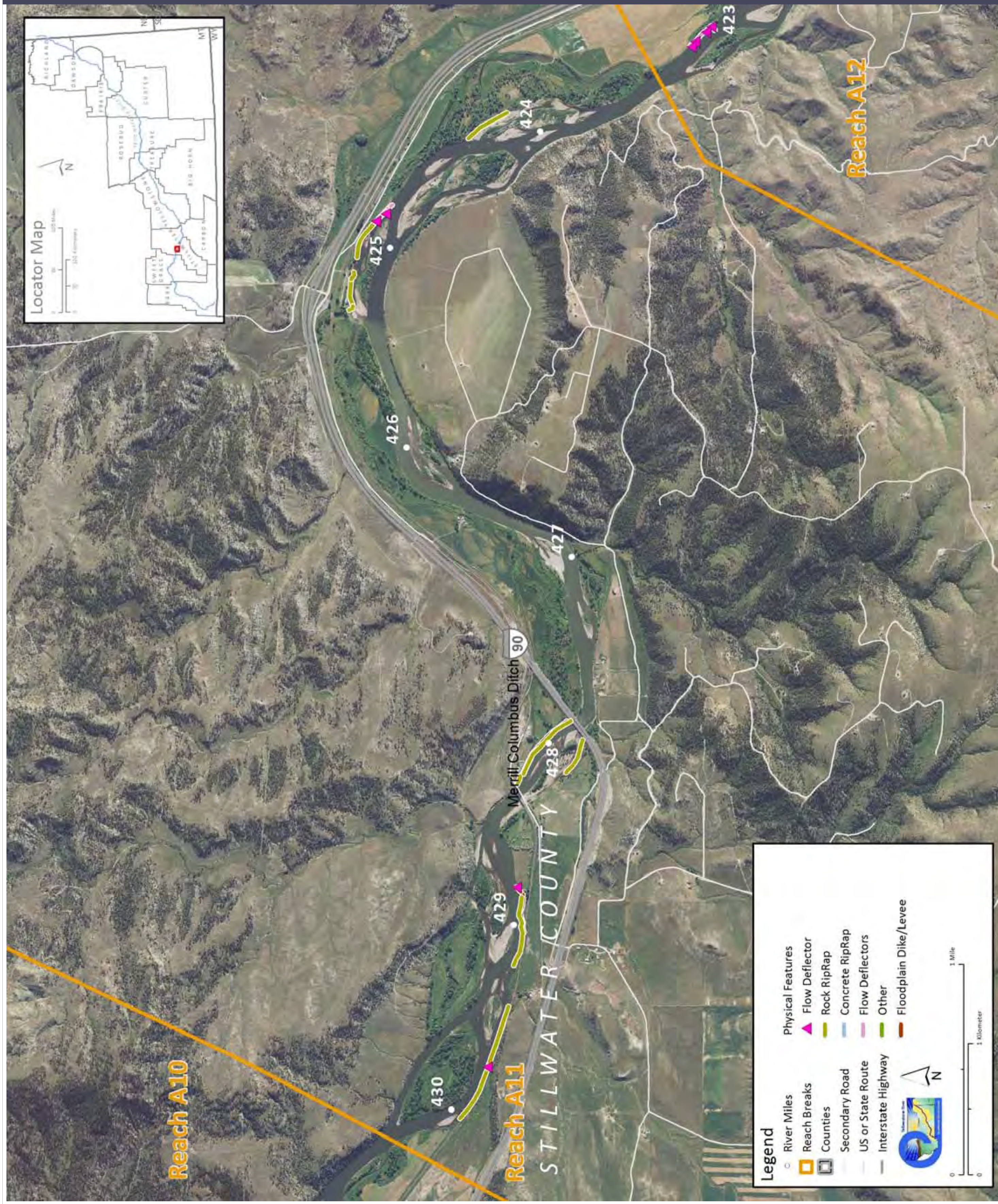
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	2.3	0.1%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

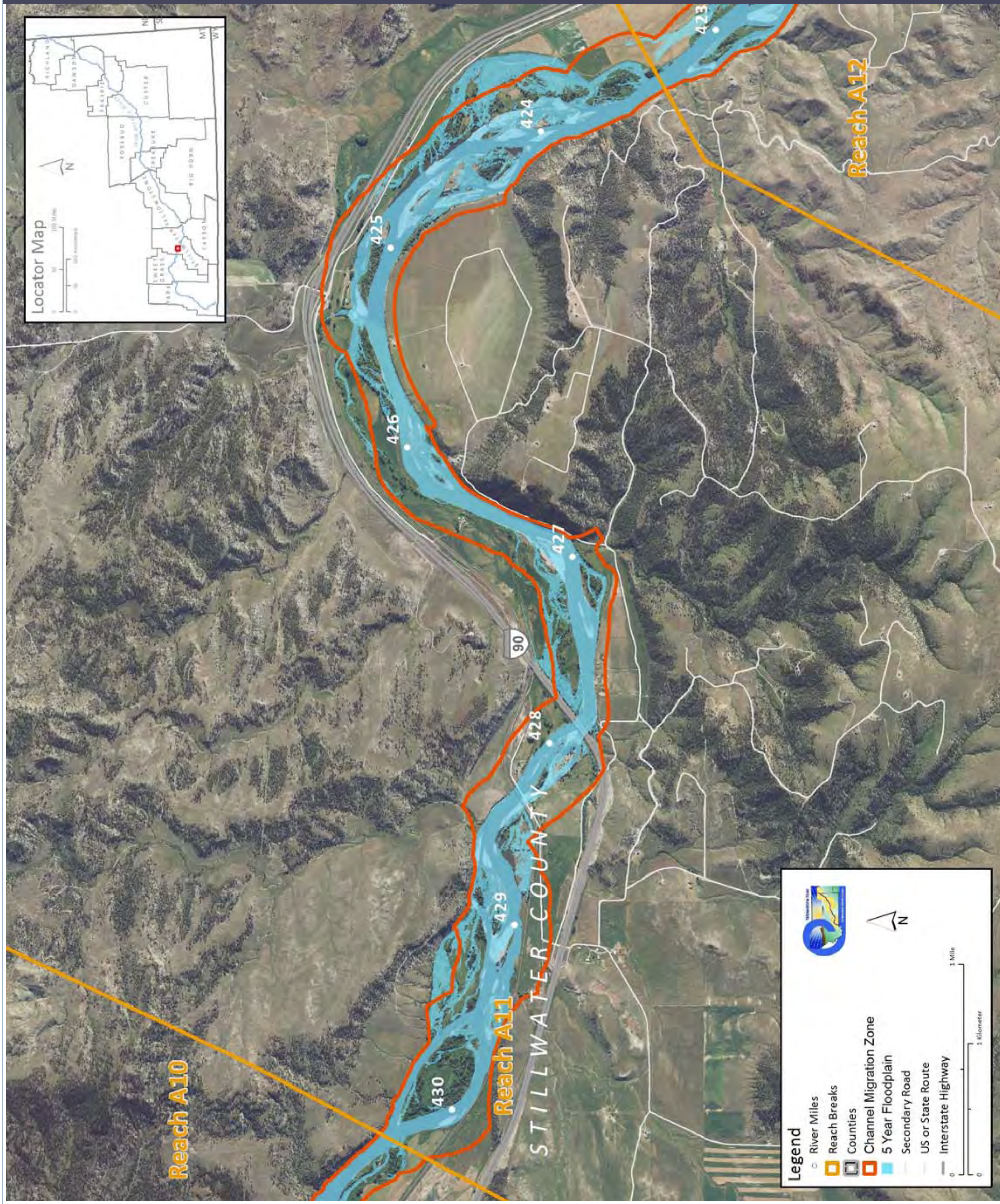
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	34.8	21.2	13.4	-21.4

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Stillwater	**Upstream River Mile**	423.3
Classification	PCB: Partially confined braided	**Downstream River Mile**	417.3
General Location	To Stillwater confluence	**Length**	6.00 mi (9.66 km)

Narrative Summary

Reach A12 is 7 miles long and is located just upstream of the mouth of the Stillwater River. The reach is a Partially Confined Braided (PCB) reach type, indicating valley wall influences and relatively extensive open gravel bars and small islands. The valley wall consists of erosion-resistant sandstone cliffs of the Hell Creek Formation. The river is confined by the valley wall to the south and by transportation infrastructure to the north. The river has been extremely dynamic in this reach; in some places that banks have migrated over a thousand feet since 1950.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 434 acres but by 2001 it had expanded to 570 acres.

About 13 % of the banks in Reach A12 are armored, with the majority of that armor being rock riprap. Between 2001 and 2011, there was a gain of about 1,182 feet of rock riprap and 560 feet of flow deflectors in the reach. At least one flow deflector has been flanked on the right bank just upstream of the Stillwater confluence at RM 418.5. About two miles of transportation encroachments were mapped in Reach A12.

On side channel that is almost four thousand feet long at RM 421 was physically blocked in Reach A12 since 1950. More recently, however, the river has migrated back into the side channel such that the majority of it is now active.

Land use in Reach A12 is predominantly agricultural, although there are several hundred acres of exurban development in the reach. Almost a thousand acres of land is under flood irrigation. A total of 293 acres of developed land are in the Channel Migration Zone. Almost all of that ground is in flood irrigation, although 14 acres are in exurban development and 16 acres are in transportation. About 6% of the CMZ is isolated by physical features.

Riparian mapping in Reach A12 shows a reduction in total acreage of open timber from 43 acres in 1950 to 23 acres in 2001.

Reach A12 was sampled as part of the avian study. The average species richness in Reach A12 was 7.6, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. One bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC), the Dickcissel, was identified in the reach.

Since 1950, Reach A12 has lost all of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 4 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to zero.

Reach A12 has approximately 3 acres of mapped Russian olive, which is most concentrated on the north side of the river on the banks of the main channel, side channels, and sloughs.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 14,400cfs to 13,600 cfs, a drop of about 6%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,080cfs to 1,690 cfs with human development, a reduction of 19%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A12 include:
- Recapture of previously blocked side channel
- Flanking of barbs

Recommended Practices for Reach A12 include:
- Bank armor removal at RM 418.5
- Russian olive removal (3acres)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	27,900	27,000	-3.2%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	51,300	50,800	-1.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	434.2	466.7	457.0	569.8	135.6	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	7,315	11.4%	1,182	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	855	1.3%	556	
Total	**8,170**	**12.7%**	**1,739**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	3,771	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	134.0	158.7	-12.71 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	5.2	6.3		
Acres/Year/Valley Mile	0.9	1.1		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	14.0	14%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	0.0	0%	

Restricted Migration Area	Acres	% of CMZ	
	91.1	6%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,331.1	2,990.0	Flood (Ac)	1,201.2	979.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	60.8	79.4	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	6.5	143.3	Pivot (Ac)	0.0	1.4	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	70.2	96.2				

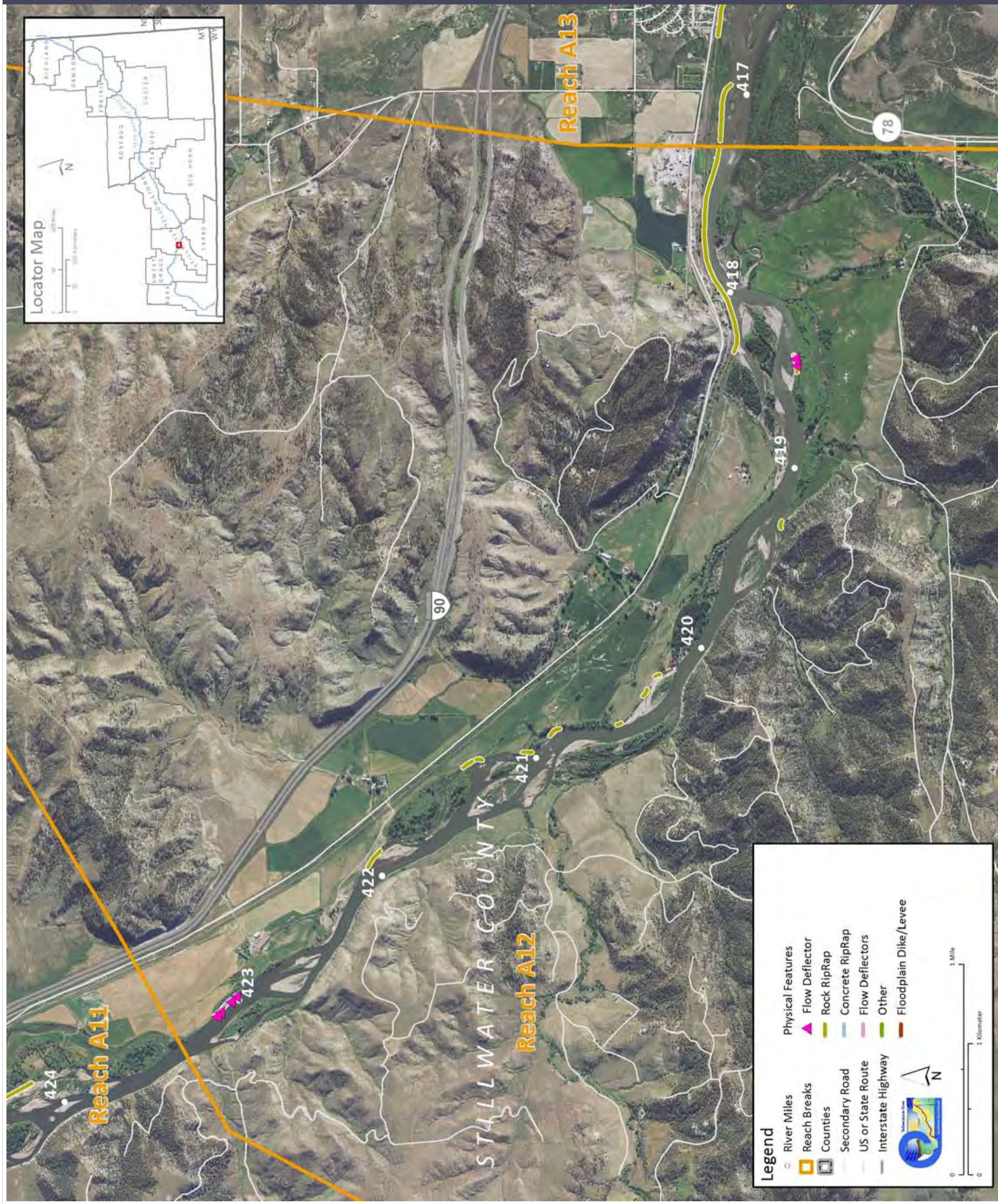
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	5.3	0.0	5.3	2.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	5.7	1.0	**130.4**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	55.5	9.9		
Scrub/Shrub	69.1	12.3		

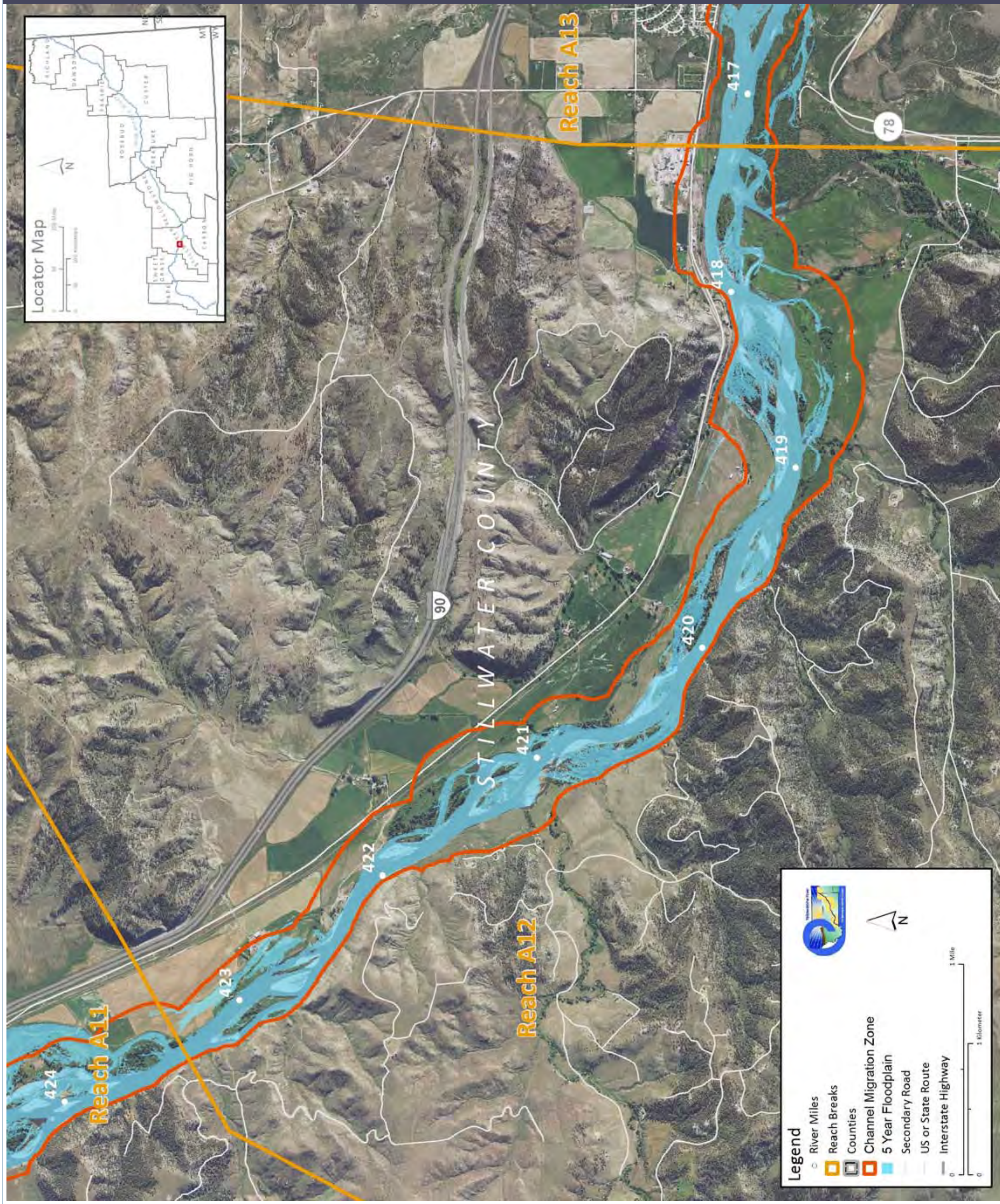
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	2.9	0.2%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	4.1	0.0	0.0	-4.1	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Stillwater	**Upstream River Mile**	417.3
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	413.7
General Location	Columbus	**Length**	3.60 mi (5.79 km)

Narrative Summary

Reach A13 is 3.6 miles long and is located at Columbus. The reach is a Partially Confined Anabranching (PCA) reach type, indicating valley wall influences and relatively extensive forested islands. Reach A13 marks an abrupt widening in the river valley as the erosion resistant sandstone cliffs of the Hell Creek Formation transition downstream into the more erodible Bearpaw Shale. The reach is urbanized with most development concentrated on the north side of the river. Migration rates since 1950 have been moderate in this reach largely due to extensive bank armoring.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 258 acres but by 2001 it had expanded to 327 acres. This was accompanied by a net loss of about 40 acres of riparian area to channel during that same timeframe.

About 28 % of the banks in Reach A13 are armored, with the majority of that armor being rock riprap. Reach A13 has almost 3,000 feet of concrete riprap, reflecting an abrupt increase in the use of concrete as armor relative to upstream. The concrete is on the north bank of the river just upstream of the Columbus Bridge. Between 2001 and 2011, there was a gain of about 2,800 feet of rock riprap in the reach; most of this was on the north side of the river adjacent to town.

Land use in Reach A13 is predominantly agricultural, although there are over 600 acres of exurban/exurban development within the mapping footprint. Approximately one half of the agricultural land is in flood irrigation (600 acres). No other types of irrigation were mapped in the reach. A total of 133 acres of developed land are in the Channel Migration Zone, and about half of that is in urban/exurban development. About 13% of the CMZ is isolated by physical features, most of which is armor protecting the railroad in Columbus.

About 18% of the historic 100-year floodplain has become isolated from the river due primarily to the downstream shadow caused by the Columbus Bridge embankment on the north side of the river.

There is one pipeline crossing in Reach A13, a natural gas crossing called the Lake Basin-Absarokee Line owned by NW energy. The pipeline crosses the river at RM 417.

One ice jam has been recorded in this reach. On February 6, 1996, an ice jam break-up was reported to cause local flooding.

There are corrals that are part of an animal handling facility in the reach, north of the river at RM 414.

Riparian mapping in Reach A13 shows a reduction of about 50 acres of closed timber in the reach since 1950.

Reach A13 has approximately 5 acres of mapped Russian olive, which is spread out both within the riparian corridor and through the town of Columbus. There are also over 100 acres of mapped wetland in the each, most of which is emergent marshes and wet meadows.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 14,400cfs to 13,600 cfs, a drop of about 6%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,270 cfs to 1,760 cfs with human development, a reduction of 22%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A13 include:
•Jump in use of concrete armor relative to upstream
•Armoring associated with urbanization
•Urban/Exurban development in CMZ

Recommended Practices for Reach A13 include:
•CMZ management at Columbus due to high level of encroachment
•Nutrient management at corrals at RM 414
•Channel Bank Stabilization Recommended Practices due to extent of armoring in reach (28%)
•Russian olive removal (5 acres)
•Pipeline management (natural gas) for main river crossing at RM417
•Wetland restoration/management due to extent of mapped wetland (110ac)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	31,000	29,800	-3.9%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	56,600	55,900	-1.2%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	258.2	280.0	301.0	326.6	68.4	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	7,874	20.7%	2,783	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	2,837	7.5%	0	
Flow Deflectors	0	0.0%	0	
Total	**10,711**	**28.2%**	**2,783**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	65.5	62.6	-38.55 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	2.5	2.5		
Acres/Year/Valley Mile	0.8	0.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	11.1	13%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	71.7	18%	

Restricted Migration Area	Acres	% of CMZ	
	100.8	13%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	1,778.1	1,332.0	Flood (Ac)	686.0	599.0	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	43.8	79.2	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	13.1	245.8	Pivot (Ac)	0.0	0.0	
Urban (Ac)	270.5	384.9				
Transportation (Ac)	68.1	66.5				

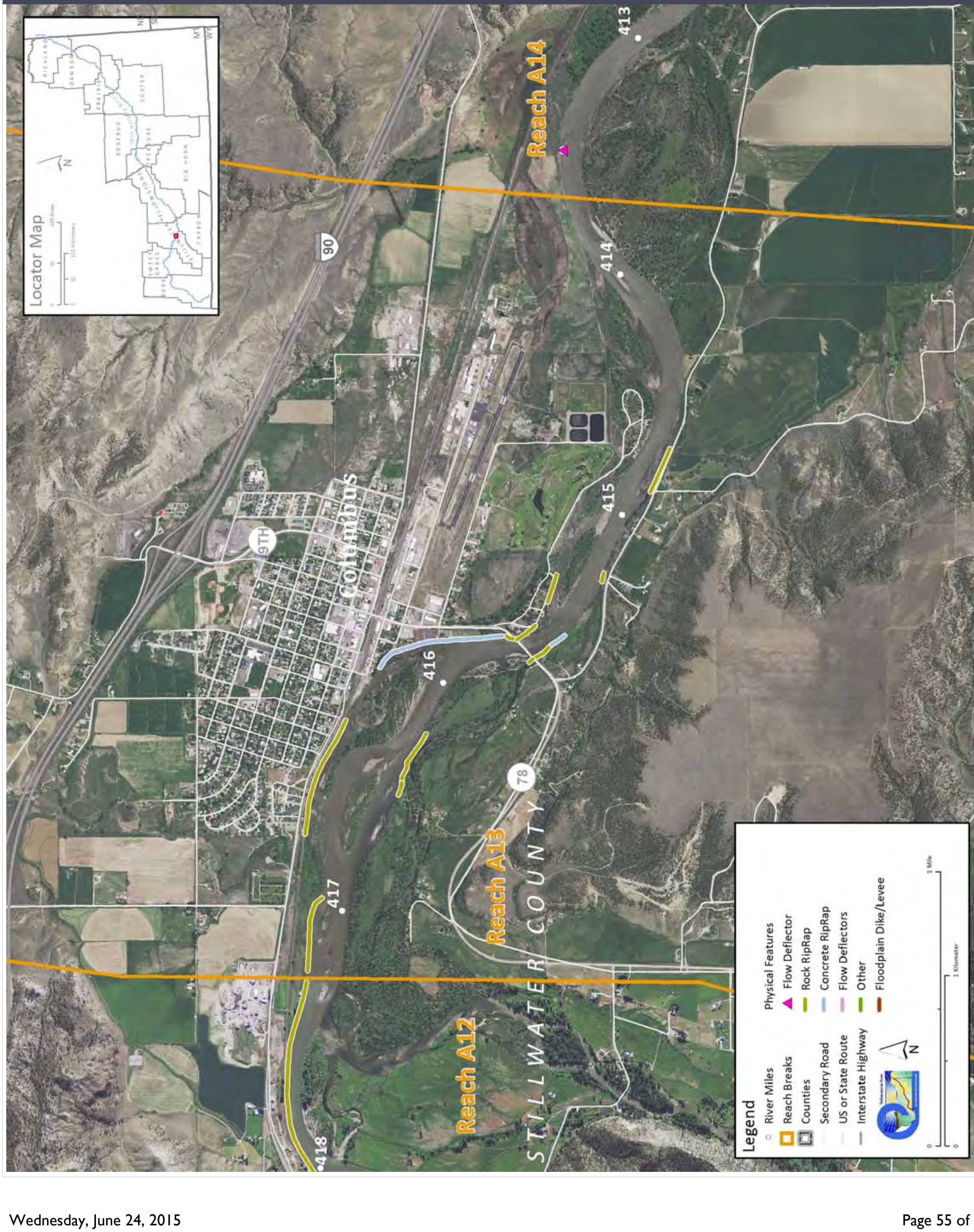
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	18.9	36.7	55.6	14.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	18.1	5.7	**110.1**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	75.8	23.8		
Scrub/Shrub	16.2	5.1		

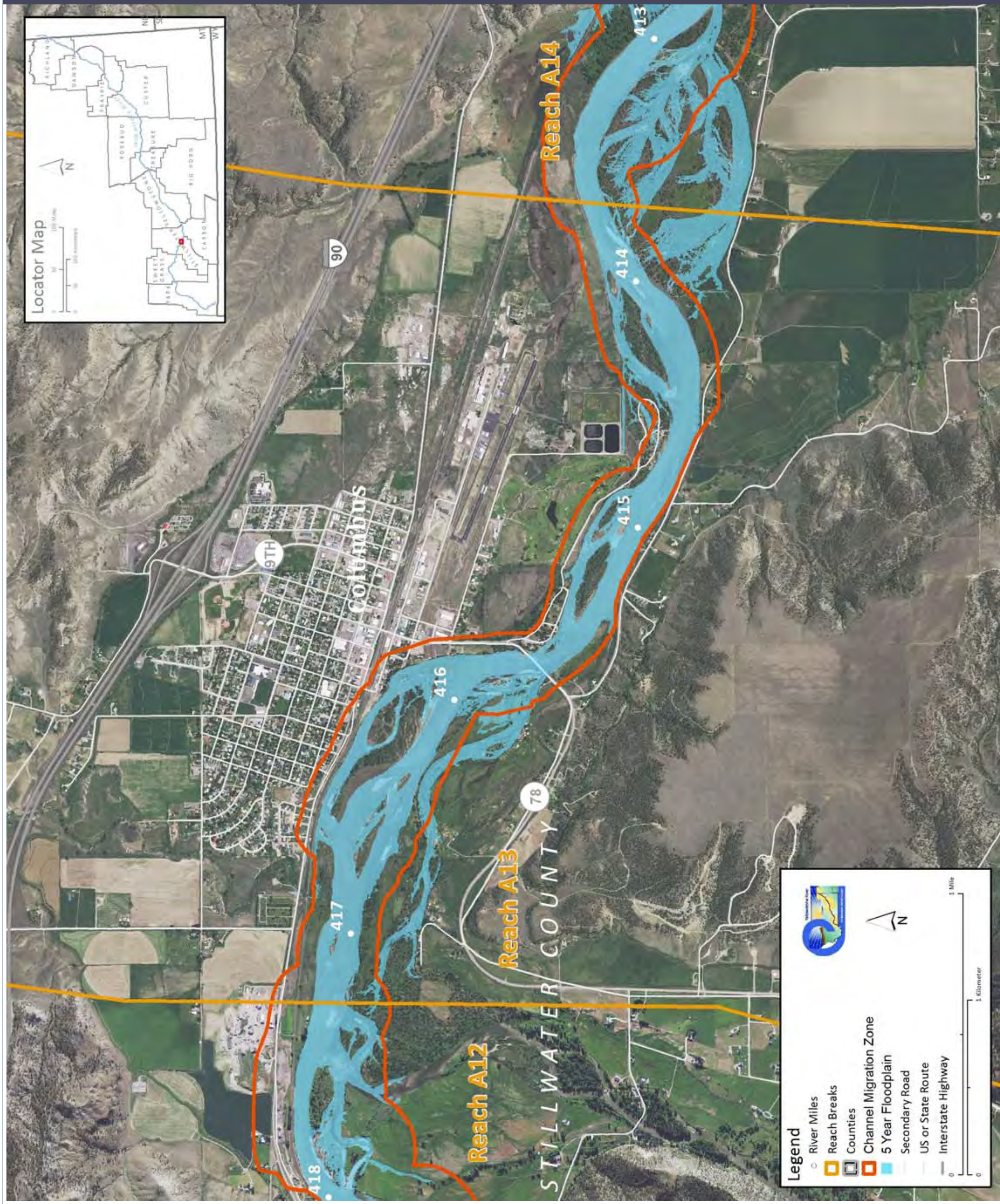
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	5.0	1.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	0.0	0.0	0.0	0.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Stillwater	**Upstream River Mile**	413.7
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	405.9
General Location	Below Columbus	**Length**	7.80 mi (12.55 km)

Narrative Summary

Reach A14 is located in Stillwater County, just downstream of Columbus. The reach is a Partially Confined Anabranching (PCA) reach type, reflecting some valley while influence coupled with relatively extensive forested islands. The reach is 7.8 miles long, extending from RM 405.9 to RM 413.7. The partial geologic confinement within Reach A14 is created by interbedded sandstone and shale of the Cretaceous-age Judith River Formation that intermittently forms the active channel margin on either its right or left bank. The Parkman Sandstone, a massive cliff-forming unit within the Judith River Formation, forms cliffs against the channel that are commonly over 150 feet high.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 637 acres but by 2001 it had expanded to 728 acres. This was accompanied by a net loss of about 32 acres of riparian area to channel during that same timeframe.

Approximately 16 percent of the bankline in Reach A14 is armored, and the armor is almost entirely rock riprap, with a very short section of flow deflectors. The armor is located almost entirely on the northern corridor margin, where transportation infrastructure (mainly railroad) follows the edge of the valley.

Over three miles of side channels have been blocked in Reach A14, with about half of the blockages occurring prior to 1950 and half after. The losses occurred on two distinct channels, one at RM 410 on the south side of the corridor and one at RM 407 on the north side.

Land use in Reach A14 is almost entirely agricultural, with almost 260 acres mapped as agricultural infrastructure. This in part reflects corrals that are part of an animal handling facility on the north side of the river at RM 409. There are 1,300 acres under flood irrigation in the reach, and 144 acres in pivot. A total of 227 acres of developed land are in the Channel Migration Zone, most of that is in flood irrigation (215 acres). Less than 2% of the CMZ is isolated by physical features, all of which is behind the armored rail line on the north side of the river.

There is one major diversion in Reach A14; Cove Ditch diverts water from the north bank at RM 410.

Reach A14 was sampled as part of the avian study. The average species richness in Reach A14 was 7.9, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. Riparian mapping in Reach A14 shows a reduction of about 100 acres of closed timber in the reach since 1950. Since 1950, Reach A14 has lost all of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 10.5 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to 0.5.

Reach A14 has approximately 2.5 acres of mapped Russian olive, which is concentrated along ditches and low riparian/wetland areas north of the river. There are also over 250 acres of mapped wetland in the each, most of which is emergent marshes and wet meadows. About 27 acres of emergent wetland have been isolated from the river corridor by the rail line at RM 413.5.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 16,200cfs to 15,100 cfs, a drop of about 7%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,280 cfs to 1,770 cfs with human development, a reduction of 22%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A14 include:
•Isolation of large wetland area by rail line
•Over 3 miles of side channel blockages
•Large corrals that are part of an animal handling facility within 1,000 feet of the riverbank

Recommended Practices for Reach A14 include:
•Side channel restoration at RM 410 and RM 407
•Russian olive removal (2.5 acres)
•Nutrient management at corrals that are part of an animal handling facility at RM 409
•Irrigation diversion structure management at Cove Ditch Diversion
•Wetland management/restoration at large complex isolated from river by rail line at RM 413.5

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	31,000	29,800	-3.9%
100 Year (cfs)	56,600	55,900	-1.2%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	637.3	675.2	635.5	727.9	90.6

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	13,457	16.4%	1,807
Concrete Riprap	0	0.0%	0
Flow Deflectors	64	0.1%	0
Total	**13,521**	**16.5%**	**1,807**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	9,672	9,176

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	185.7	141.7
Acres/Year	7.1	5.7
Acres/Year/Valley Mile	1.0	0.8

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

-31.84 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	40.7	13%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	25.7	1%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	4,716.0	4,443.6
Ag. Infrastructure (Ac)	73.7	258.5
Exurban (Ac)	0.0	0.0
Urban (Ac)	0.0	0.0
Transportation (Ac)	90.2	188.5

	1950	2011
Flood (Ac)	1,663.6	1,319.8
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	144.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	11.7	3.2	14.9	2.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	14.4	2.0
Emergent	211.3	29.3
Scrub/Shrub	57.6	8.0

Total Wetland Acres **283.3**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

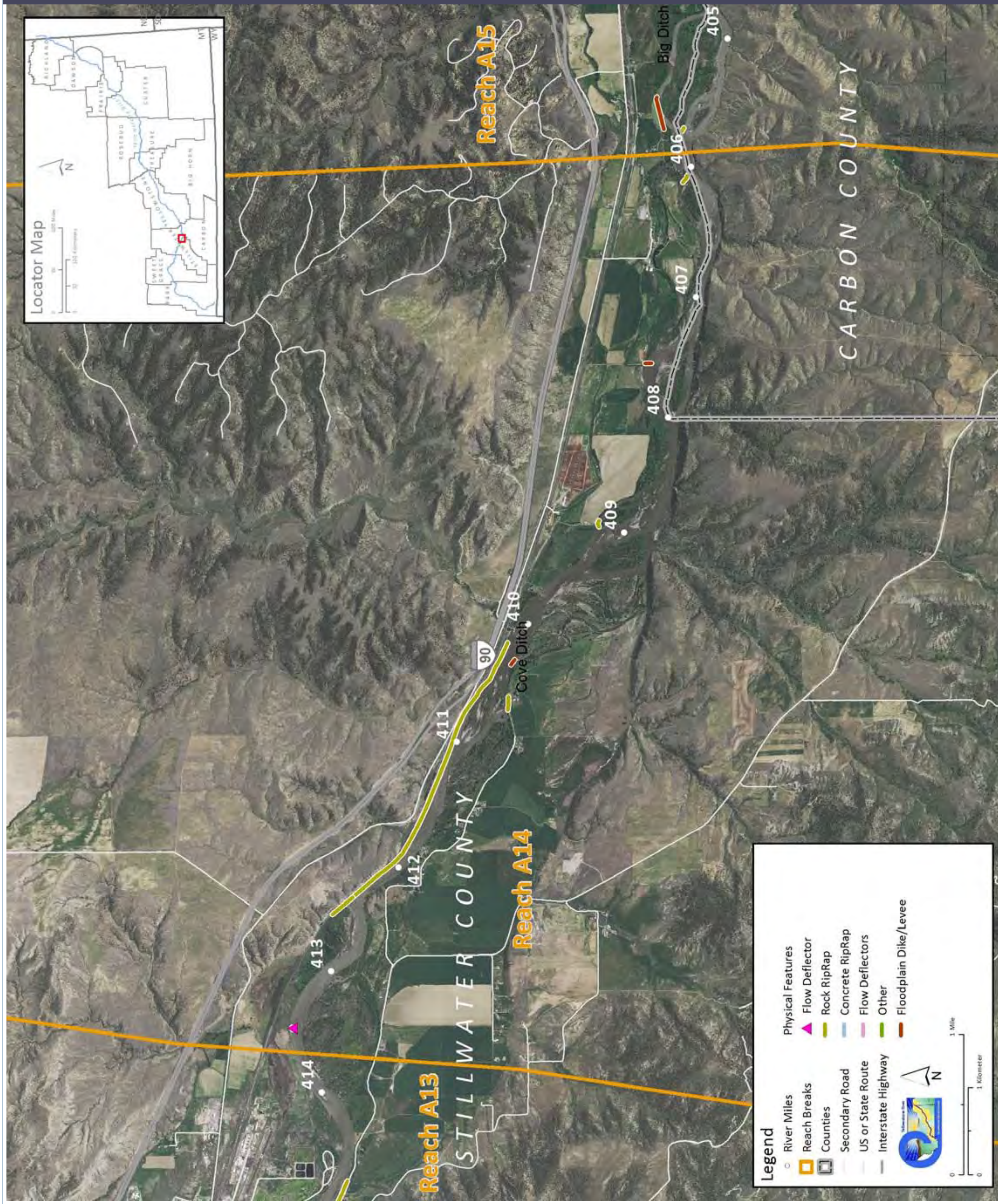
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	2.5	0.1%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

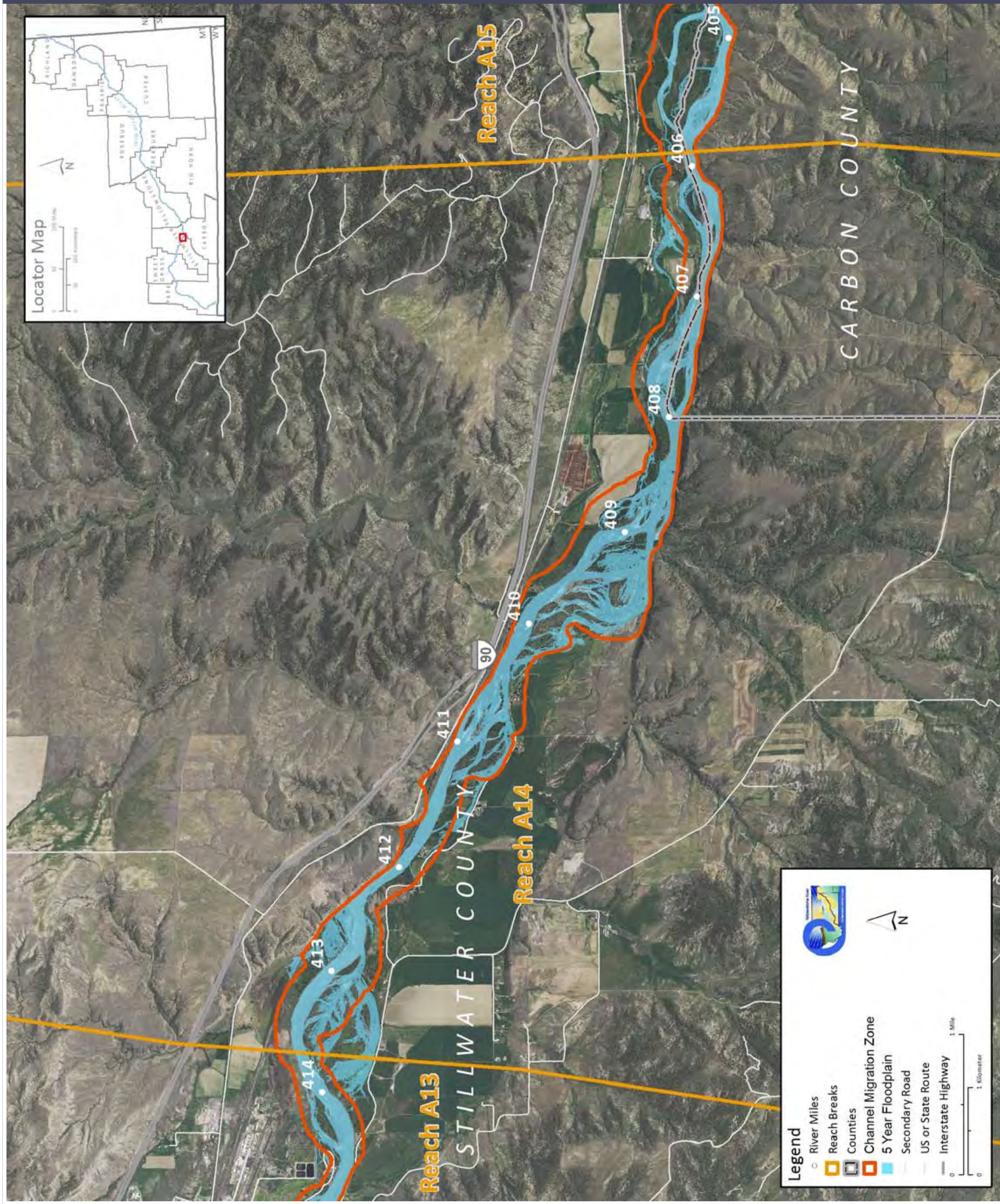
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	10.5	0.5	0.5	-10.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives — Reach A15

County	Stillwater	**Upstream River Mile**	405.9
Classification	PCB: Partially confined braided	**Downstream River Mile**	400
General Location	Follows Stillwater/Carbon County line	**Length**	5.90 mi (9.50 km)

Narrative Summary

Reach A15 is located in Stillwater County between Columbus and Park City. The reach is a Partially Confined Braided (PCB) reach type, reflecting some valley while influence coupled with relatively extensive open gravel bars and low flow channels. The reach is 5.9 miles long. The partial geologic confinement within Reach A15 is created by interbedded sandstone and shale of the Cretaceous-age Judith River Formation that intermittently forms the active channel margin on its right bank. The Parkman Sandstone, a massive cliff-forming unit within the Judith River Formation, forms cliffs against the channel that are commonly over 150 feet high.

Approximately 8 percent of the bankline in Reach A15 is armored, and the armor is almost entirely rock riprap, with a very short section of concrete armor. The armor is entirely located on the north bank of the river, across from the bluffs to the south.

Although no side channels have been mapped as blocked in the reach, the total anabranching channel length has dropped from 6.2 miles in 1950 to 4.2 miles in 2001.

Land use in Reach A15 is almost entirely agricultural, with over 200 acres mapped as agricultural infrastructure. This includes a large corral complex that is part of an animal handling facility on the north side of the river at RM 404. The corrals are behind a canal, but within a few hundred feet of the riverbank. There are 528 acres under flood irrigation in the reach, and 81 acres in pivot. A total of 119 acres of developed land are in the Channel Migration Zone, and all of that land is in flood irrigation. About 9% of the CMZ is isolated by physical features, all of which is behind armored canals associated with the Big Ditch Diversion, which diverts water from the north bank at RM 405.3. The Big Ditch Diversion structure fully spans a side channel of the river that is about 275 feet wide.

Riparian mapping in Reach A15 shows a reduction of about 60 acres of closed timber in the reach since 1950. Riparian recruitment rates have been relatively high; between 1950 and 2001 there were 200 acres of areas that recruited new riparian vegetation, and most of that was in old 1950s channels that were abandoned and became colonized. These abandoned channels also have high concentrations of Russian olive. Since 1950, Reach A15 has lost almost all of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 20 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to 1.

There are also over 150 acres of mapped wetland in the each, most of which is emergent marshes and wet meadows. Large expanses of emergent wetlands have developed in side channels that have been passively lost since 1950 ("passively" meaning not blocked but abandoned).

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 16,200cfs to 15,100 cfs, a drop of about 7%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,286 cfs to 1,770 cfs with human development, a reduction of 23%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A15 include:
•Passive loss of 2 miles of side channel
•Russian olive colonization in abandoned side channels
•Emergent wetland development in abandoned side channels
•Large corrals that are part of an animal handling facility within 300 feet of the riverbank

Recommended Practices for Reach A15 include:
•Side channel restoration to reactivate 2 miles of passively lost channels
•Russian olive removal (1.2 acres)
•Nutrient management at corrals that are part of an animal handling facility at RM 404
•Consideration of fish watercraft passage at Big Ditch Diversion Structure
•Consideration of fish passage limitations at Big Ditch Diversion Structure
•Wetland management/restoration due to extent of mapped wetland (150ac)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	31,000	29,800	-3.9%
100 Year (cfs)	56,600	55,900	-1.2%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	450.3	488.7	440.1	511.1	60.8

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	4,667	7.5%	35
Concrete Riprap	483	0.8%	0
Flow Deflectors	0	0.0%	0
Total	**5,150**	**8.3%**	**35**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	1,617	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	141.8	120.0
Acres/Year	5.5	4.8
Acres/Year/Valley Mile	1.1	0.9

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

4.7 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	27.2	25%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	122.4	8%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	2,738.8	2,533.8
Ag. Infrastructure (Ac)	96.8	213.3
Exurban (Ac)	0.0	2.2
Urban (Ac)	0.0	0.0
Transportation (Ac)	59.4	144.9

	1950	2011
Flood (Ac)	924.9	527.9
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	80.5

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	9.1	0.1	9.3	2.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	10.4	2.0
Emergent	131.1	25.4
Scrub/Shrub	27.4	5.3

Total Wetland Acres **168.9**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

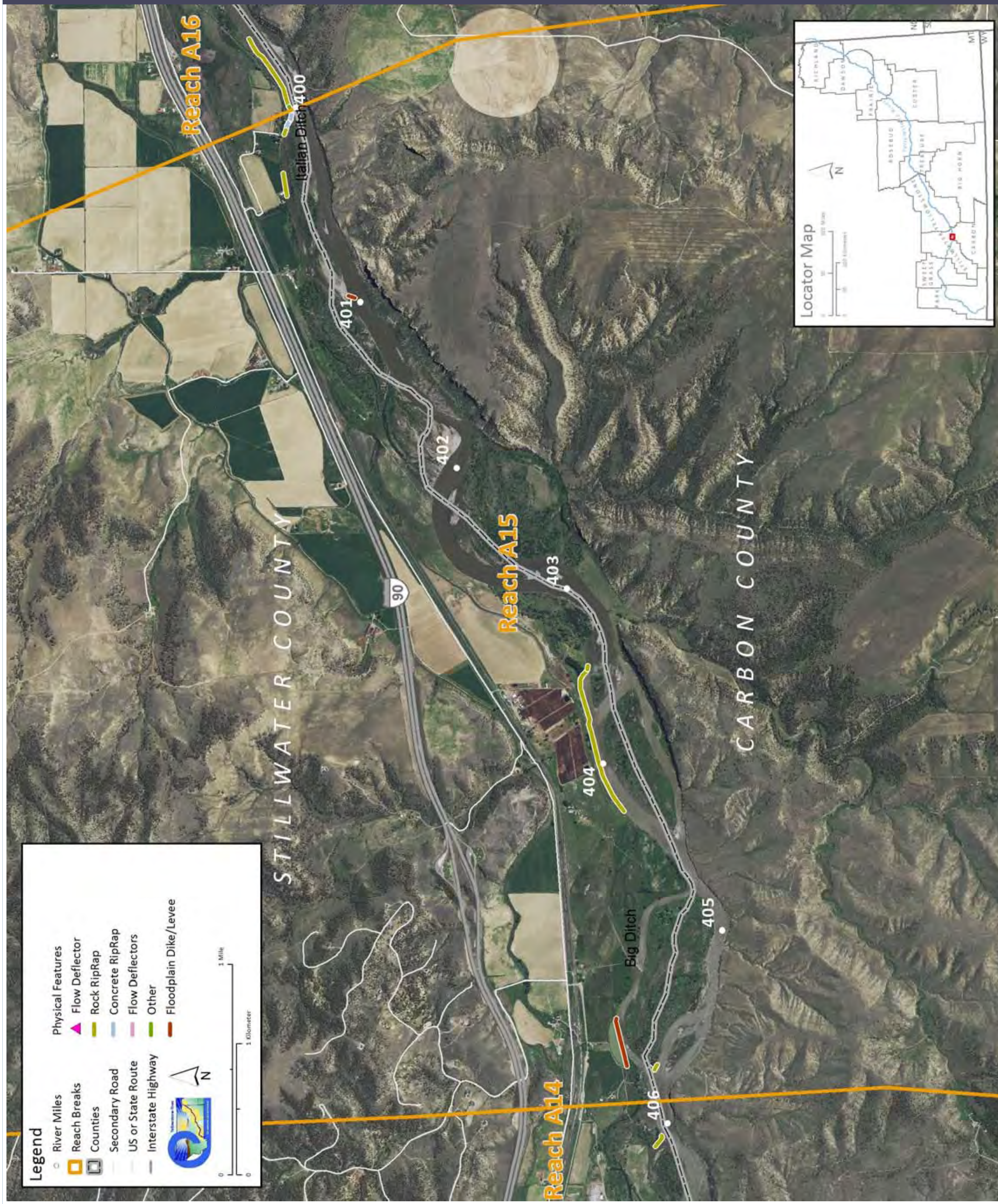
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	1.2	0.1%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

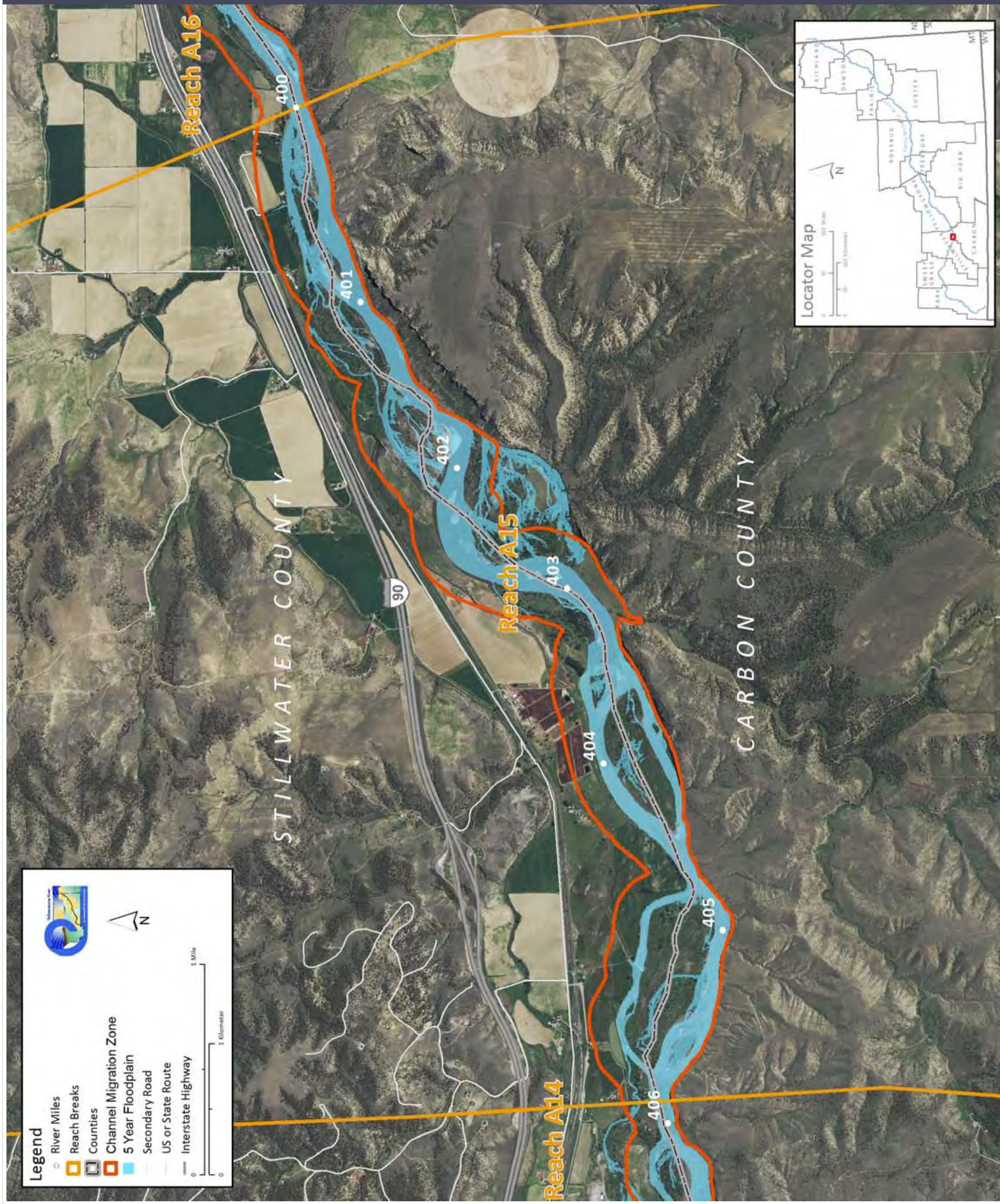
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	19.9	17.5	21.2	1.2

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Stillwater	**Upstream River Mile**	400
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	392.4
General Location	Park City	**Length**	7.60 mi (12.23 km)

Narrative Summary

Reach A16 is 7.6 miles long and is located just south of Park City. The reach is a Partially Confined Anabranching reach type, indicating some valley wall influences as well as relatively extensive forested islands. The partial geologic confinement within Reach A16 is created by interbedded sandstone and shale. In addition, both low and high alluvial terraces intermittently form the active river corridor margin.

Approximately 9 percent of the bankline in Reach A16 is armored, and the armor is almost entirely rock riprap, some short sections of concrete armor and flow deflectors. The armor is located almost entirely on the northern corridor margin, against terrace margins. Its use is split evenly between protecting agricultural and exurban residential land uses. On the upstream end of the reach, rock armor protects the Italian Ditch Diversion and Canal, which divert water on the north bank of the river at RM 400. Over four miles of floodplain dikes have been mapped in the reach, most of which follow ditches on the north floodplain.

Although there is no evidence that side channels have been intentionally blocked off in Reach A16, there has still been a net loss of over a mile of side channel since 1950. Similar to most reaches in Region A, the loss of side channels has been accompanied by an overall increase in the total channel footprint; since 1950, the bankfull channel area of Reach A16 has increased by 40 acres.

Land use in Reach A16 is almost entirely agricultural, although there are almost 300 acres of urban/exurban development in the mapping footprint. There are corrals that are part of an animal handling facility within 1,000 feet of an abandoned river swale at RM 395. Over a thousand acres under of ground in Reach A16 are under flood irrigation, and about 11 are in pivot. About 150 acres of developed land are in the Channel Migration Zone, and almost 40 acres of that is in urban/exurban development. About 6% of the total CMZ is restricted by bank armor and dikes.

There is one pipeline crossing in Reach A16. It crosses under the river at RM396.7 and consists of a 24 inch crude oil pipeline that is owned by Kinder Morgan Pipelines. This pipeline was horizontally drilled during its installation.

Reach A16 was sampled as part of the avian study. The average species richness in Reach A16 was 8.5, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. An average of one cowbird was observed during the field sampling visits. Reach A16 has lost about one half of its riparian forest considered at low risk of cowbird parasitism since 1950. At that time, there were about 12 acres of forest per valley mile considered to be isolated enough from agricultural infrastructure and urban/exurban development to be considered at low risk. By 2011, about 6.6 acres considered low risk remained.

There are over 250 acres of mapped wetland in the reach, with most of that emergent marshes wand wet meadows. Many of these wetland areas occupy old river swales on the floodplain north of the river, or abandoned channels in the active corridor.

The reach has extensive Russian olive, with almost 30 acres of mapped footprint in the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 16,900cfs to 15,500 cfs, a drop of about 8%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,310 cfs to 1,780 cfs with human development, a reduction of 23%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A16 include:
•Passive loss of over a mile of side channel
•Russian olive colonization in abandoned side channels
•Emergent wetland development in abandoned side channels

Recommended Practices for Reach A16 include:
•Diversion structure management at Italian Ditch Diversion RM 400
•Nutrient management at corrals that are part of an animal handling facility at RM395.
•Russian olive removal (29acres)
•Wetland management/restoration due to extent of mapped emergent wetland (214 acres emergent, 270 acres total wetland)

Yellowstone River Reach Narratives

Reach A16

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	32,200	30,600	-5.0%
100 Year (cfs)	58,600	57,600	-1.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	746.5	772.1	676.5	812.6	66.1

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	6,789	8.4%	2,351
Concrete Riprap	9	0.0%	-158
Flow Deflectors	128	0.2%	128
Total	**6,926**	**8.5%**	**2,321**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	203.1	214.4
Acres/Year	7.8	8.6
Acres/Year/Valley Mile	1.2	1.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat): -4.96 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	42.3	13%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	104.4	5%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	4,008.9	3,532.8
Ag. Infrastructure (Ac)	70.7	132.8
Exurban (Ac)	0.0	268.0
Urban (Ac)	0.0	0.0
Transportation (Ac)	21.5	73.5

	1950	2011
Flood (Ac)	1,587.8	1,095.2
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	10.6

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	7.2	3.5	10.6	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	10.7	1.6
Emergent	214.0	32.0
Scrub/Shrub	43.3	6.5

Total Wetland Acres: **268.0**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

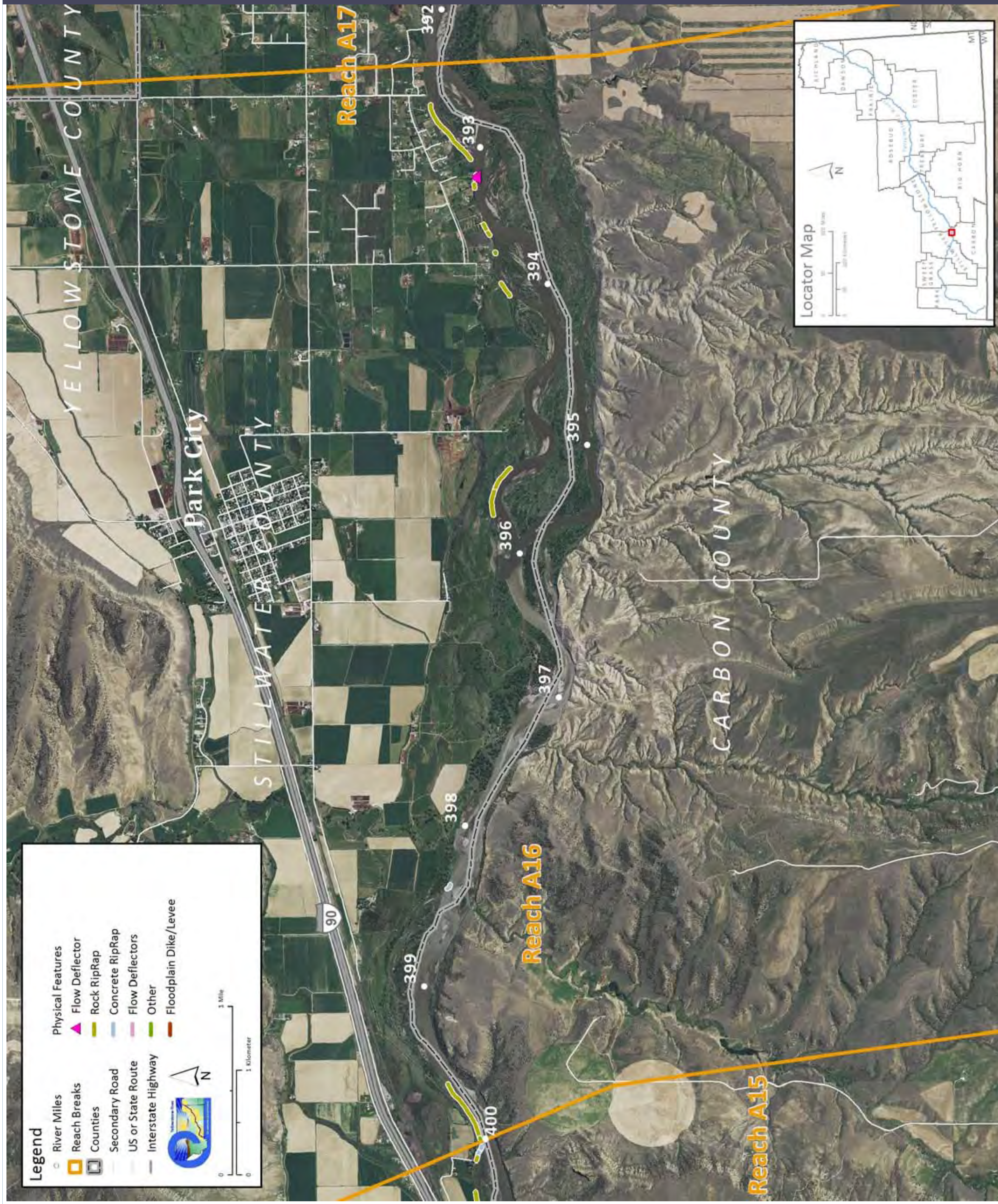
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	28.7	1.8%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	12.1	14.5	6.6	-5.5

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

County	Yellowstone	**Upstream River Mile**	392.4
Classification	UA: Unconfined anabranching	**Downstream River Mile**	386
General Location	To Laurel	**Length**	6.40 mi (10.30 km)

Narrative Summary

Reach A17 is 7.6 miles long and is located just above Laurel. The reach is classified as Unconfined Anabranching (UA), which is characteristically one of the most dynamic reach types on the river. The river is flowing in the alluvial valley with minimal influences of the valley wall and through numerous forested islands. There are sites in Reach A17 where the river has migrated almost 1,000 feet since 1950.

Approximately 13 percent of the bankline in Reach A17 is armored by rock riprap, concrete riprap and flow deflectors. Between 2001 and 2011 the total length of rock riprap increased by about a half of a mile. At RM 387, a ~750 foot long stretch of flow deflectors on the left bank have been flanked, and by fall 2011 the river had migrated about 120 feet behind the flanked armor. The deflectors are still visible in the channel. In some places such as at RM 389.8, bank armor on both sides of the river narrows the corridor to about one channel width, or 1,000 feet.

Over a mile of side channels in Reach A17 were blocked prior to 1950. Two major channels were blocked on the north side of the river, one at the Buffalo Mirage Fishing Access Site at RM 391.5, and the other at Rm 389.5. These channels, as well as other secondary channels that were passively loss, host fairly dense concentrations of Russian olive. Similar to most reaches in Region A, the loss of side channels has been accompanied by an increase in the total river footprint, indicating that flow concentration into the main river channel has caused it to enlarge. Between 1950 and 2001, the size of the channel increased from 560 acres to 645 acres.

Land use in Reach A17 is primarily agricultural, although there are almost 600 acres of urban/exurban development in the reach as the river approaches the City of Laurel. Since 1950, there has been a reduction in flood irrigated acres of about 550 acres, and an increase in pivot irrigation from 0 acres in 1950 to 284 acres in 2011. A total of 383 acres of developed ground are in the mapped Channel Migration Zone; and about 11% of the CMZ has been isolated by physical features protecting those land uses.

At RM 388.5, a headgate diverts water into an old side channel that has been converted to a canal on the north side of the river. About ½ mile downstream, the canal is riprapped where it was recently threatened by rapid northward river migration. At this location, the river has migrated over 800 feet northward since 1950. The main channel of the river now flows along the riprapped canal embankment for about 750 feet.

There are corrals that are part of an animal handling facility within 600 feet of the north riverbank at RM 392.

Side channel loss and channel migration in Reach A17 has resulted in relatively high rates of riparian recruitment. Since 1950, there has been 330 acres of land that experience recruitment of new riparian vegetation. Most of that recruitment was in abandoned channels (200 acres) and about 27 acres of recruitment was direct result of channel migration.

Two ice jams have been recorded in Reach A17, in 1996 and 1997. Both occurred during the month of February, and were reported to have occurred at the Laurel Bridge.

There are over 200 acres of mapped wetland in the reach, with most of that emergent marshes and wet meadows. Many of these wetland areas occupy river swales on the floodplain north of the river, or abandoned channels in the active corridor.

Almost 22 acres of Russian olive has been mapped in the floodplain.

Reach A17 was sampled as part of the avian study. The average species richness in Reach A17 was 7.7, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. An average of 0.9 cowbirds (a bird that parasitizes other bird's nests) were observed in cottonwood habitats during the field sampling visits. Reach A17 has lost about two thirds of its riparian forest considered at low risk of cowbird parasitism since 1950. At that time, there were about 28 acres of forest per valley mile considered to be isolated enough from agricultural infrastructure and urban/exurban development to be considered at low risk. By 2011, about 10 acres per valley mile considered low risk remained.

A total of three Potential Species of Concern (PSOCs) were observed in Reach A17 during the avian study, including the Black and White Warbler, Chimney Swift, and Ovenbird. One Species of Concern (SOC), the Bobolink, was also observed in Reach A17.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 16,900cfs to 15,500 cfs, a drop of about 8%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,320 cfs to 1,780 cfs with human development, a reduction of 23%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A17 include:
•Flanking of flow deflectors and accelerated erosion behind flanked structures
•Physical blockage of over a mile of side channel
•Russian olive colonization in abandoned side channels

•Emergent wetland development in abandoned side channels
•Ice jamming potentially associated with the Laurel Bridge

Recommended Practices for Reach A17 include:
•Bank armor removal (flanked flow deflectors), RM 387
•Side channel restoration at RM 391.5 and RM 389.5
•Nutrient management associated with corrals that are part of an animal handling facility at RM 392.
•Russian olive removal (22 acres)
•Wetland management/restoration due to extent of mapped wetland (200)
•Irrigation diversion structure management at headgate on side channel at RM 388.5

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	32,200	30,600	-5.0%
100 Year (cfs)	58,600	57,600	-1.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	560.0	608.9	557.5	644.6	84.6

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	6,184	9.1%	2,584
Concrete Riprap	2,205	3.2%	0
Flow Deflectors	671	1.0%	-176
Total	**9,060**	**13.3%**	**2,407**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	7,639	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	195.3	180.6
Acres/Year	7.5	7.2
Acres/Year/Valley Mile	1.3	1.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat): -19.75 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	46.4	9%
100 Year	89.9	7%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	245.6	11%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	4,530.2	4,110.3
Ag. Infrastructure (Ac)	68.6	118.5
Exurban (Ac)	59.1	292.3
Urban (Ac)	95.4	203.9
Transportation (Ac)	50.2	50.2

	1950	2011
Flood (Ac)	1,927.0	1,384.1
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	283.8

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	6.0	0.8	6.8	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	9.4	1.6
Emergent	203.4	35.6
Scrub/Shrub	13.4	2.3

Total Wetland Acres: **226.2**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

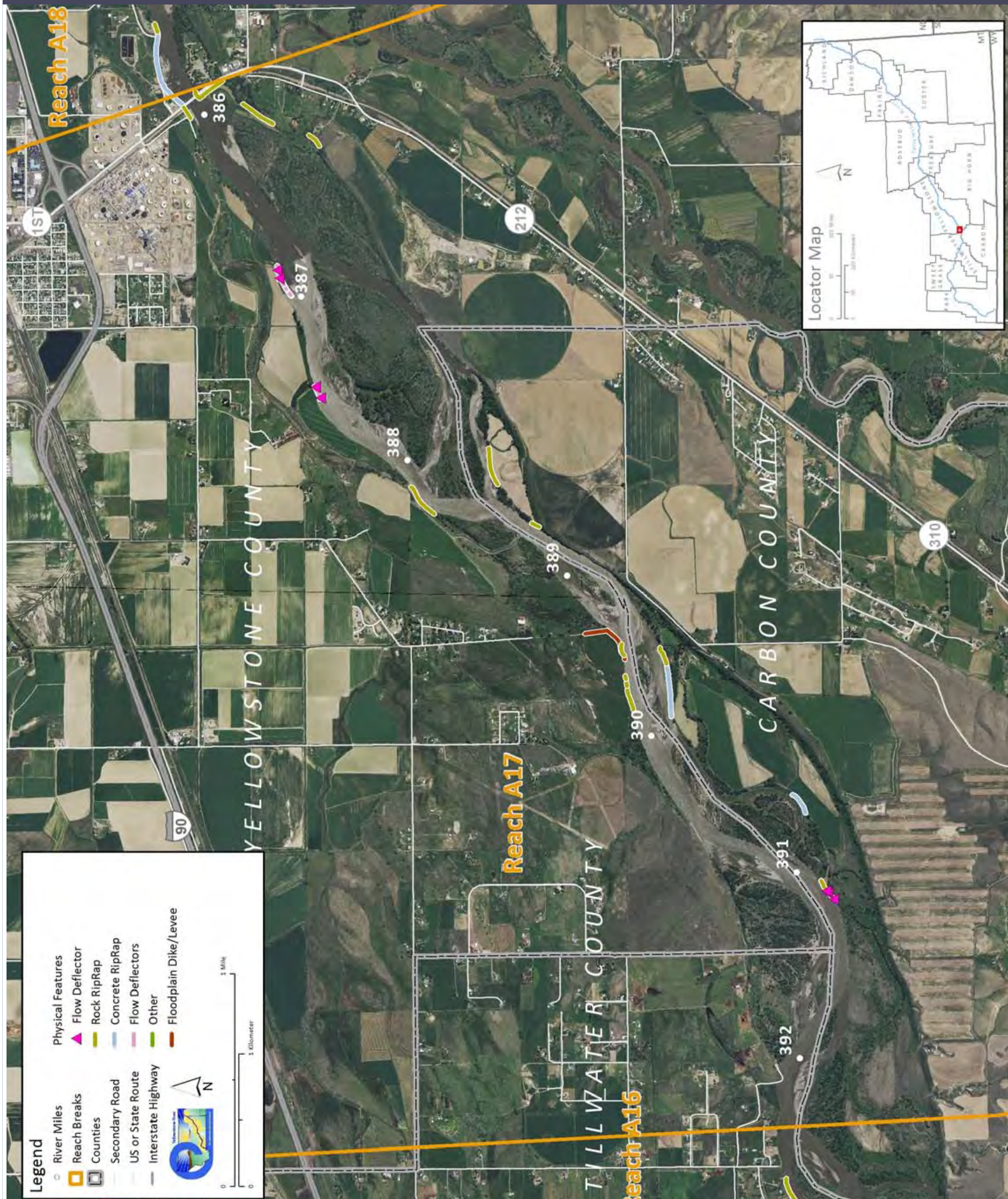
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	21.8	6.7%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

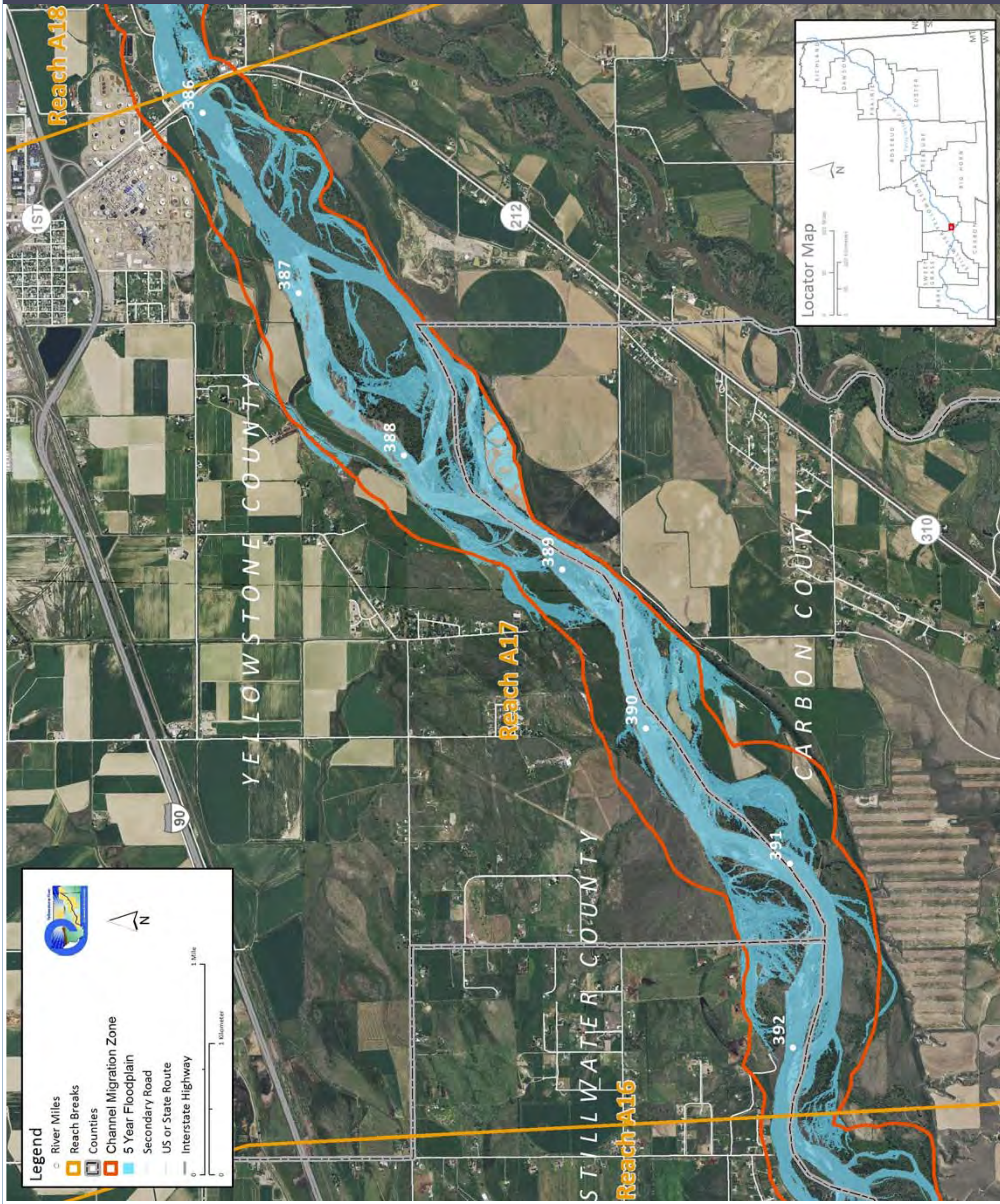
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	27.7	64.2	9.7	-18.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	386
Classification	UA: Unconfined anabranching	**Downstream River Mile**	383.5
General Location	To Clarks Fork	**Length**	2.50 mi (4.02 km)

Narrative Summary

Reach A18 is 2.5 miles long and extends from Laurel to the mouth of the Clarks Fork River. The reach is classified as Unconfined Anabranching (UA), which is characteristically one of the most dynamic reach types on the river. The reach has one large island and even though fairly intensively armored as flows through Laurel, there has been over 1,100 feet of southward channel migration since 1950 at one location about ½ mile downstream of the bridge.

Reach A18 is perhaps best known by the series of pipeline crossings below the Laurel Bridge. In 2011, floodwaters on the Yellowstone River peaked July 2, 2011 at 70,600 cfs, which is an estimated 25-50 year flood event. On July 1, 2011, the day before the peak, a 12-inch diameter crude oil pipeline called the ExxonMobil Silvertip Pipeline, ruptured just downstream of the bridge in Reach A18. The pipeline was originally installed in a trench across the river that was 5-7 feet deep. The rupture spilled an estimated 50,000 gallons of oil into the Yellowstone River; the incident received national attention and millions of dollars were spent on cleanup. The Silvertip Pipeline and several others at this location have been replaced by HDD (Horizontal Directionally Drilled) lines.

The industrial land uses at Laurel uses coupled with the dynamic nature of the Yellowstone River in Reach A18 has resulted in the armoring of almost 40% of the river in this reach. That armor consists of rock riprap, concrete riprap, and flow deflectors. Almost all of the armor is located on the north bank where it protects the City of Laurel sewage treatment facility, as well as a canal that leaves the river at RM 385.7. There is one small section of concrete armor on the north bank, and it appears that the upper 300 feet of this armor has been flanked and now is visible in the middle of the river. Recent concerns over the main intake structure for the city's water supply sheds some light on the dynamics of the river, and potentially the influence of high density bank armor on channel stability. The 2011 flood evidently caused the river to downcut at the intake, perching the structure, such that there are current efforts in motion to relocate the intake several miles upstream. This downcutting may be related to the high density of armor between Laurel and Billings that effectively focuses flow into the main channel and can drive channel incision (downcutting). Reach conditions just downstream in Reach B1 support this hypothesis.

There are over 3 miles of mapped dikes in Reach A18. Dikes, levees, and transportation encroachment features have isolated about one half of the historic 100-year floodplain in the reach. Almost 17% of the 5-year floodplain has become isolated from the river. Most of the isolated 100-year floodplain area is south of the river, between the Yellowstone and Clarks Fork Rivers.

Land use in Reach A18 is primarily agricultural, although there are almost 380 acres of urban/exurban development in the reach as the river passes south of the City of Laurel. All of the irrigated land in Reach A18 is in flood irrigation. A total of 110 acres of developed ground are in the mapped Channel Migration Zone; and the over 90% of that is in urban/exurban land use. A total of 31% of the CMZ has become isolated by physical features.

Riparian mapping indicates that since 1950, about 67 acres in the reach were cleared to support irrigation and other land uses. There are about 18 acres of mapped Russian olive in the floodplain.

Since 1950, about 150 acres of land in Reach A18 was colonized by new riparian vegetation. There are over 140 acres of mapped emergent wetland in the reach, which consists primarily of emergent marshes and wet meadows.

Almost 18 acres of Russian olive has been mapped in the floodplain.

Reach A18 was sampled as part of the avian study. The average species richness in Reach A17 was 7.1, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. On average, of 0.9 cowbirds were observed in cottonwood habitats during the field sampling visits. Reach A18 has lost all of its riparian forest considered at low risk of cowbird parasitism since 1950. At that time, there were 3.4 acres of forest per valley mile considered to be isolated enough from agricultural infrastructure and urban/exurban development to be considered at low risk. By 2011, that had been reduced to zero.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 16,900cfs to 15,500 cfs, a drop of about 8%. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,780 cfs to 1,950 cfs with human development, a reduction of 30%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760cfs under unregulated conditions to 1,680cfs under regulated conditions at the Livingston gage, a reduction of 4.6%.

CEA-Related observations in Reach A18 include:
•Flanking of concrete armor
•Pipeline rupture in highly armored reach
•Water intake perching in highly armored reach
•Russian olive colonization
•Emergent wetland development in abandoned side channels
•Floodplain isolation at confluence between Clarks Fork and Yellowstone River from transportation-related infrastructure
•Extensive CMZ encroachment in urbanized reach

Recommended Practices for Reach A18 include:
•Irrigation diversion structure management at headgate on at a canal at RM 385.7
•Flanked concrete armor removal RM384
•Russian olive removal (18 acres)
•Floodplain restoration between lower Clarks Fork River and Yellowstone River
•Pipeline Management for several crossings at Laurel.

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	32,200	30,600	-5.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	58,600	57,600	-1.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	198.9	250.8	227.3	280.8	82.0	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	3,885	15.6%	220	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	3,782	15.2%	-736	
Flow Deflectors	1,525	6.1%	58	
Total	**9,192**	**37.0%**	**-459**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	85.7	94.5	-57.18 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	3.3	3.8		
Acres/Year/Valley Mile	1.6	1.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	15.0	17%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	303.5	54%	

Restricted Migration Area	Acres	% of CMZ	
	274.8	31%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	2,401.7	1,767.8	Flood (Ac)	945.9	893.5	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	46.8	46.4	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	27.2	332.4	Pivot (Ac)	0.0	0.0	
Urban (Ac)	2.5	42.6				
Transportation (Ac)	22.8	23.0				

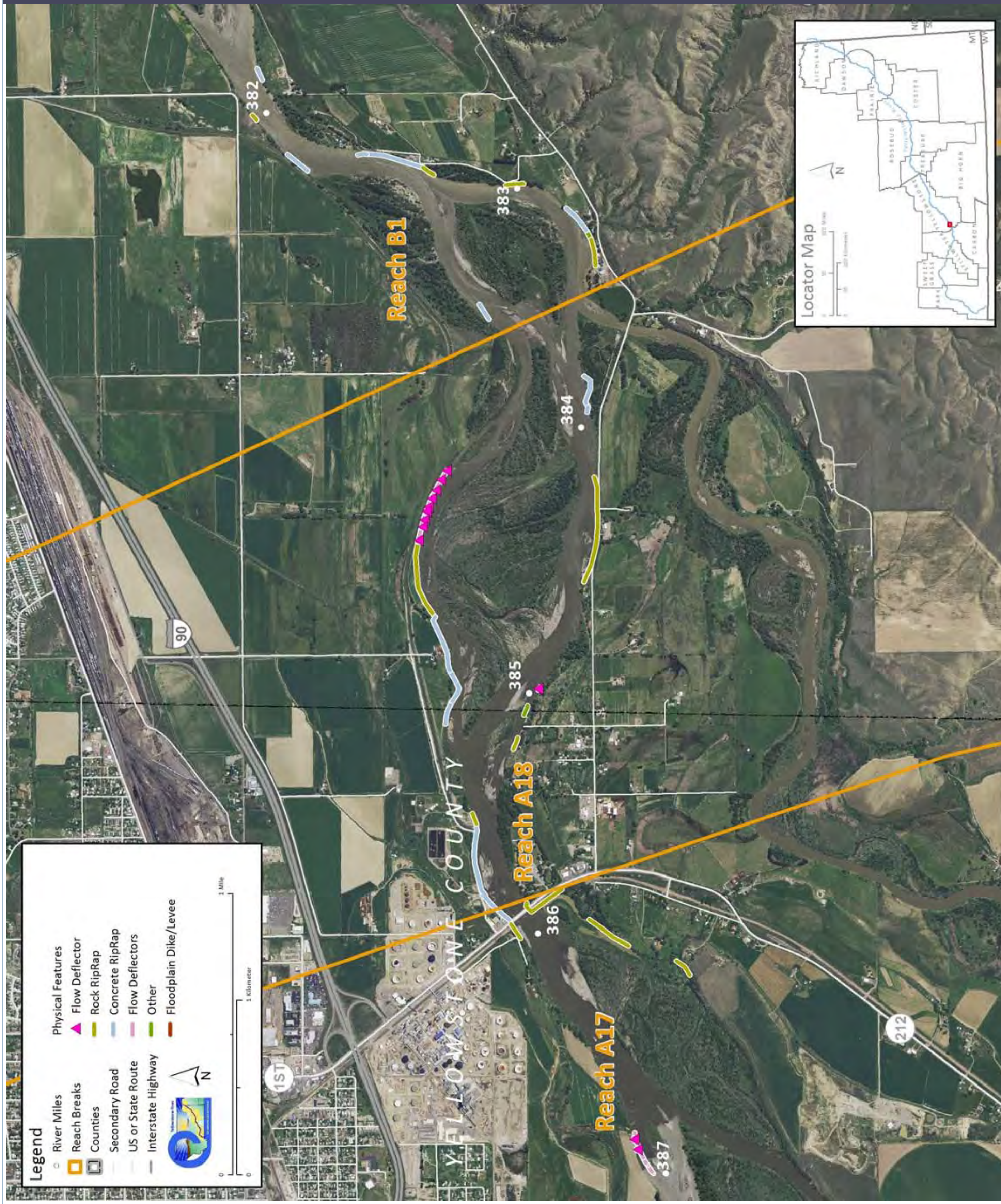
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	39.9	27.3	67.2	9.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	15.8	7.7	**188.7**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	139.7	68.2		
Scrub/Shrub	33.2	16.2		

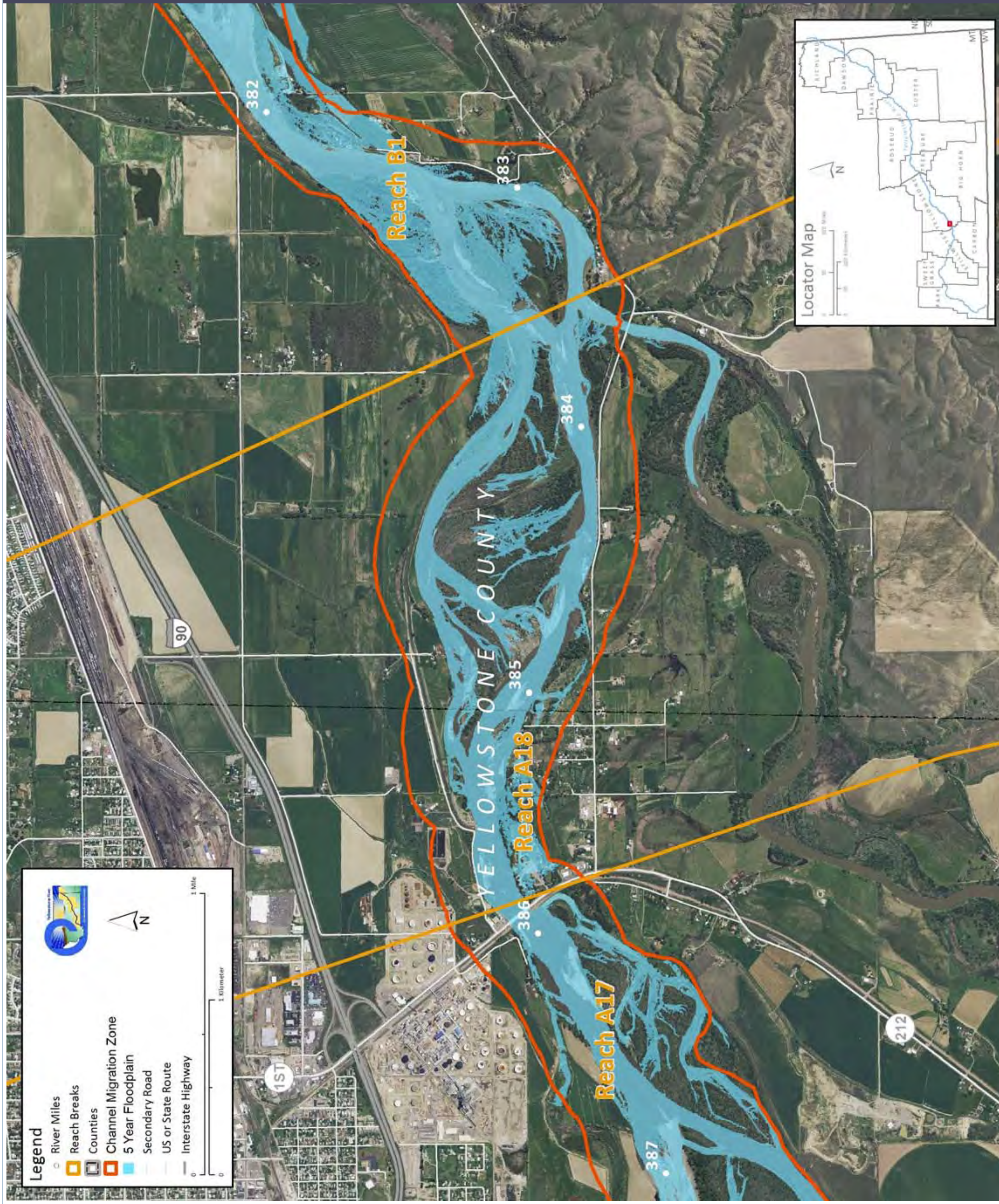
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	17.9	2.7%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	3.4	0.0	0.0	-3.4	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	383.5
Classification	UB: Unconfined braided	**Downstream River Mile**	368.3
General Location	Laurel to Billings	**Length**	15.20 mi (24.46 km)

Narrative Summary

Reach B1, located in Yellowstone County, extends from the mouth of the Clark Fork River to Billings. It is approximately 15.4 miles long, extending from RM 367.0 to 382.4. It is an Unconfined Braided (UB) reach type indicating minimal influence of the valley wall coupled by extensive open gravel bars and low flow channels. Human impacts in Reach B1 include early bridge construction and stream corridor narrowing, flow consolidation through diking and bank armoring, and loss of side channel due to physical blockages and apparent downcutting. Flow alterations in this reach have been substantial; the mean annual flood has dropped an estimated 17% due to human influences, and summer low flows have dropped by 42%.

In total there are 57,118 feet of bank armor in Reach B1, which equates to 10.82 miles of bank armor in a 15.4 mile long reach of river. Concrete riprap is the most prevalent type of armor, with about 5.5 miles present in 2011, even after the loss of 2,870 feet or concrete armor protection between 2001 and 2011.There are almost four miles of rock riprap, over 4,000 feet of which was constructed since 2001. There are also 7,616 feet of flow deflectors in the reach, and about 2,500 feet of those flow deflectors were built between 2001 and 2011. The most rapid expansion of armor occurred between 1950 and 1995, when the total length of bank protection expanded from 14,872 feet to 47,339 feet.

Numerous bank armor structures have been eroded out in Reach B1. Typically flanked, failed armor was identified at the following locations:
•RM 383L: 330 feet of flow deflectors totally lost
•RM 382.3R: lower 175 feet of concrete riprap flanked
•RM 281.5R: upper 400 feet of concrete riprap flanked: Idled crude oil pipeline is less than 200 feet behind this flanked armor
•RM 380.2R: lower 600 feet of concrete armor flanked
•RM 377.8: upper 540 feet of concrete armor flanked
•RM 373.8R: upper 300 feet and lower 270 feet of concrete armor flanked

The loss of side channel length through time has been extensive. Prior to 1950, almost a mile of side channels had been blocked on the south side of the river at RM 373.8 and at the South Billings Blvd Bridge at RM 371. Since 1950, another 14,800 feet have been blocked by dikes. One major blockage is located about 2 miles upstream of the Duck Creek Bridge at RM 381 and another near the gravel pit/trailer park complex at RM 373. Other side channels have been lost passively, without blockages. In total, Reach B1 has been characterized by a loss of 7 miles of side channel length between 1950 and 2001, the majority of which occurred between 1976 and 1996.

A review of available data indicate that the loss of side channels in Reach B1 is both directly and indirectly related to bank stabilization within the reach. Between 1950 and 1976, a series of dikes were constructed upstream of South Billings Blvd to block the course of a primary channel, isolating several thousand feet of channel. Womack (2000) notes that “the greatest measureable change has occurred due to abandonment of secondary channels, primarily due to construction of dikes and secondarily due to channel armoring. A relatively short dike at the upstream end of a braided reach can have a disproportionate effect, because it may effectively eliminate miles of channel”. These blockages are associated with some of the braiding parameter reduction in Reach B1. However, the most loss of side channels occurred after 1976, when the dikes above South Billings Blvd. were already in place. Some of these channels were abandoned due to blockage by dikes, and other locations of channel abandonment and braiding parameter reduction show no apparent direct relationship to physical features.

The side channels that were passively abandoned in Reach B1 are commonly perched above the main Yellowstone River channel. This perching indicates that abandonment may be related to downcutting of the main channel. Womack (2000) noted that width to depth ratios decreased in heavily armored reaches due to flow consolidation in a single channel. Womack suggests that channel confinement and consolidation into fewer channels has resulted in downcutting and reduction in width to depth ratio. Flow alterations have also likely contributed to side channel abandonment.

Several bridges were constructed in Reach B1 prior to 1950. These bridges all constrict the natural meander corridor of the river and have been associated with channel downcutting. Womack (2000) showed seven feet of degradation immediately upstream of the South Billings Blvd Bridge.

The primary land use in the reach is non-irrigated agriculture although several thousand acres of agricultural land has been developed since 1950. In 2011, there were about 3,000 acres of land under flood irrigation and 240 acres under pivot in Reach B1. Between 1950 and 2011, the extent of urban/exurban land use expanded from 310 acres to over 2,000 acres. The development has extended into the Channel Migration Zone (CMZ). A total of 810 acres of CMZ are developed, with 242 acres of ground developed for urban/exurban use and 84 acres in pivot irrigation. Another 470 acres of land in the CMZ are under flood irrigation. As a consequence of extensive development in the CMZ, about 25% of the total CMZ footprint has become restricted due to armoring and dike construction.

There is one animal handling facility within 300 feet of the north riverbank just downstream of the Duck Creek Bridge at RM 377.7.

A total of 610 acres of the historic 100-year floodplain has become isolated from the river, which is 14% of the total 100-year floodplain footprint. Most of the 100-year floodplain isolation is due to transportation infrastructure. Similarly, about 13% of the 5-year floodplain (270 acres) has been isolated by transportation infrastructure. There are 184 acres of flood irrigated land in the 5-year floodplain, and 73 acres in pivot. Whereas most of the isolated 100-year floodplain area is behind the I-90 corridor in the city of Billings, most of the isolated 5-year area is in the stream corridor, which supports the interpretation that some downcutting in the reach has perched historic channels and floodplain area.

There are several pipeline crossings in Reach B1. At RM 382, two pipelines cross under the river; one is a natural gas pipeline owned by NW Energy LLC, and the other is an idled crude oil pipeline owned by Conoco Phillips. The idled crude oil pipeline follows the river close to the bank at RM281.5R where concrete armor has been flanked. There are four pipelines at South Billings Blvd; the one of these pipelines that was built to carry crude oil has been idled under nitrogen. The other pipelines are all natural gas.

Over 400 acres of wetland have been mapped in the reach, with most of that (270 acres) emergent wetland marsh that is located primarily in the active stream corridor and in abandoned channels. A total of 42 acres of Russian olive have been mapped in the reach, and these trees are dispersed throughout the corridor.

Reach B1 was sampled as part of the avian study. The average species richness in Reach B1 was 8.0, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. One bird species of concern (SOC), the Black-Billed Cuckoo, was identified in the reach. Three bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, including the Black and White Warbler, Chimney Swift, and Ovenbird. Since 1950, Reach B1 has all of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 3.5 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to zero.

Reach B1 was sampled as part of the fisheries study. A total of 31 fish species were sampled in the reach, and none of these species have been identified by the Montana Natural Heritage Program as Species of Concern (SOC).

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 22,800cfs to 18,900 cfs, a drop of about 17%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,900 cfs to 2,000 cfs with human development, a reduction of 31%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,836cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B1 include:
•Blockage of miles of side channel
•Extensive armoring with CMZ encroachment
•Passive loss of major side channels due to downcutting and flow alterations

Recommended Practices for Reach B1 include:
•Side channel restoration at RM 381 and RM373
•Pipeline crossing management – natural gas pipeline at RM382
•Flanked armor removal at RM383, RM382.3, RM281.5, RM380.2, RM377.8, and RM373.8
•CMZ management due to extent of current CMZ restriction (25%)
•Russian olive removal
•Pipeline management at crossings and also where concrete armor has flanked where idled crude oil pipeline runs parallel to bank at RM285.1R
•Nutrient management at corrals that are part of an animal handling facility within 300 feet of river at RM 377.7 just downstream of Duck Creek Bridge.

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	42,700	38,500	-9.8%
100 Year (cfs)	76,200	73,700	-3.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	1,809.2	1,745.6	1,505.2	1,696.7	-112.5

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	20,753	12.9%	4,418
Concrete Riprap	28,749	17.8%	-2,870
Flow Deflectors	7,616	4.7%	2,553
Total	**57,118**	**35.5%**	**4,102**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	4,970	14,812

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	490.8	362.9
Acres/Year	18.9	14.5
Acres/Year/Valley Mile	1.4	1.1

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

209.05 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	267.4	13%
100 Year	610.6	14%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	1,285.4	25%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	9,453.9	7,931.3
Ag. Infrastructure (Ac)	221.2	354.2
Exurban (Ac)	142.1	710.4
Urban (Ac)	174.6	1,542.1
Transportation (Ac)	102.1	151.0

	1950	2011
Flood (Ac)	2,905.2	2,922.5
Sprinkler (Ac)	0.0	26.1
Pivot (Ac)	0.0	241.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	57.0	119.4	176.4	8.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	81.4	6.2
Emergent	269.3	20.4
Scrub/Shrub	70.9	5.4

Total Wetland Acres **421.6**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

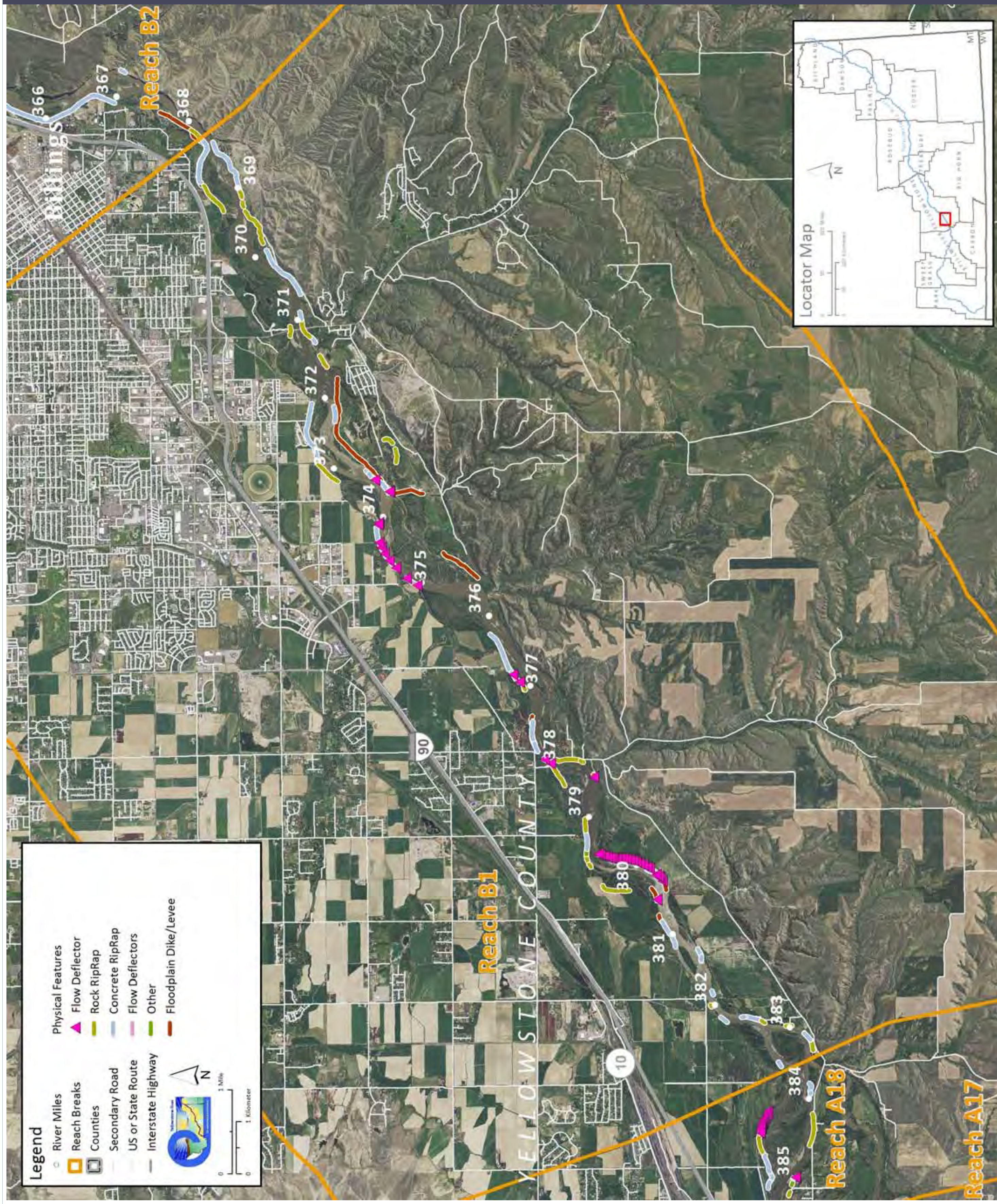
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	41.6	1.8%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	3.5	0.0	0.0	-3.5

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

County	Yellowstone	**Upstream River Mile**	368.3
Classification	PCB: Partially confined braided	**Downstream River Mile**	362.2
General Location	Billlings	**Length**	6.10 mi (9.82 km)

Narrative Summary

Reach B2, located in Billings is 6.1 miles long, extending from the rimrock bluffs south of town, under the I-90 Bridge, to the refinery area at Lockwood. It is a Partially Confined Braided (PCB) reach type indicating some influence of the bluff line on the river coupled by extensive open gravel bars and low flow channels. Reach B2 is extensively urbanized, with floodplain dikes, industrial and urban/exurban development, pipeline crossings, and bridges throughout the reach. Flow alterations in this reach have been substantial; the mean annual flood has dropped an estimated 17% due to human influences, and summer low flows have dropped by 42%.

In total there are 21,700 feet of bank armor in Reach B2, which equates to 4.1 miles of bank armor in a 6 mile long reach of river. Concrete riprap is the most prevalent type of armor, with about three miles present in 2011.There is almost a mile of rock riprap and a few flow deflectors. There are also over three miles of floodplain dikes mapped in the reach.

Since 1950, 6,566 feet of side channels have been blocked by dikes. These blocked side channels are in highly urbanized areas upstream of the I-90 Bridge and at the water treatment plant downstream.

The primary land use in the reach is urban/exurban development. A total of 620 acres of the historic 100-year floodplain has become isolated from the river, which is 41% of the total 100-year floodplain footprint. Most of the 100-year floodplain isolation is due to the Interstate Highway Embankment. Approximately 21% of the Channel Migration Zone has become restricted due to physical features, most of which are riprap installed to protect urban/industrial land uses.

A total of three ice jams have been recorded in Reach B2. One of these jams occurred in February of 1996, and the other two in January of 1997. They all resulted in flooding and the January 3 1997 jam caused some evacuations. The jams were reported as forming upstream of the I-90 Bridge.

There are numerous pipeline crossings in Reach B2. At RM 367 two pipelines cross under the river. One is a crude oil pipeline owned by Beartooth Pipeline that is HDD (Horizontal Directionally Drilled). The other is a petroleum product pipeline owned by Phillips 66 that as of Fall 2012 was trenched, and according to the addendum to the Yellowstone River Pipeline Risk Assessment, had 4 to 10 feet of cover. Further downstream, there are on the seven pipelines listed in the Pipeline Risk Assessment Report at RM365. Several of these pipelines are trenched as a bundle, with a reported minimum of two feet of cover.
About 25 acres of Russian olive have been mapped in Reach B2.

Reach B2 was sampled as part of the fisheries study. A total of 31 fish species were sampled in the reach and one of those species was sauger, which has been identified by the Montana Natural Heritage Program as a Species of Concern (SOC).

Reach B2 was sampled as part of the avian study. The average species richness in Reach B2 was 7.0, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. Two bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, the Ovenbird and the Plumbeous Vireo.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 23,700cfs to 19,700 cfs, a drop of about 17%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,910 cfs to 2,000 cfs with human development, a reduction of 31%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,836cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B2 include:
•Extensive armoring with CMZ encroachment

Recommended Practices for Reach B2 include:
•Pipeline crossing management
•Russian olive removal

Yellowstone River Reach Narratives — Reach B2

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	44,200	39,800	-10.0%
100 Year (cfs)	78,600	76,000	-3.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
517.8	536.9	501.3	534.2	16.4

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	4,329	6.7%	828
Concrete Riprap	17,283	26.8%	0
Flow Deflectors	91	0.1%	91
Total	**21,702**	**33.7%**	**918**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	6,566

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	136.5	88.0
Acres/Year	5.3	3.5
Acres/Year/Valley Mile	0.9	0.6

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

-37.22 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	58.1	15%
100 Year	620.1	41%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
255.5	21%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	2,457.5	1,071.5
Ag. Infrastructure (Ac)	33.0	17.2
Exurban (Ac)	318.3	0.0
Urban (Ac)	760.2	2,495.1
Transportation (Ac)	46.0	127.8

	1950	2011
Flood (Ac)	469.3	0.0
Sprinkler (Ac)	0.0	5.5
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
0.0	317.3	317.3	51.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	44.5	8.0
Emergent	19.6	3.5
Scrub/Shrub	11.6	2.1

Total Wetland Acres **75.7**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
24.6	3.2%

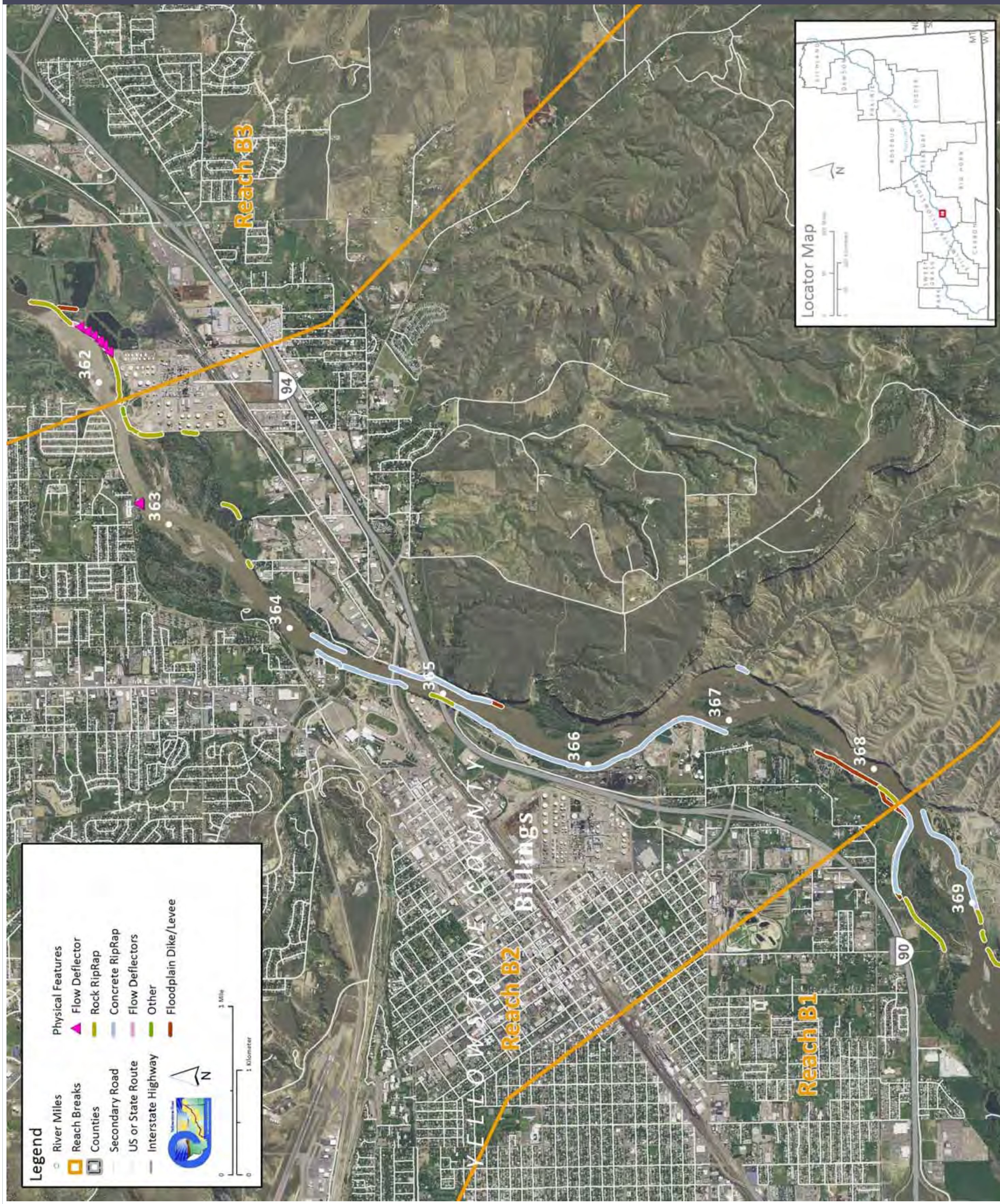
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

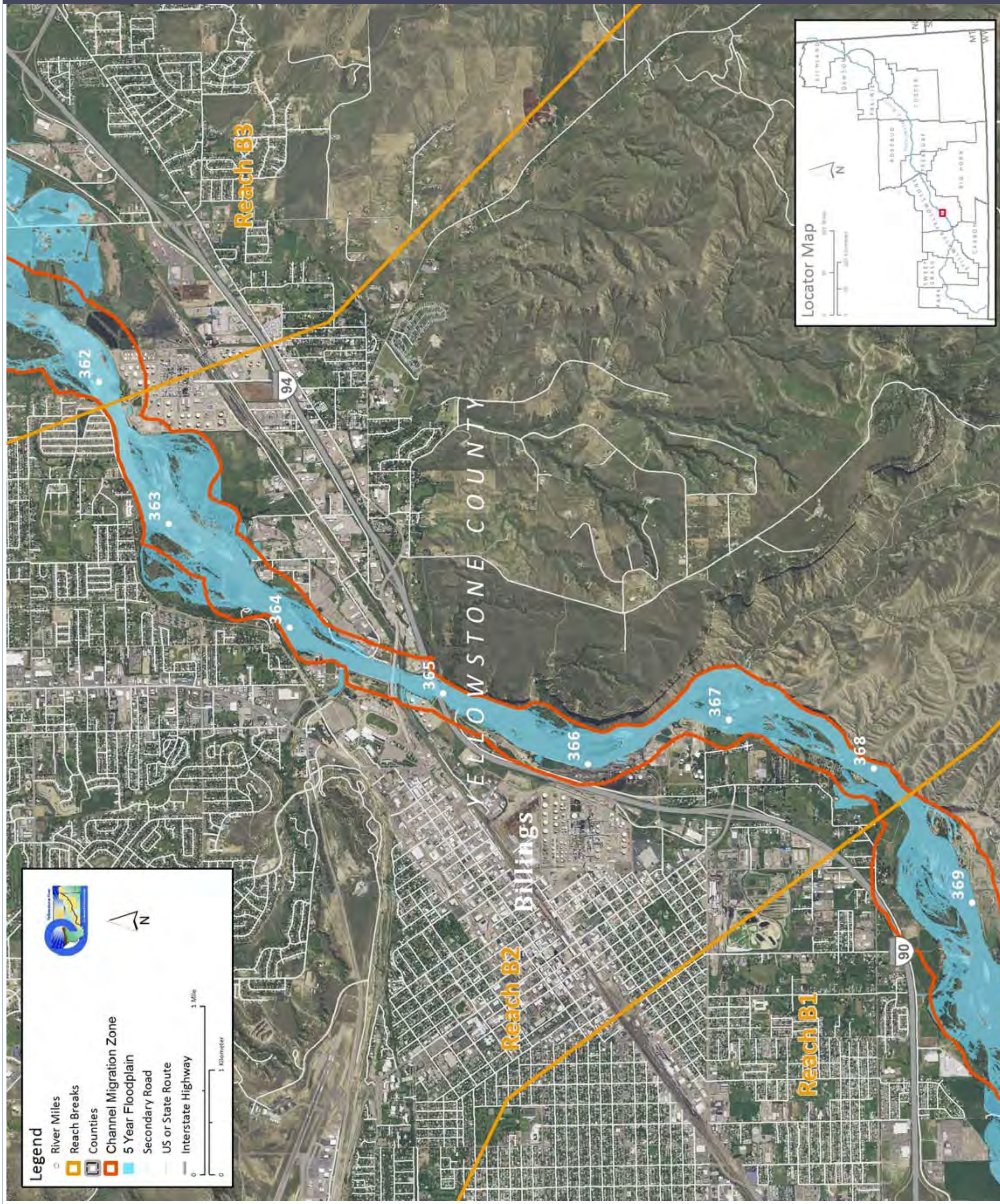
1950	1976	2001	Change 1950-2011
5.0	1.9	4.0	-1.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives

Reach B3

County	Yellowstone	**Upstream River Mile**	362.2
Classification	UB: Unconfined braided	**Downstream River Mile**	357.9
General Location	East Billings	**Length**	4.30 mi (6.92 km)

Narrative Summary

Reach B3 is 4.3 miles long and located in east Billings. The reach is characterized by loss of several miles of side channel, extensive Russian olive infestation, and substantial flow alterations due to human influences.

In total there are about 13,500 feet of bank armor in Reach B3, which covers almost 30% of the bankline. Most of the armor is rock riprap, although there are over 3,000 feet of flow deflectors mapped in the reach, as well as over a mile of floodplain dikes.

Prior to 1950, 11,000 feet of side channels had been blocked in the reach, and since that time another 14,000 feet have been similarly blocked by small dikes. These ~4 miles of blocked channel are about equivalent in length to that of the main river. That said, as of 2001 there were still about 35,000 feet of active side channel in Reach B3.

Solid waste dumps were mapped on old side channels on the east floodplain areas at RM361.5 and RM 360.6. There is one major headgate on the left bank of the river that feeds a heavily armored canal that is heavily armored at RM 359.9.

Flow alterations in the reach, which include a 10% drop in the 2-year flood, which along with side channel blockages has promoted the encroachment of riparian vegetation into old channel areas. Since 1950, almost 200 acres of riparian vegetation colonized previously un-vegetated side channels. Floodplain turnover rates have gone down since 1976 by about 2 acres per year, indicating slower rates of erosion.

Since 1950, predominantly agricultural land uses in Reach B3 have been converted to a mix of agriculture and urban/exurban development. About 1,000 acres of urban/exurban development has taken place since 1950. About 470 acres of ground continues to be flood irrigated in this area of east Billings. Approximately 16% of the Channel Migration Zone has become restricted due to physical features, all of which are bank armor installations designed to protect urban/industrial and agricultural land uses.

About 50 acres of Russian olive have been mapped in Reach B3. There are also fairly extensive mapped wetlands, with about 230 acres of total wetland area mapped, 95 acres of which are emergent wet meadows and marsh areas.

Reach B3 was sampled as part of the fisheries study. A total of 29 fish species were sampled in the reach, and none of those species have been identified by the Montana Natural Heritage Program as a Species of Concern (SOC).

Reach B3 was sampled as part of the avian study. The average species richness in this reach was 7.5, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. One bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, the Plumbeous Vireo.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 23,900cfs to 19,800 cfs, a drop of about 17%. The 2-year flood, which strongly influences overall channel form, has dropped from 44,500cfs to 40,100 cfs, which is a reduction of 10%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,920 cfs to 2,010 cfs with human development, a reduction of 31%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,836cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B3 include:
•Riparian encroachment with flow alterations
Extensive armoring with CMZ encroachment

Recommended Practices for Reach B3 include:
•Side channel reactivation at RM 362.0, 360.5, 359.8 and RM 359.0
•Russian olive removal
•Solid waste dump removal RM 361.5 and RM 360.6
•Irrigation diversion structure management at RM359.9.

Yellowstone River Reach Narratives

Reach B3

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	44,500	40,100	-9.9%
100 Year (cfs)	79,200	76,600	-3.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	576.6	595.2	489.5	548.1	-28.5

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	10,047	21.7%	-252
Concrete Riprap	592	1.3%	0
Flow Deflectors	3,111	6.7%	42
Total	**13,750**	**29.7%**	**-209**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	11,002	13,693

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	184.6	127.0
Acres/Year	7.1	5.1
Acres/Year/Valley Mile	1.9	1.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

57.31 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	154.8	14%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	265.8	16%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	2,717.1	1,770.0
Ag. Infrastructure (Ac)	50.5	51.4
Exurban (Ac)	21.4	616.2
Urban (Ac)	116.0	485.1
Transportation (Ac)	21.2	20.4

	1950	2011
Flood (Ac)	420.2	472.5
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	29.6	166.2	195.8	21.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	95.8	25.3
Emergent	94.9	25.0
Scrub/Shrub	40.5	10.7

Total Wetland Acres **231.2**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

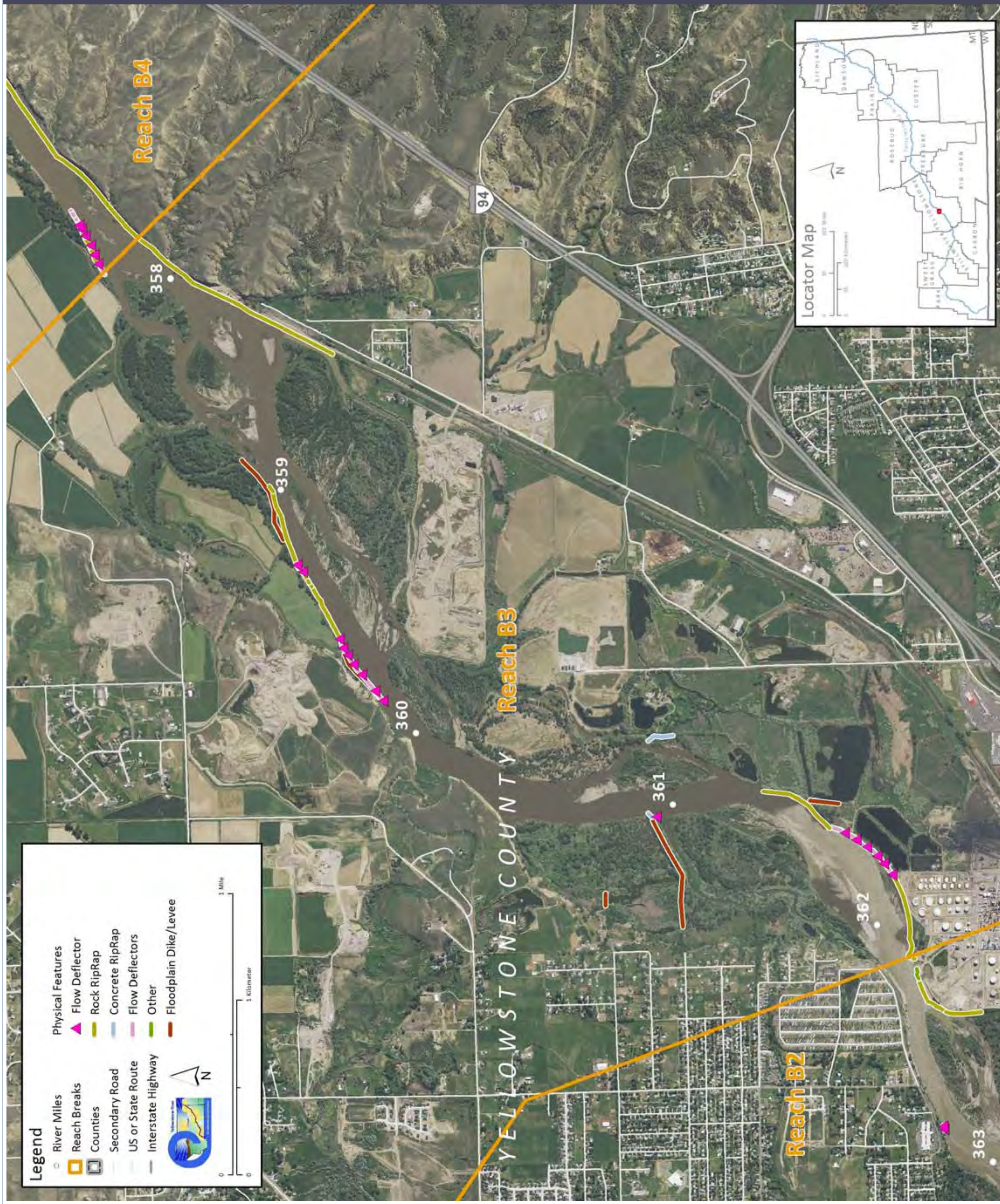
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	49.8	4.1%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

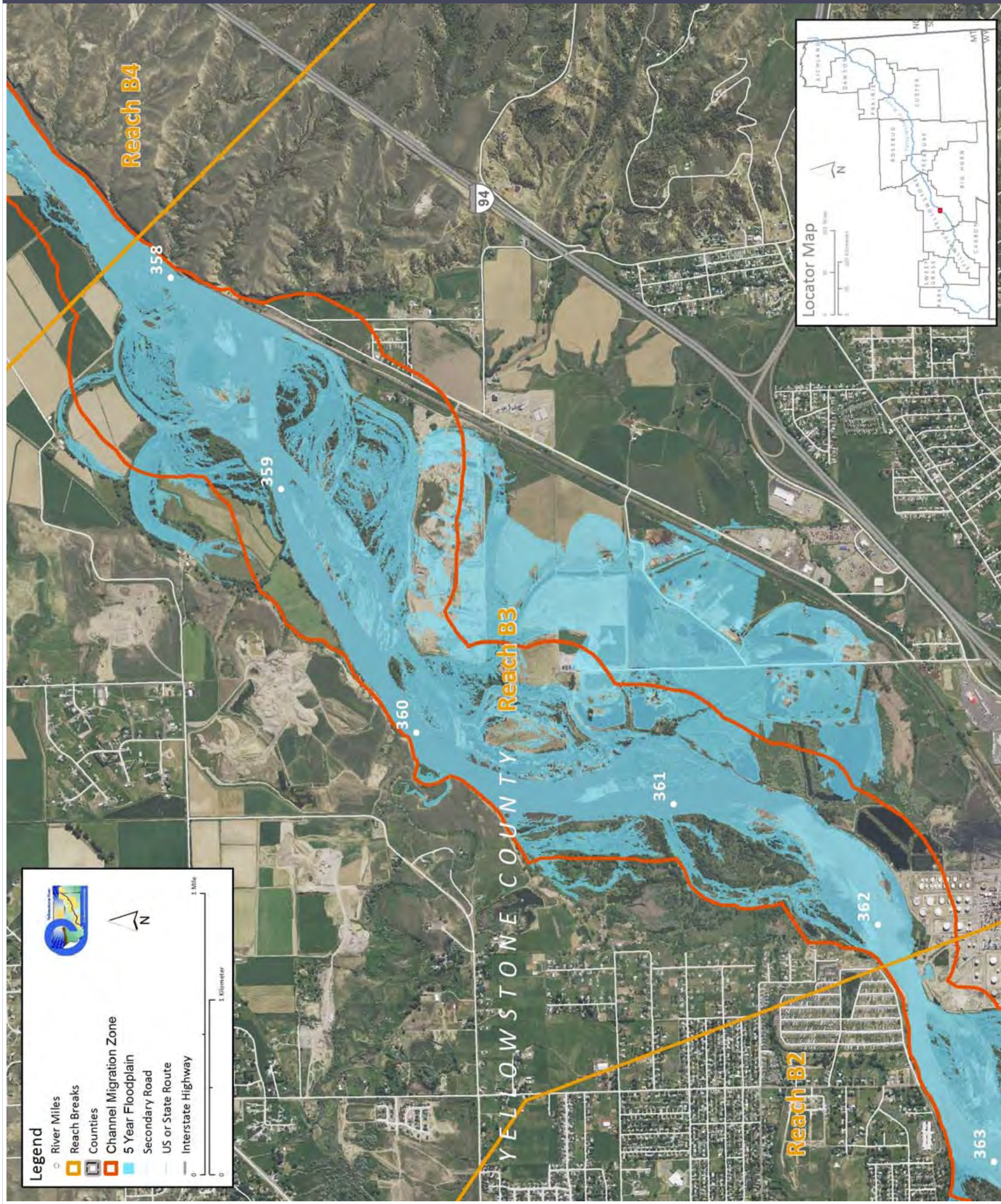
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	19.8	0.0	0.8	-19.1

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	357.9
Classification	PCS: Partially confined straight	**Downstream River Mile**	354
General Location	Upstream of Huntley	**Length**	3.90 mi (6.28 km)

Narrative Summary

Reach B4 is 3.9 miles long and located upstream of Huntley. It is classified as a Partially Confined Straight (PCS) reach type because within this reach the river flows straight along the south valley wall with minimal meandering. The reach is characterized by the most extensive bank armoring of any reach on the river.

In total there are about 29,000 feet of bank protection in Reach B4, such that 74% of the bankline is armored. Most of the armor is rock riprap, although there are over 8,000 feet of concrete riprap mapped in the reach, as well as over a 9,000 of floodplain dikes. Between 2001 and 2011, 500 feet of concrete riprap and 1,050 feet of flow deflectors were eroded out in the reach. The failed flow deflectors and concrete riprap have been largely replaced by rock riprap, although at the upstream end of the reach at RM 357.8, about 300 feet of flanked flow deflectors are in the river about 75 feet off of the left (north) bank.

The predominant land use in the reach is agriculture, with about 1,200 acres of land in flood irrigation in 2011. A total of 204 acres of developed land uses have encroached into the Channel Migration Zone (CMZ), including 193 acres of flood irrigation and 11 acres of transportation corridor. In order to protect these land uses, bank armor installations have isolated about one half of the river's CMZ.

Huntley Diversion Dam is located at RM 355.8. The structure diverts flow into the Huntley Main Canal, which follows the southern margin of the Yellowstone River floodplain. The diversion capacity of Huntley Dam is 600 cfs, and the project has the capacity to provide irrigation water to 30,000 acres of farm land. The crest length of the structure is 325 feet, and its structural height is 10.5 feet (http://www.usbr.gov/dataweb/dams/yellowstone_river_diversion.htm). The Huntley diversion structure was originally constructed as a temporary earthfill dam in 1931. In 1934, the temporary structure was modified to a concrete weir. In 1959, the dam underwent considerable rehabilitation due to undermining caused by settling and cracking of the concrete structure. As part of repairs required after recent flooding on the river, a fish passage channel was constructed around the north end of the dam. The structure is located at a point of split flow on the river, and blocks only the main channel. However, 2001 color infrared air photos of the site show that at low flows, the unblocked secondary channels are essentially dry and therefore incapable of passing fish

Developed land uses are also common in commonly flooded areas. About 280 acres of flood irrigated land is within the 5-year floodplain area.

There are corrals that are part of an animal handling facility adjacent to the north bank of the river at RM 355.

About 2.3 acres of Russian olive have been mapped in Reach B4.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 24,000cfs to 19,900 cfs, a drop of about 17%. The 2-year flood, which strongly influences overall channel form, has dropped from 44,700cfs to 40,300 cfs, which is a reduction of 10%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,940 cfs to 2,010 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B4 include:
•Flanking of flow deflectors
•Repair of damaged flow deflectors with riprap

Recommended Practices for Reach B4 include:
•Flanked flow deflector removal at RM 357.8
•Nutrient management at corrals associated with animal handling facility at RM355.
•Fish passage at Huntley Diversion Dam
•Watercraft passage at Huntley Diversion Dam
•Irrigation Diversion structure management at Huntley Diversion Dam

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	44,700	40,300	-9.8%
100 Year (cfs)	79,400	76,800	-3.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
322.4	315.6	315.7	360.6	38.2

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	20,729	52.1%	1,205
Concrete Riprap	8,331	20.9%	-502
Flow Deflectors	258	0.6%	-1,056
Total	**29,318**	**73.7%**	**-353**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	72.7	60.4
Acres/Year	2.8	2.4
Acres/Year/Valley Mile	0.8	0.7

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

-14.25 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	131.5	14%
100 Year	28.9	2%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
484.3	44%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	2,775.5	2,552.4
Ag. Infrastructure (Ac)	75.7	167.6
Exurban (Ac)	0.0	40.9
Urban (Ac)	0.0	0.0
Transportation (Ac)	21.8	59.4

	1950	2011
Flood (Ac)	727.6	1,161.5
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
11.4	0.0	11.4	3.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	17.0	4.6
Emergent	34.3	9.2
Scrub/Shrub	8.1	2.2

Total Wetland Acres **59.5**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
2.3	1.1%

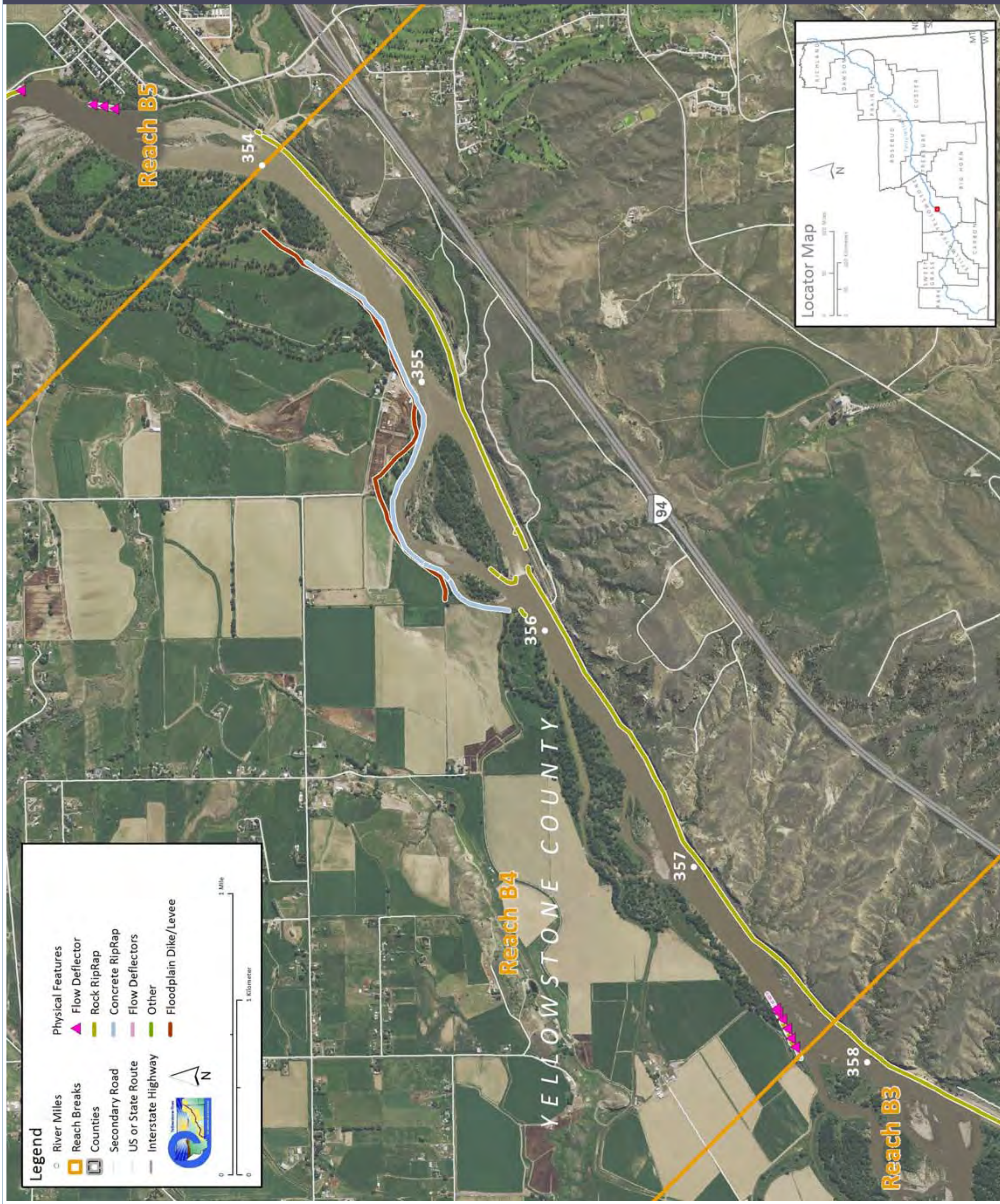
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

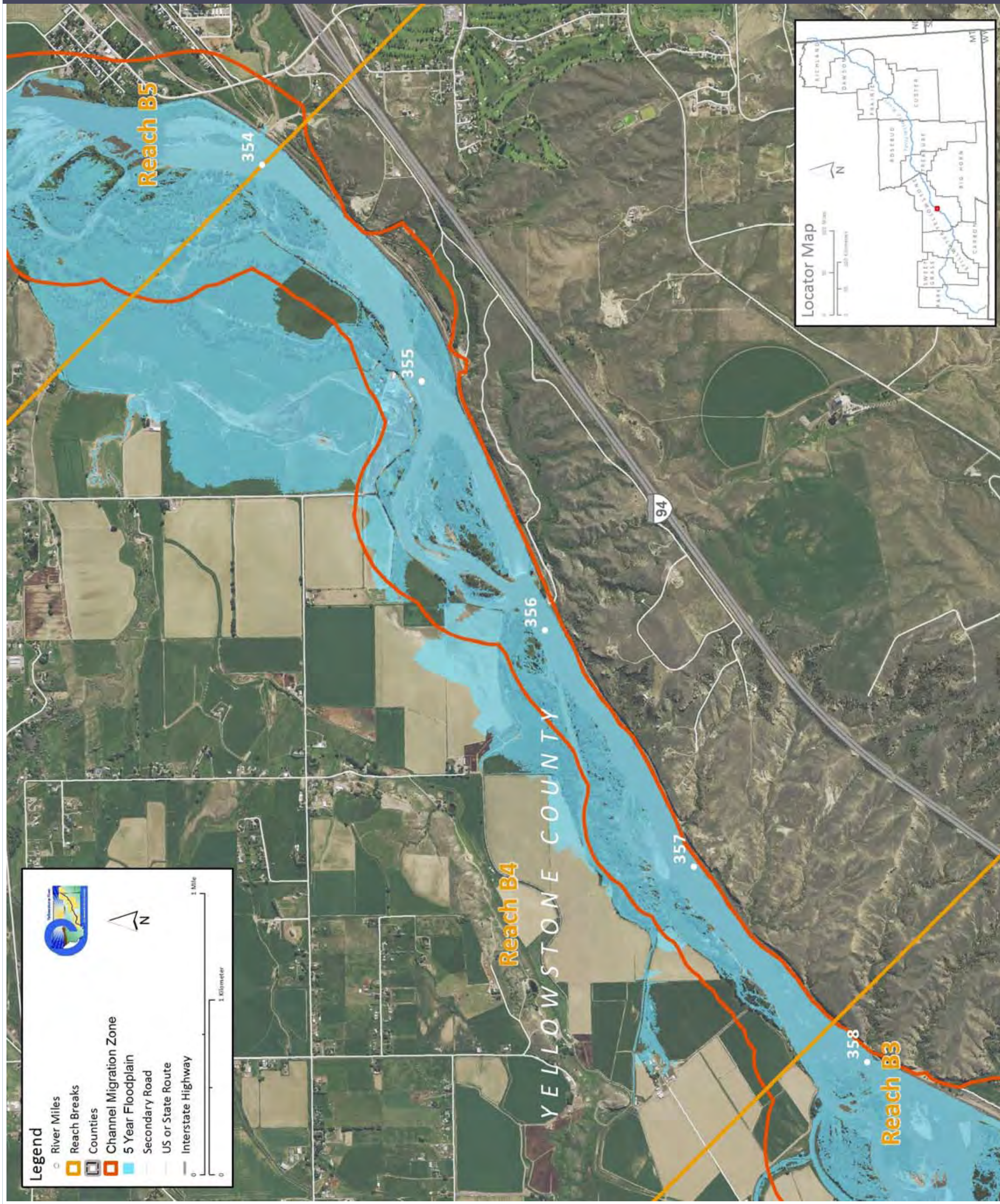
1950	1976	2001	Change 1950-2011
0.5	0.0	0.0	-0.5

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives Reach B5

County	Yellowstone	**Upstream River Mile**	354
Classification	UA: Unconfined anabranching	**Downstream River Mile**	346.7
General Location	Huntley: includes Spraklin Island	**Length**	7.30 mi (11.75 km)

Narrative Summary

Reach B5 is 7.4 miles long and is located near Huntley and Spraklin Island. The reach is an Unconfined Anabranching (UA) reach type, which indicates little influence by the valley wall coupled with relatively extensive forested islands and side channels. These reach types tend to be the most dynamic within the river corridor. Reach B5 flows northward though a wide valley section where the relatively erodible Bearpaw shale has retreated over geologic time, leaving an unusually broad river corridor. In Reach B5 the river crosses the valley from south to north, further contributing to the lack of confinement and allowance for channel migration.

About 12% of the bankline in Reach B5 is armored. In 2011, there was about a mile of concrete riprap, a half mile of rock riprap, and 1,500 feet of flow deflectors in the reach. Over the decade prior to that, however, 1,200 feet of concrete riprap and 1,150 feet of flow deflectors had eroded out, and 2,000 feet of rock riprap built, indicating a tendency for concrete and flow deflectors to fail coupled by an overall shift towards rock riprap bank protection between 2001 and 2011.

One of the most spectacular examples of barb failures on the Yellowstone River is in Reach B5, where about 1,300 feet of barbs on the left bank just downstream of the Huntley Bridge were flanked between 2001 and 2005. The river then migrated about 200 feet behind the barbs and the bank has since been armored with rock riprap. The flanked barbs remain visible in the middle of the river in 2011 imagery. Another barb was flanked on the left bank at RM350, and is prominently exposed 65 feet off of the bank. In the lowermost end of the reach at RM 347, about 900 feet of concrete armor was flanked on the right bank, and the river is now up to 200 feet behind the armor, migrating rapidly to the east. This area has seen over 800 feet of river migration since 1950.

Prior to 1950, about 11,400 feet of side channels were blocked in the reach by small dikes. These channels are on both sides of the river just downstream of the Huntley Bridge at RM 352.5. Further downstream at RM 348 there are numerous older swales south of the river that are also blocked.

Land uses in the reach are primarily agricultural, with about 1,300 acres of flood irrigated land mapped as of 2011. There are also almost 600 acres of urban/exurban development. The Channel Migration Zone (CMZ) has been developed for multiple land uses; as of 2011, there were 389 acres of flood irrigation, 24 acres of urban/exurban land, and 10 acres of transportation infrastructure within the CMZ. About 14% of the total CMZ footprint has become restricted by bank armor and road prisms.

Trash dumps have been mapped on the left stream bank at RM 351.2, and up on the north bluff at RM 347.1. One large animal handling facility was mapped about 800 feet south of the river at RM 347.8.

About 55 acres of Russian olive have been mapped in Reach B5. The reach also hosts over 200 acres of mapped wetland areas, about 170 acres of which are emergent marshes and wet meadows.

Riparian recruitment in the reach has exceeded 500 acres since 1950; about half of that recruitment occurred in areas that were 1950s channel and the other half in areas that were eroded between 1950 and 2001.

Reach B5 was sampled as part of the avian study. The average species richness in this reach was 8.4, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. Two bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, the Plumbeous Vireo and the Ovenbird.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 25,600 cfs to 21,200 cfs, a drop of about 17%. The 2-year flood, which strongly influences overall channel form, has dropped from 47,400cfs to 42,600 cfs, which is a reduction of 10%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,000 cfs to 2,050 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

Because of the flow alterations, about 22% of the 5-year floodplain has become isolated in Reach B5.

CEA-Related observations in Reach B5 include:
•Flanking of flow deflectors and concrete riprap
•Blockage of over two miles of side channel pre-1950

Recommended Practices for Reach B5 include:
•Side channel restoration at RM 352.5
•Flanked flow deflector removal at RM 352.5 and 350.0
•CMZ management due to development within CMZ footprint
•Russian olive removal

•Nutrient management at animal handling facility at RM347.8.
•Solid waste removal at RM351.2L and 347.1L

Yellowstone River Reach Narratives — Reach B5

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	47,400	42,600	-10.1%
100 Year (cfs)	84,000	81,200	-3.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	890.9	992.2	897.6	1,031.9	140.9

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	2,399	3.1%	1,847
Concrete Riprap	5,361	6.8%	-1,218
Flow Deflectors	1,550	2.0%	-1,153
Total	**9,310**	**11.9%**	**-523**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	11,393	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	312.0	278.7
Acres/Year	12.0	11.1
Acres/Year/Valley Mile	1.9	1.8

1950-2001 In-channel riparian encroachment (negative number indicates retreat): -56.24 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	253.4	22%
100 Year	12.4	1%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	396.2	14%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	3,731.1	3,041.4
Ag. Infrastructure (Ac)	92.8	159.3
Exurban (Ac)	63.0	567.5
Urban (Ac)	0.0	0.0
Transportation (Ac)	45.0	48.6

	1950	2011
Flood (Ac)	920.7	1,271.2
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	65.9	22.2	88.1	7.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	17.7	2.8
Emergent	169.8	27.1
Scrub/Shrub	52.3	8.3

Total Wetland Acres **239.8**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

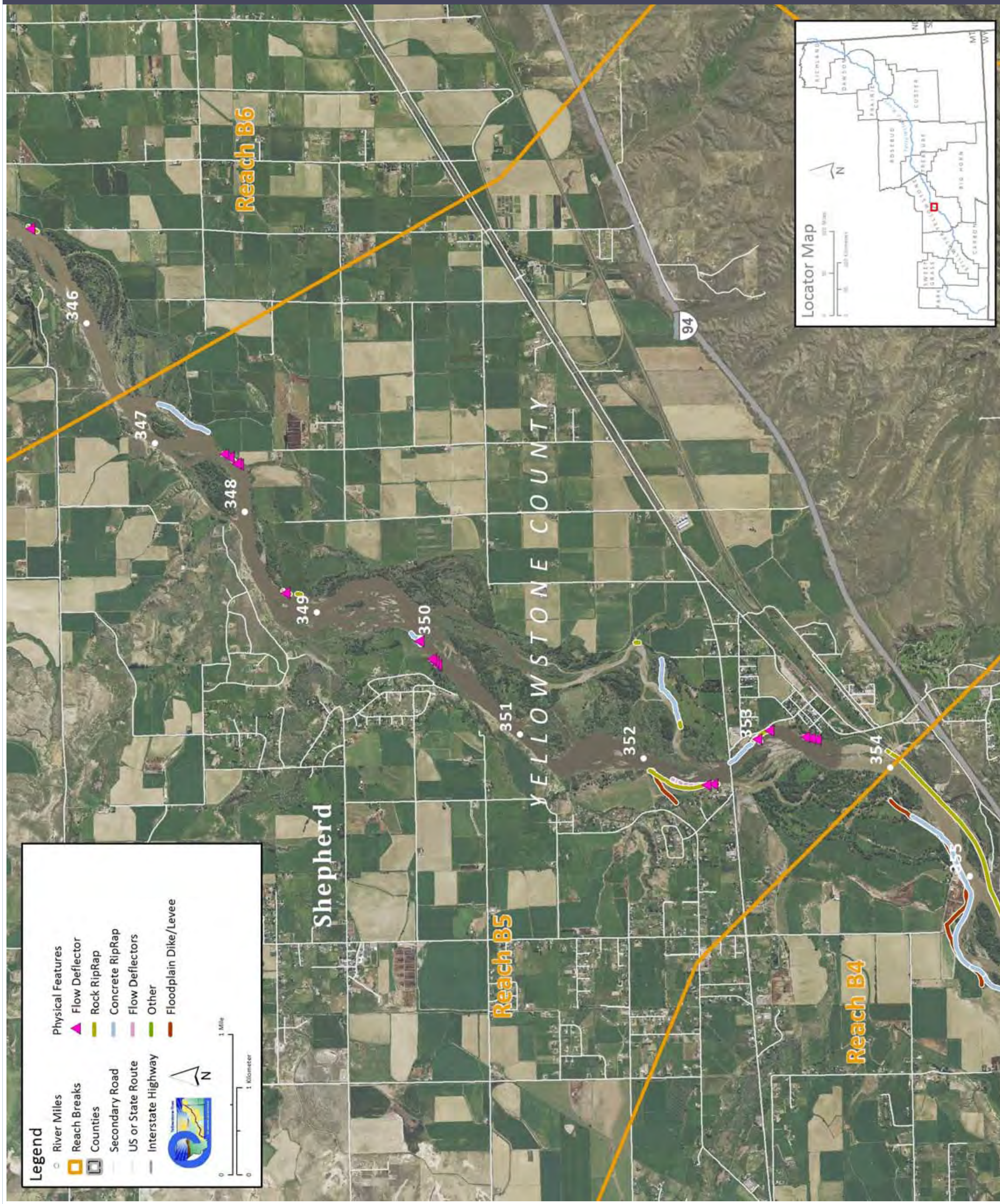
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	54.5	3.2%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

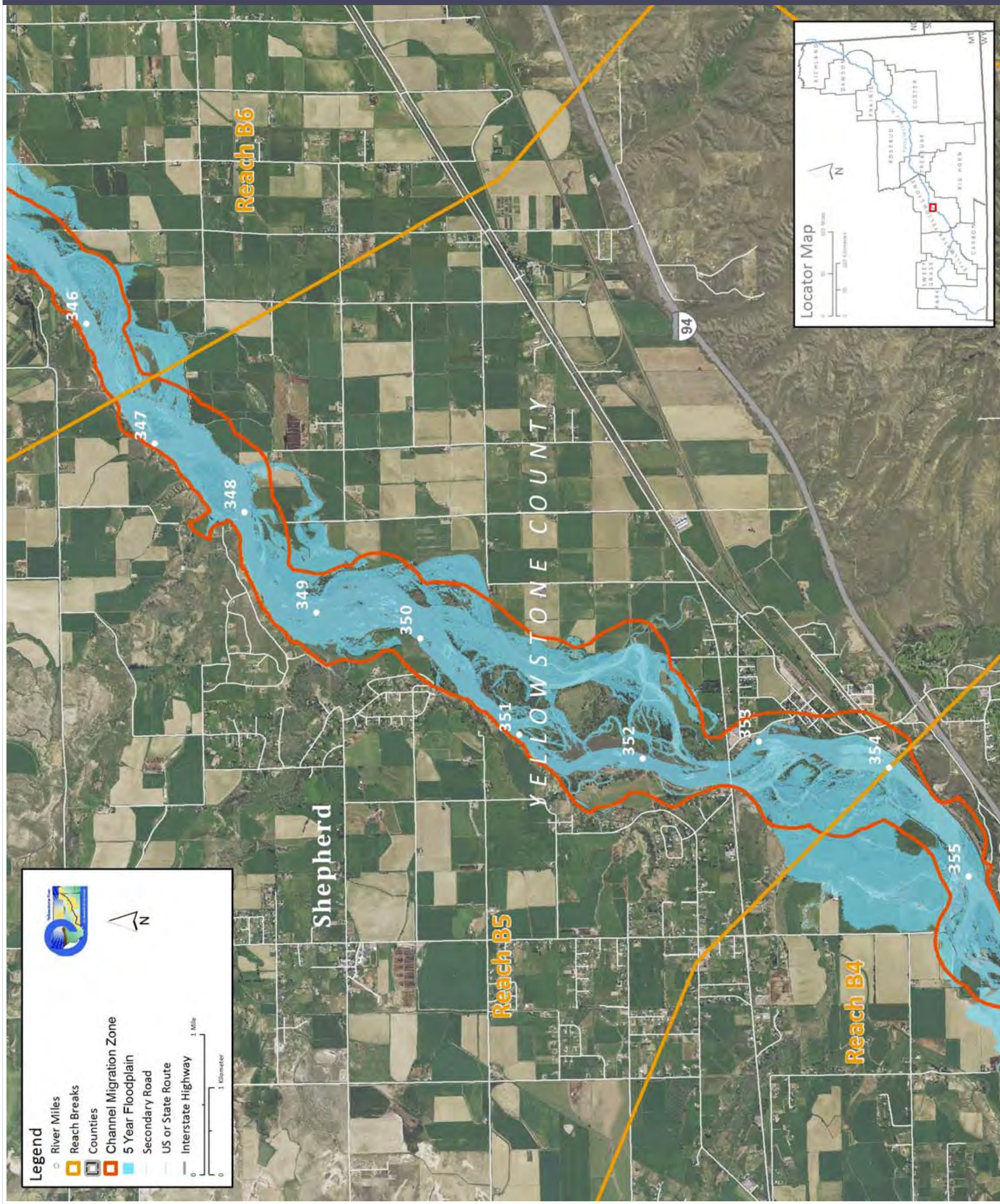
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	3.5	1.2	0.7	-2.8

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives — Reach B6

County	Yellowstone	**Upstream River Mile**	346.7
Classification	PCB: Partially confined braided	**Downstream River Mile**	340.6
General Location	Ballantine	**Length**	6.10 mi (9.82 km)

Narrative Summary

Reach B6 is 6.1 miles long and is located Ballantine. The reach is a Partially Confined Braided (PCB) reach type, which indicates some valley wall influence coupled with relatively extensive unvegetated bars and low flow islands. Within Reach B6, the river flows closely along the north valley wall. The Gritty Stone fishing access site is located in the downstream end of the reach.

About 6.3% of the bankline in Reach B6 is armored, and the majority of that armor (2,300 feet) is concrete riprap. Since 2001, riprap has expanded by about 430 feet. Reach B6 also hosts almost 1,500 feet of car body riprap, which is fairly unusual in terms of extent on the Yellowstone River. The car bodies were put in place between 1950 and 1995, and their mapped location is at RM 341.7R, although they are difficult to see on the imagery.

Prior to 1950, a side channel that was about 1,350 feet long was blocked by a small dike at RM343. Even though this side channels was blocked, there has been a net gain of over three miles of side channel since 1950.

Land uses in the reach are primarily agricultural, with about 1,862 acres of flood irrigated land mapped as of 2011. The Channel Migration Zone (CMZ) has been developed for primarily flood irrigation; as of 2011, there were 237 acres of flood irrigated land in the CMZ, and about 9% of the total CMZ footprint has become restricted by bank armor and road prisms. The modern 5-year floodplain contains over 200 acres of flood-irrigated ground.

There is one mapped animal handling facility in the reach at RM 345.5R. It is within 800 feet of the active river bank.

The 100-year floodplain has also been restricted; about 210 acres or 11.4% of the historic 100-year floodplain area has become isolated from the river by agricultural infrastructure.

Since 1950, there has been almost 250 acres of riparian recruitment in the reach, and most of that was in the primary and secondary 1950s channels that were abandoned.

One ice jam has been recorded in Reach B6. On January 3, 1997, an ice jam occurred at RM 345 that caused severe flooding and resulted in evacuations.

There are 49 acres of mapped Russian olive in the reach, and the mapping indicates that it has expanded on islands and in side channels. Riparian recruitment in the reach has exceeded 500 acres since 1950; about half of that recruitment occurred in areas that were 1950s channel and the other half in areas that were eroded between 1950 and 2001.

Reach B6 was sampled as part of the avian study. The average species richness in this reach was 8.25, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 26,000 cfs to 21,100 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped from 48,300cfs to 43,000 cfs, which is a reduction of 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,000 cfs to 2,050 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

Because of the flow alterations, about 25% of the 5-year floodplain has become isolated in Reach B5. Much of that 5-year floodplain isolation is within old swales on the south side of the river. The 5-year flood discharge has dropped by 8.25% in this reach due to human influences, primarily irrigation.

CEA-Related observations in Reach B6 include:
- Gain in anabranching channel length
- Ice jamming
- Side channel blockage at RM343.

Recommended Practices for Reach B6 include:
- Russian olive removal
- Nutrient management at corrals associated with animal handling facility at RM 534.5R

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	48,300	43,000	-11.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	85,300	82,200	-3.6%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	583.2	616.6	578.5	617.8	34.6	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	304	0.5%	304	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	2,275	3.5%	106	
Flow Deflectors	23	0.0%	23	
Total	**2,602**	**4.0%**	**433**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	1,352	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	141.8	120.5	-36.52 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	5.5	4.8		
Acres/Year/Valley Mile	1.0	0.9		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	343.9	25%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	209.2	11%	

Restricted Migration Area	Acres	% of CMZ	
	141.6	9%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,682.8	3,694.9	Flood (Ac)	1,317.8	1,862.1	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	51.6	136.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	96.2	
Urban (Ac)	0.0	3.5				
Transportation (Ac)	16.6	17.1				

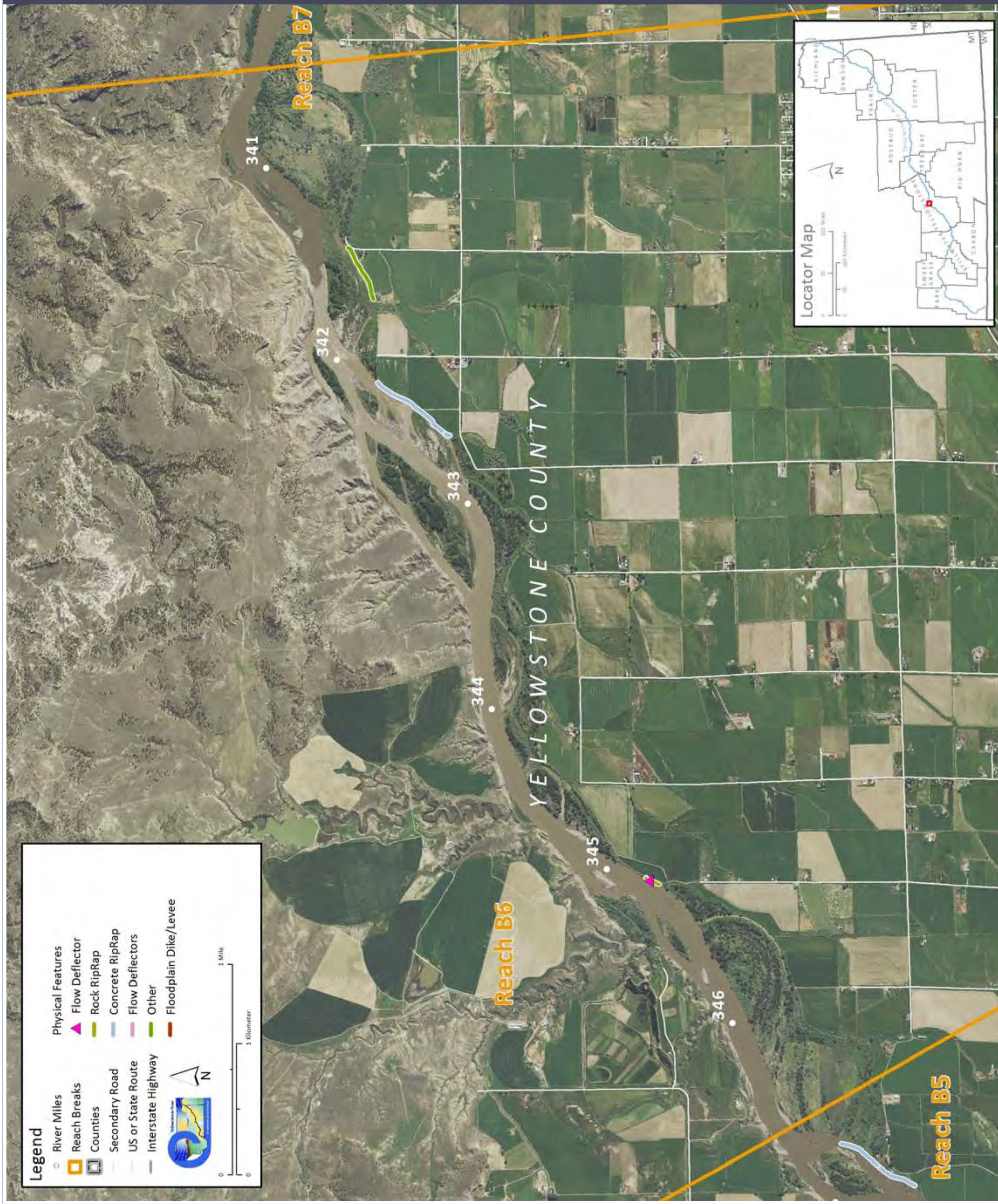
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	1.9	1.0	2.8	0.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	2.9	0.5	**112.4**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	71.5	12.7		
Scrub/Shrub	38.0	6.7		

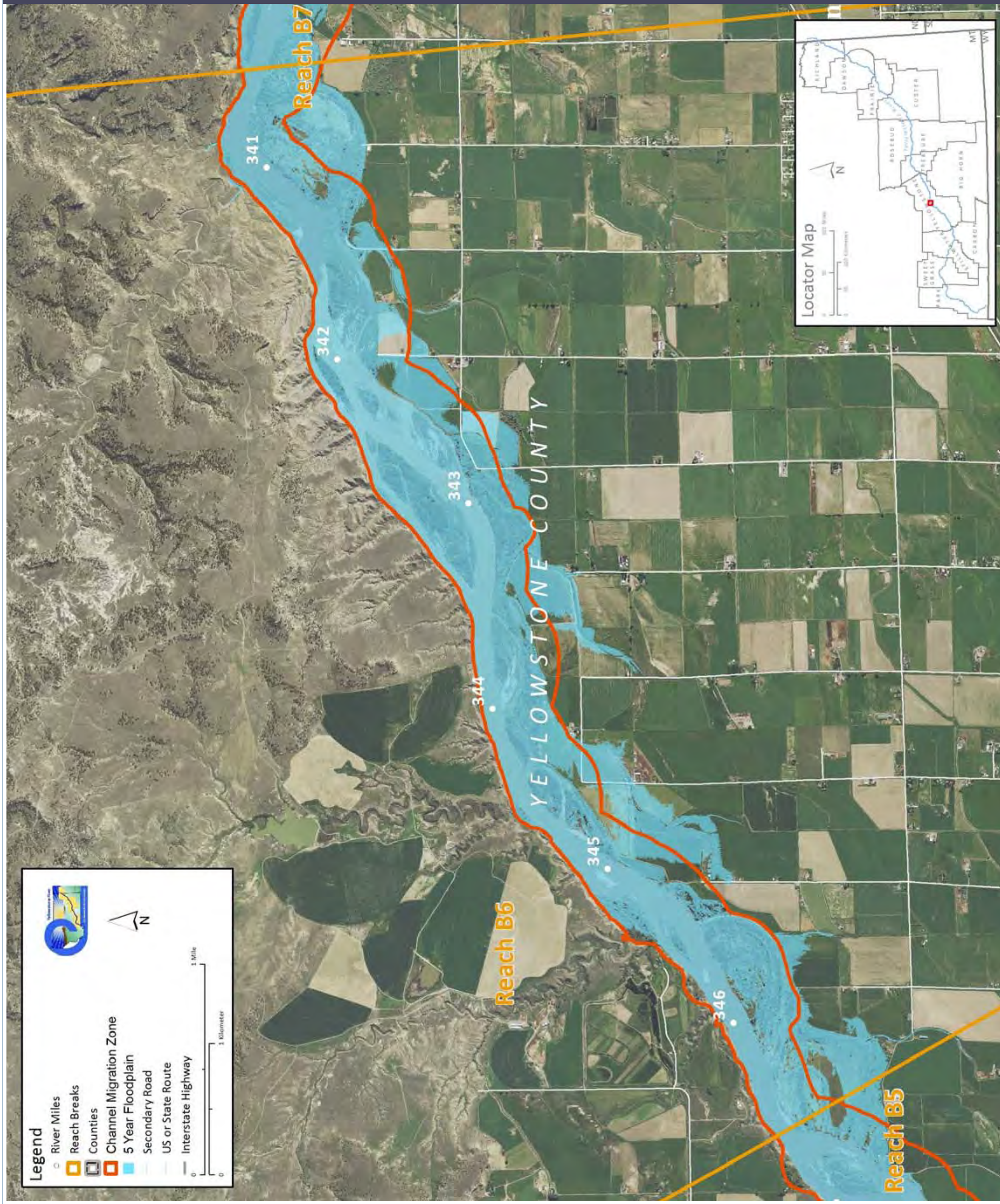
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	48.7	2.8%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	1.8	2.0	0.4	-1.4	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	340.6
Classification	UB: Unconfined braided	**Downstream River Mile**	331.8
General Location	To Pompey's Pillar	**Length**	8.80 mi (14.16 km)

Narrative Summary

Reach B7 is located just upstream of Pompey's Pillar. The Reach is almost 9 miles long and is currently largely unconfined with a primary channel thread and numerous mid-channel bars and point bars. In the 1950's, the main channel flowed more closely along the north valley wall; southward migration since that time has reduced the influence of the valley wall on stream geomorphology. The valley is wide in this area, which is typical where the bounding rock units are made up of the relatively erodible Cretaceous-age Bearpaw shale.

Only 290 feet of the streambank in Reach B7 is armored, and no side channels have been blocked.

Land uses in the reach are primarily agricultural, with about 1,340 acres of flood irrigated land mapped as of 2011. The Channel Migration Zone (CMZ) has been developed for primarily flood irrigation; as of 2011, there were 390 acres of flood irrigated land in the CMZ, and about 4% of the total CMZ footprint has become restricted by bank armor and road prisms. The modern 5-year floodplain contains over 275 acres of flood-irrigated ground.

Reach B7 shows major southward migration of the river since 1950, with one area experiencing over 1,600 feet of migration over the past 60 years. The river has gained length, and the valley wall influence has become much less prevalent, as virtually all migration in this and adjacent reaches has been to the south. Since 1950 this section of river has lost almost 20,000 feet of anabranching channel length, and there is no strong indication that this loss is directly associated with floodplain dikes. Rather, it appears that significant lengths of anabranching channels were passively abandoned, which may be the consequence of a 19% reduction in the mean annual flood due to human influences.

South of the river over 600 acres of historic 100-year floodplain have been isolated from the river by the railroad. This includes a very broad area between the railroad and Interstate that will likely remain isolated since it is over 3,000 feet from the modern river. This area represents 22% of the total historic 100-year floodplain area.

The mouth of Arrow Creek is in Reach B7, and the lower portion of the creek has been captured by the river, shortening the tributary and likely driving downcutting upstream.

Reach B7 has 56 mapped acres of Russian olive that can be found in dense stands, however the extensive lateral migration of the river has promoted extensive recruitment of new woody riparian habitat. Since the 1950s there has been about 640 acres of riparian recruitment in the reach. The acreage of recruitment has exceeded that of erosion of riparian areas by 131 acres. Additionally, there are 260 mapped wetlands in the reach, including 135 acres of wet meadows and marsh.

Reach B7 was sampled as part of the avian study. The average species richness in this reach was 8.8, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. One bird species identified by the Montana Natural Heritage Program as a Potential Species of concern was identified, the Dicksissel. Another species identified as a Species of Concern was identified, the Red-headed Woodpecker.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 27,200 cfs to 22,100 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,010 cfs to 2,060 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

Because of the flow alterations, about 28% of the 5-year floodplain has become isolated in Reach B7. Much of that 5-year floodplain isolation is within irrigated fields on the south side of the river.

CEA-Related observations in Reach B7 include:
•Migration away from valley wall resulting in loss of bluff pool habitat.
•Passive abandonment of anabranching channels likely associated with reduced mean annual flows.
•Rapid channel migration through cleared, often flood irrigated fields.

Recommended Practices for Reach B7 include:
•Russian olive removal

Yellowstone River Reach Narratives — Reach B7

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	50,400	44,900	-10.9%
100 Year (cfs)	88,800	85,600	-3.6%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	956.1	958.6	834.0	914.6	-41.5

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	0	0.0%	0
Concrete Riprap	289	0.3%	0
Flow Deflectors	0	0.0%	0
Total	**289**	**0.3%**	**0**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	319.9	255.1
Acres/Year	12.3	10.2
Acres/Year/Valley Mile	1.6	1.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

130.84 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	611.4	28%
100 Year	699.0	22%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	124.7	4%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	4,646.5	4,391.6
Ag. Infrastructure (Ac)	60.6	187.9
Exurban (Ac)	0.0	58.4
Urban (Ac)	0.0	0.0
Transportation (Ac)	53.6	60.9

	1950	2011
Flood (Ac)	1,212.2	1,339.3
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	37.7	4.9	42.6	4.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	11.1	1.5
Emergent	135.1	17.8
Scrub/Shrub	110.7	14.6

Total Wetland Acres **256.9**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

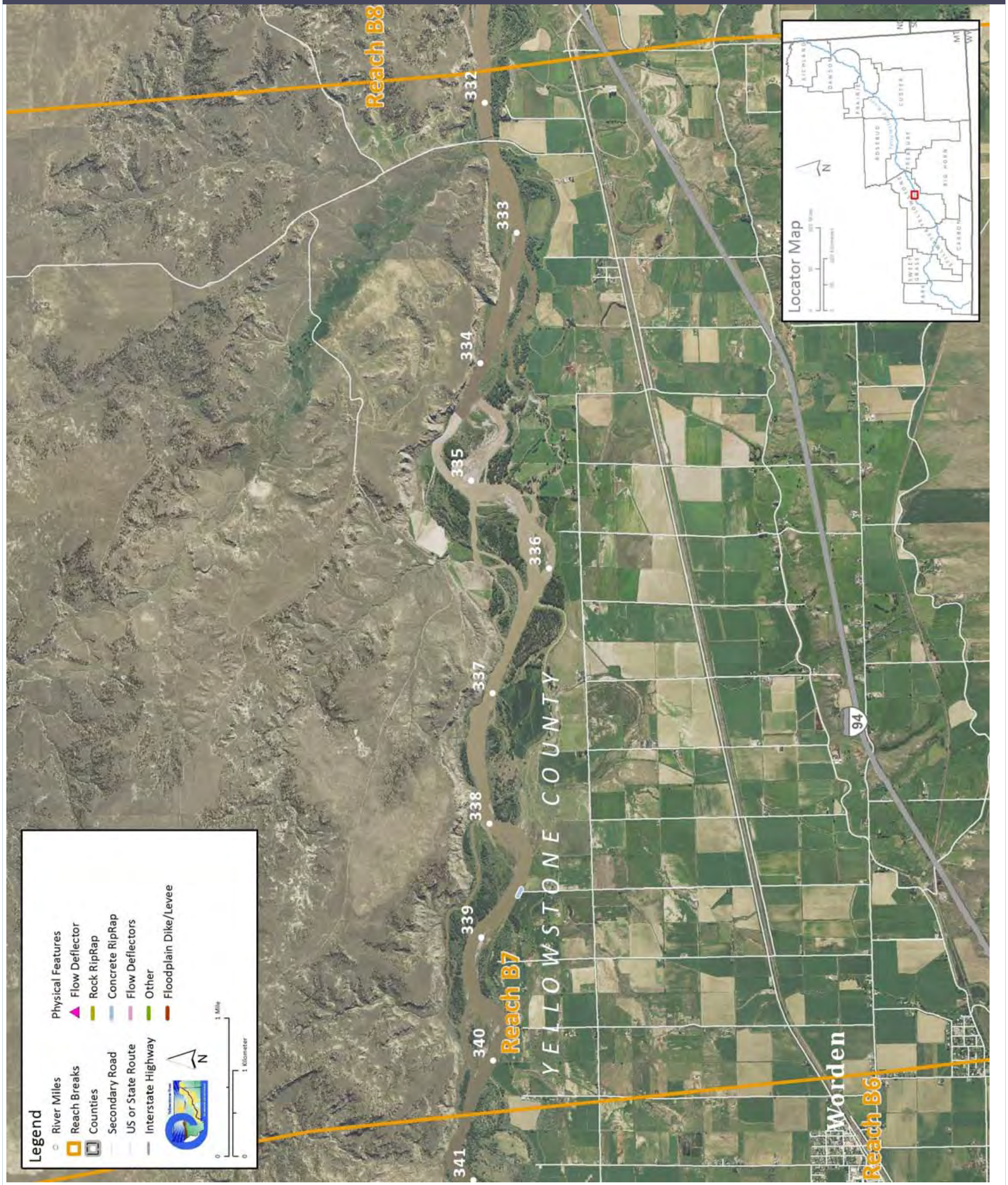
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	55.7	2.2%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

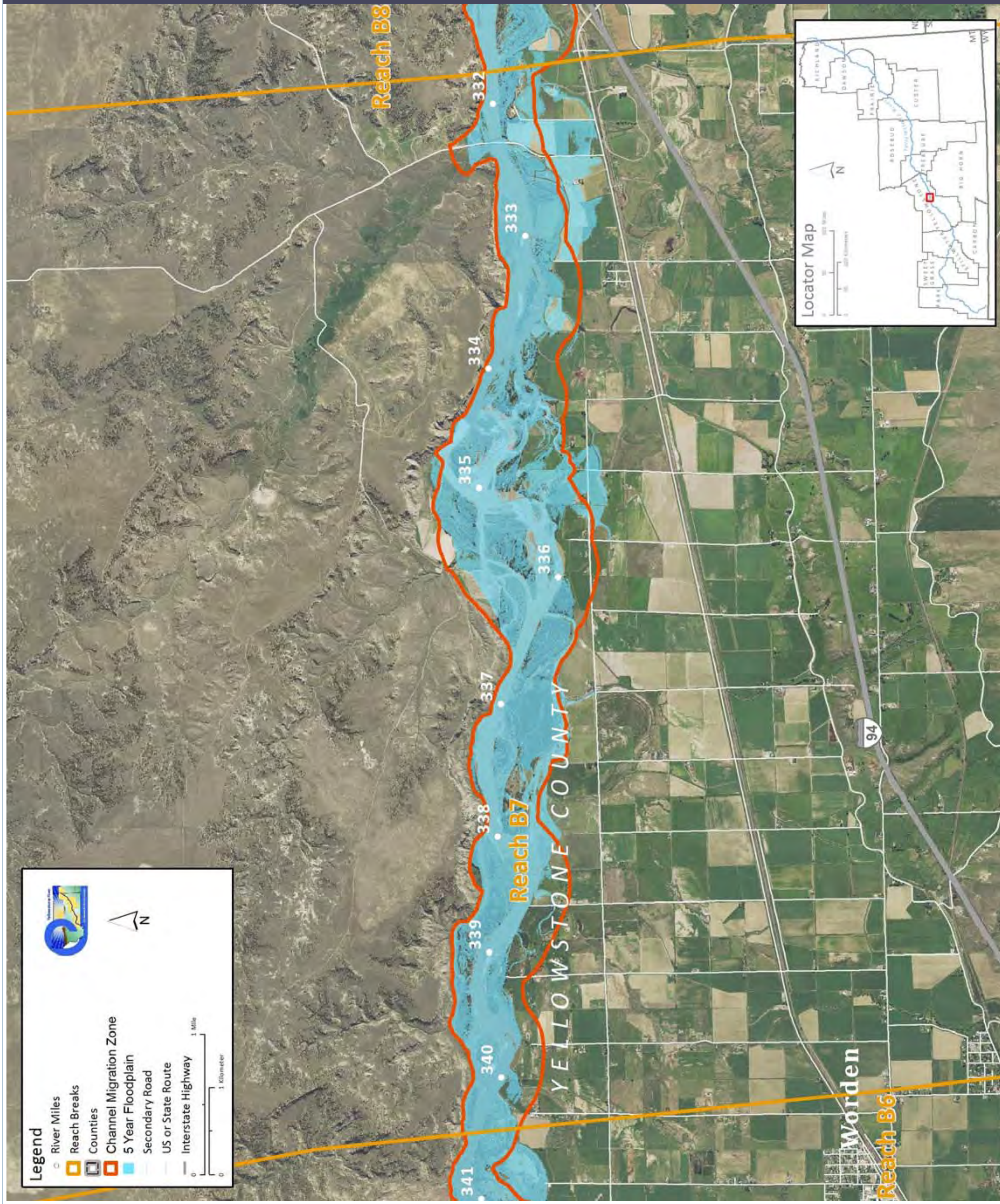
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	9.2	3.0	6.4	-2.8

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	331.8
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	322.7
General Location	Bull Mountain	**Length**	9.10 mi (14.65 km)

Narrative Summary

Reach B8 is located downstream of Pompey's Pillar. The Reach is 9.1 miles long and is partially confined by the valley wall with numerous forested islands. In the 1950's, the main channel flowed more closely along the north valley wall; southward migration since that time has reduced the influence of the valley wall on stream geomorphology. The valley is wide in this area, which is typical where the bounding rock units are made up of the relatively erodible Cretaceous-age Bearpaw shale.

Just over 3,000 feet of streambank are armored by rock riprap, which is about 3.3% of the total bankline. All of the bank armor in the reach is protecting the rail line on the south side of the river. High resolution imagery from fall 2011 indicates that at RM328 about 570 feet of rock riprap has been flanked on the right bank against the rail line, and that the flanked rock is about 80 feet into the river off of the south bank. Currently, the river is within 100 feet of the rail line and migrating rapidly in that direction.

One side channel that is about 6,200 feet long at RM 326R was blocked prior to 1950.

Land uses in the reach are primarily agricultural, with about 1,240 acres of flood irrigated land mapped as of 2011. There are 124 acres of land in sprinkler and 86 under pivot. The modern 5-year floodplain contains about 250 acres of flood-irrigated ground.

One dump site was mapped on an old swale adjacent to a flood irrigated field at RM 326.5R.

The Channel Migration Zone (CMZ) has been developed for primarily flood irrigation; as of 2011, there were 457 acres of flood irrigated land in the CMZ, and about 7% of the total CMZ footprint has become restricted by bank armor and road prisms. The railroad has isolated almost 9% of the historic 100-year floodplain in the reach. About 22% of the 5-year floodplain has become isolated in Reach B8. Much of that 5-year floodplain isolation is due to transportation infrastructure on the south side of the river.

Similar to Reach B7 upstream, Reach B8 shows major southward migration of the river since 1950, with one area at RM 324.3 experiencing over 1,500 feet of migration over the past 60 years. This southward migration has threatened the rail line at RM 328R.

Overall, the migration rates and floodplain turnover rates have dropped since 1976 from 1.9 acres/valley mile/year from 1950 to 1976 to 1.5 acres/valley mile/year from 1976-2001.

Reach B8 has 91 mapped acres of Russian olive that can be found in dense stands, especially on forested islands. Even so, the extensive lateral migration of the river has promoted extensive recruitment of new woody riparian habitat. Since the 1950s there has been about 600 acres of riparian recruitment in the reach, most of which was riparian colonization of old 1950's channel area. The acreage of recruitment has exceeded that of erosion of riparian areas by 51 acres. Additionally, there are 271 mapped wetlands in the reach, including 147 acres of wet meadows and marsh. The reach contains about 33 wetland acres per valley mile, which is a relatively high value for the Yellowstone River.

Reach B8 was sampled as part of the avian study. The average species richness in this reach was 7.8, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. One bird species identified by the Montana Natural Heritage Program as a Potential Species of concern was identified, the Plumbeous Vireo. Another species identified as a Species of Concern was identified, the Red-headed Woodpecker.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 28,000 cfs to 22,800 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,040 cfs to 2,070 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B8 include:
•Migration away from valley wall resulting in loss of bluff pool habitat.
•Blockage of one side channel at RM 326 sometime prior to 1950
•Transportation infrastructure –caused isolation of 5-year floodplain south of the river at RM 329.5

Recommended Practices for Reach B8 include:
•Side channel reactivation at RM 326
•Dump removal at RM 326.5R
•Flanked armor removal at RM328R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	51,700	46,100	-10.8%
100 Year (cfs)	90,900	87,600	-3.6%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
1,051.1	1,093.5	1,003.0	1,089.4	38.3

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	3,208	3.3%	0
Concrete Riprap	0	0.0%	0
Flow Deflectors	0	0.0%	0
Total	**3,208**	**3.3%**	**0**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
6,209	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	391.0	291.8
Acres/Year	15.0	11.7
Acres/Year/Valley Mile	1.9	1.5

1950-2001 In-channel riparian encroachment (negative number indicates retreat)
50.51 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	442.3	22%
100 Year	219.4	9%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
224.3	7%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	4,889.1	4,506.4
Ag. Infrastructure (Ac)	90.7	123.1
Exurban (Ac)	43.0	77.4
Urban (Ac)	0.0	0.0
Transportation (Ac)	105.3	235.1

	1950	2011
Flood (Ac)	1,269.7	1,238.8
Sprinkler (Ac)	6.1	124.4
Pivot (Ac)	0.0	85.9

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
46.9	0.0	46.9	4.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	10.3	1.3
Emergent	147.4	18.8
Scrub/Shrub	113.7	14.5

Total Wetland Acres
271.4

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
91.2	3.2%

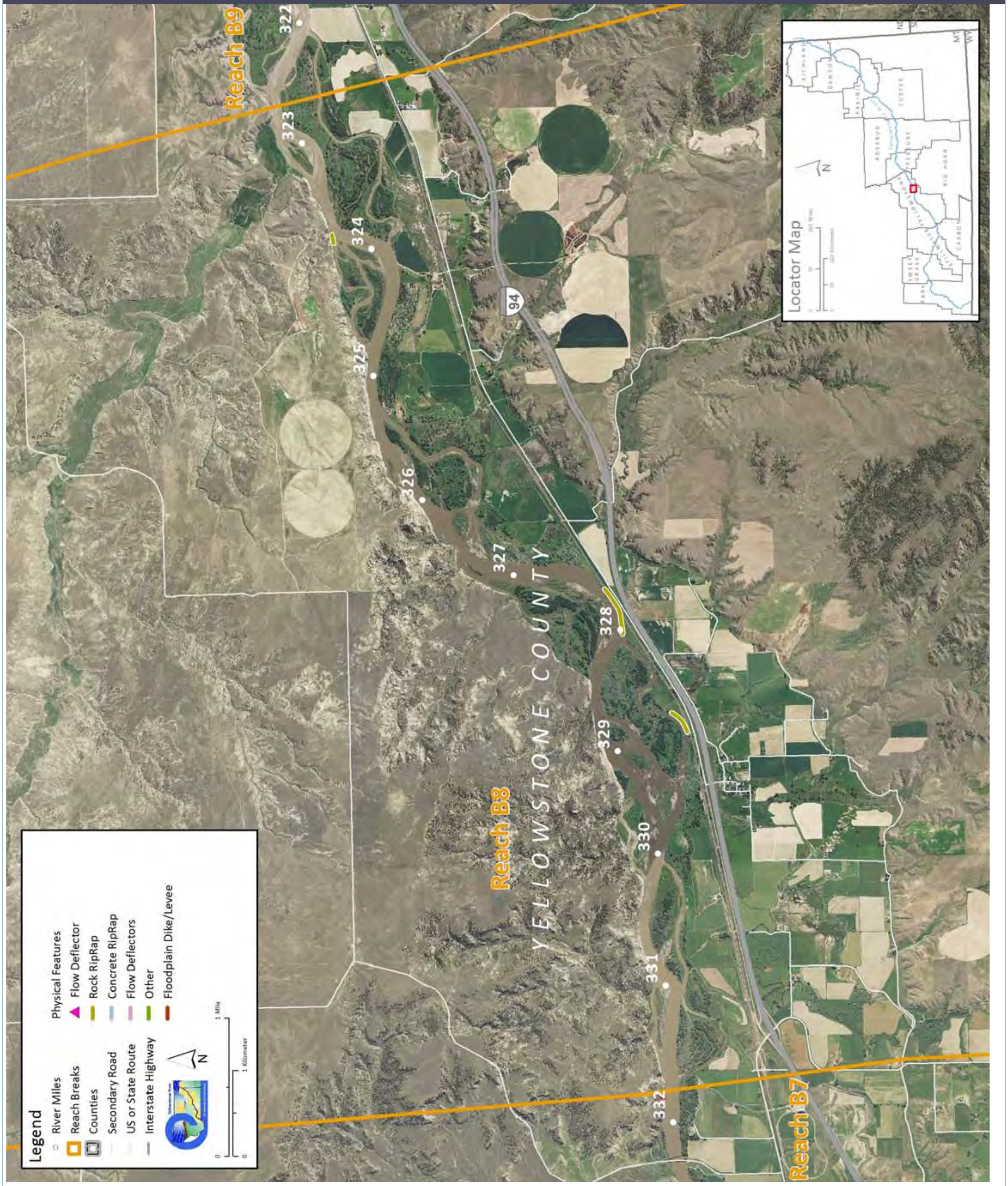
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

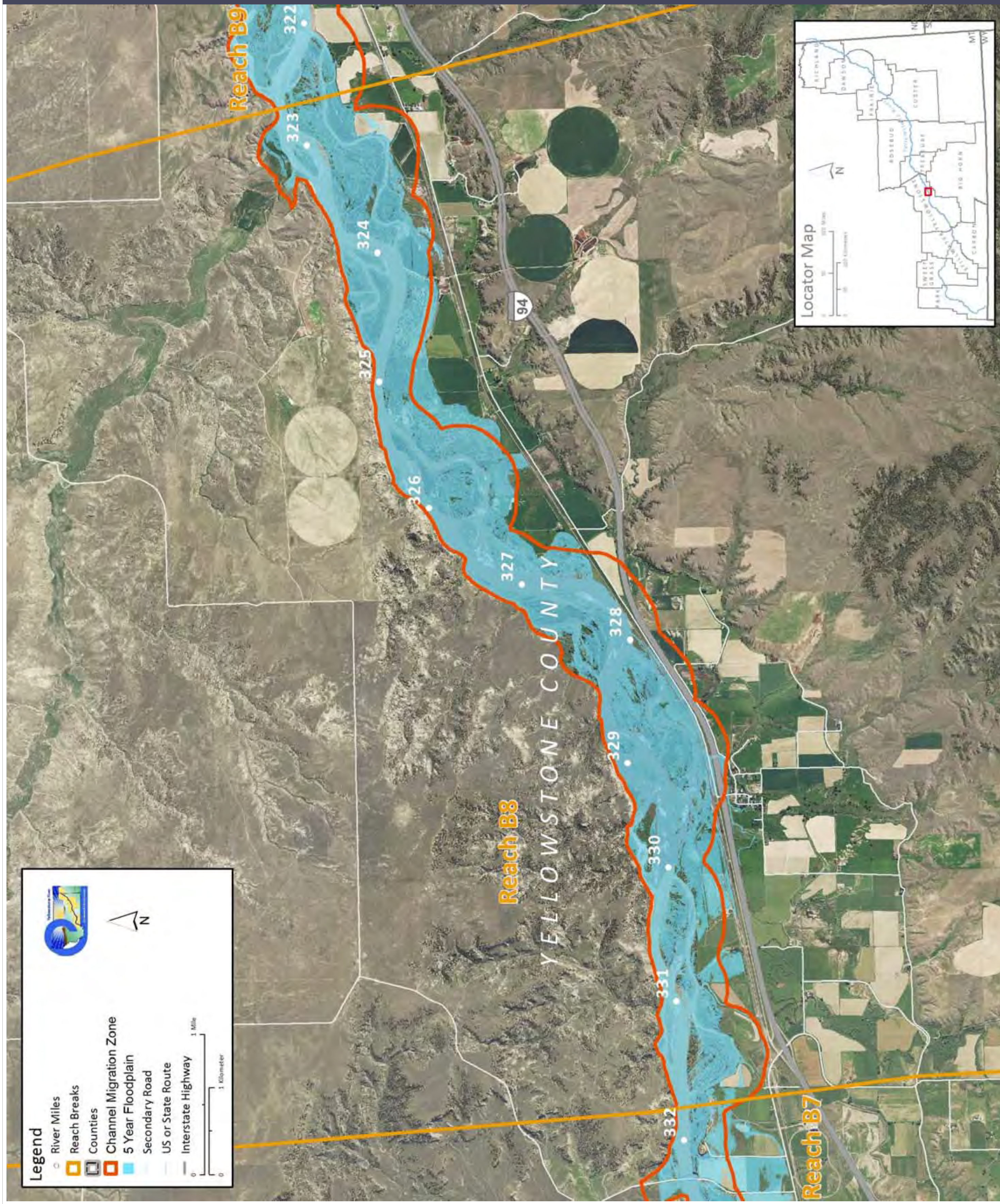
1950	1976	2001	Change 1950-2011
8.5	7.5	8.4	0.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	322.7
Classification	UA: Unconfined anabranching	**Downstream River Mile**	318
General Location	Reed Creek	**Length**	4.70 mi (7.56 km)

Narrative Summary

Reach B9 is located in lower Yellowstone County near Reed Creek. The Reach is 4.7 miles long and is an Unconfined Anabranching (UA) reach type, indicating the presence of extensive forested islands with little valley wall influence on the main channel. This reach type is typically the most dynamic in the system due to a lack of confinement and extent of side channels.

About 7,300 feet of streambank are armored by rock riprap, which is about 15% of the total bankline. Most of the bank armor in the reach is protecting the rail line on the south side of the river, and most of it is located along the edge of a section of bluff line. Another section of armor is protecting a major power line crossing on the north bank at RM321. Currently, two towers on the crossing are right on the edge of the river.

One side channel that is about 8,000 feet long at RM 321.5L was blocked prior to 1950. The lower end of this old channel still holds open water, but the upstream end has been graded into fields and also supports two major power line towers.

Land uses related to both irrigation and the railroad have encroached into the Channel Migration Zone (CMZ) in Reach B9. Overall, land uses in the reach are primarily agricultural, with about 508 acres of flood irrigated land mapped as of 2011. About half of that irrigated acreage is within the CMZ. There are 384 acres under pivot, about 75 of which are within the CMZ. The railroad has encroached into 101 acres of the CMZ and is primarily responsible for its isolation. In total, just under 10% of the CMZ has been restricted due to bank armor, and 7.3% of the restriction is due to the railroad, while 2.4% is associated with the protection of irrigated lands.

The modern 5-year floodplain contains about 76 acres of flood-irrigated ground, and 64 acres of ground under pivot.

Waco-Custer Diversion Dam is located at RM 320. The Waco-Custer ditch company was formed in the early 1900's, and the diversion dam was constructed shortly thereafter (http://www.fws.gov/YellowstoneRiverCoordinator/Waco-custer.html). The Waco-Custer diversion supports approximately 4,300 acres of irrigation, with a diversion capacity of 125 cfs. The structure is located approximately eight miles west of Custer, at River Mile 320. At the diversion, the Yellowstone River flows through two main channels, and the structure itself blocks only the right channel. The structure feeds the Waco-Custer Canal, which flows on the south floodplain surface of the Yellowstone River.

Migration rates in several locations in Reach B9 have exceeded an average of 10 feet per year since the mid-1950's. At Rm 322, the river migrated almost 200 feet between 2001 and 2011, which is double that average rate of 10 feet per year. That rapid recent migration has been through irrigated fields on the south side of the river. Lateral migration of the river has promoted extensive recruitment of new woody riparian habitat. Since the 1950s there has been about 210 acres of riparian recruitment in the reach, most of which was riparian colonization of old 1950's channel area. Additionally, there are 213 mapped wetlands in the reach, including 105 acres of emergent wetland types such as wet meadows and marsh. The reach contains about 53 wetland acres per valley mile, which is a relatively high value for the Yellowstone River.

Reach B9 has had a major loss of forest area that is considered at low risk of cowbird parasitism. In 19590, there were about 48 acres per valley mile of such forest, and that had been reduced by 2001 to 21 acres per valley mile.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 30,200 cfs to 24,500 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,060 cfs to 2,080 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

About 23% of the 5-year floodplain has become isolated in Reach B9, and the vast majority of this isolation is on the south side of the river at RM321 where the rail line has isolated an historic side channel. Much of that 5-year floodplain isolation is due to transportation infrastructure on the south side of the river. This isolated floodplain area still holds open water in a distinct swale.

CEA-Related observations in Reach B9 include:
•Blockage of one side channel at RM 321.5 sometime prior to 1950
•Railroad isolation of major channel remnant that supports open water.

Recommended Practices for Reach B9 include:
•Side channel reactivation at RM 321.5—may be difficult due to power line
•CMZ management due to~10% restriction of CMZ
•Russian olive removal
•Floodplain reconnection where active rail line has isolated historic channel remnant at RM321R.
•Fish passage BMP at Waco Custer Diversion Dam (not complete blockage)
•Watercraft passage BMP at Waco Custer Diversion Dam (side channel passage exists)
•Irrigation Infrastructure management at Waco Custer Diversion Dam.

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	55,500	49,400	-11.0%
100 Year (cfs)	97,200	93,600	-3.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
485.8	524.8	515.2	539.2	53.5

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	7,304	14.9%	0
Concrete Riprap	0	0.0%	0
Flow Deflectors	89	0.2%	0
Total	**7,393**	**15.1%**	**0**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
7,943	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	166.0	162.6
Acres/Year	6.4	6.5
Acres/Year/Valley Mile	1.6	1.7

1950-2001 In-channel riparian encroachment (negative number indicates retreat): 6.4 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	175.0	23%
100 Year	0.0	0%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
168.5	10%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	2,906.3	2,697.0
Ag. Infrastructure (Ac)	12.0	62.4
Exurban (Ac)	0.6	0.6
Urban (Ac)	0.0	0.0
Transportation (Ac)	61.4	153.2

	1950	2011
Flood (Ac)	656.7	507.8
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	384.1

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
4.9	0.5	5.4	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	24.3	6.2
Emergent	104.6	26.9
Scrub/Shrub	83.6	21.5

Total Wetland Acres: **212.5**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
5.9	0.3%

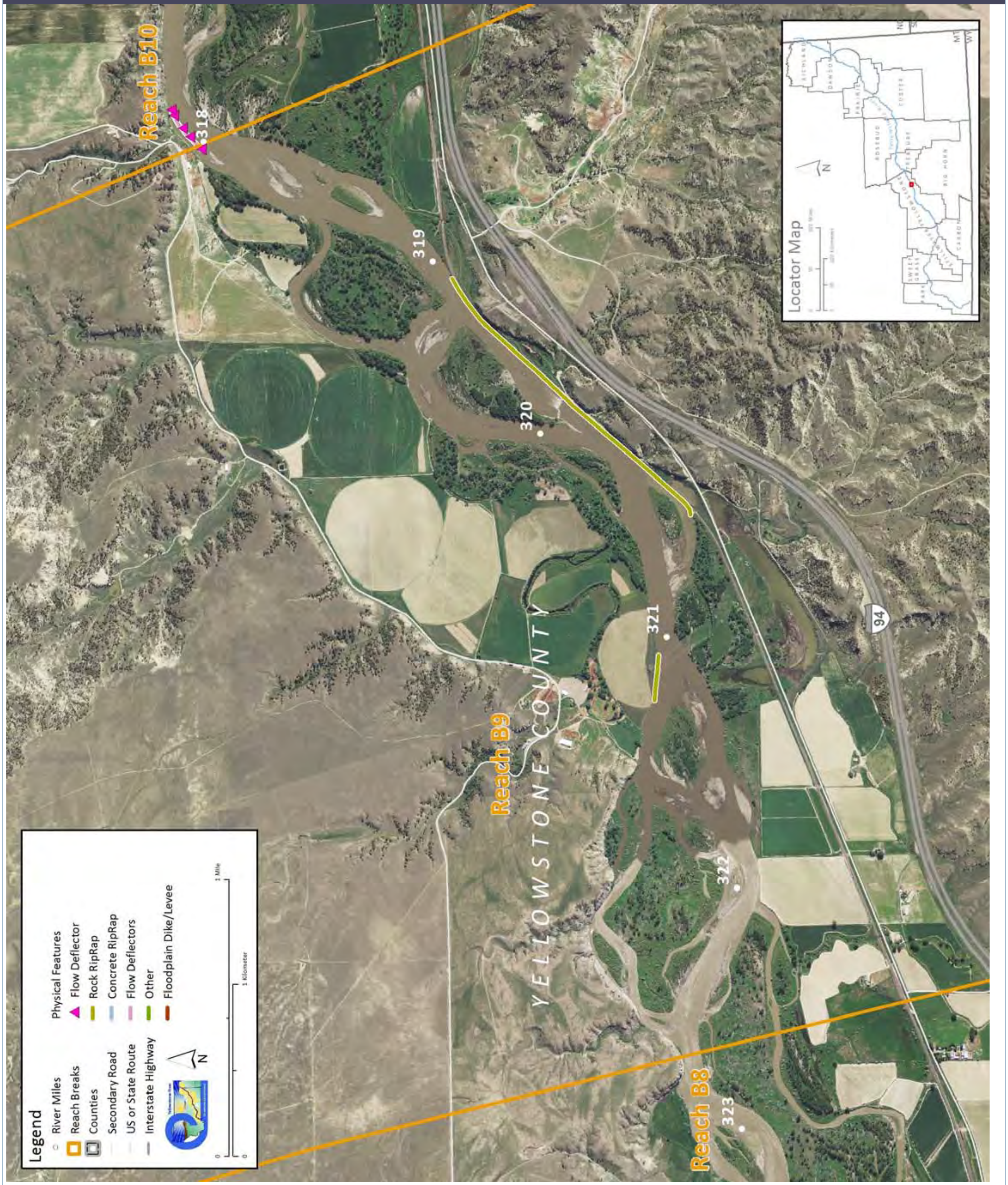
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

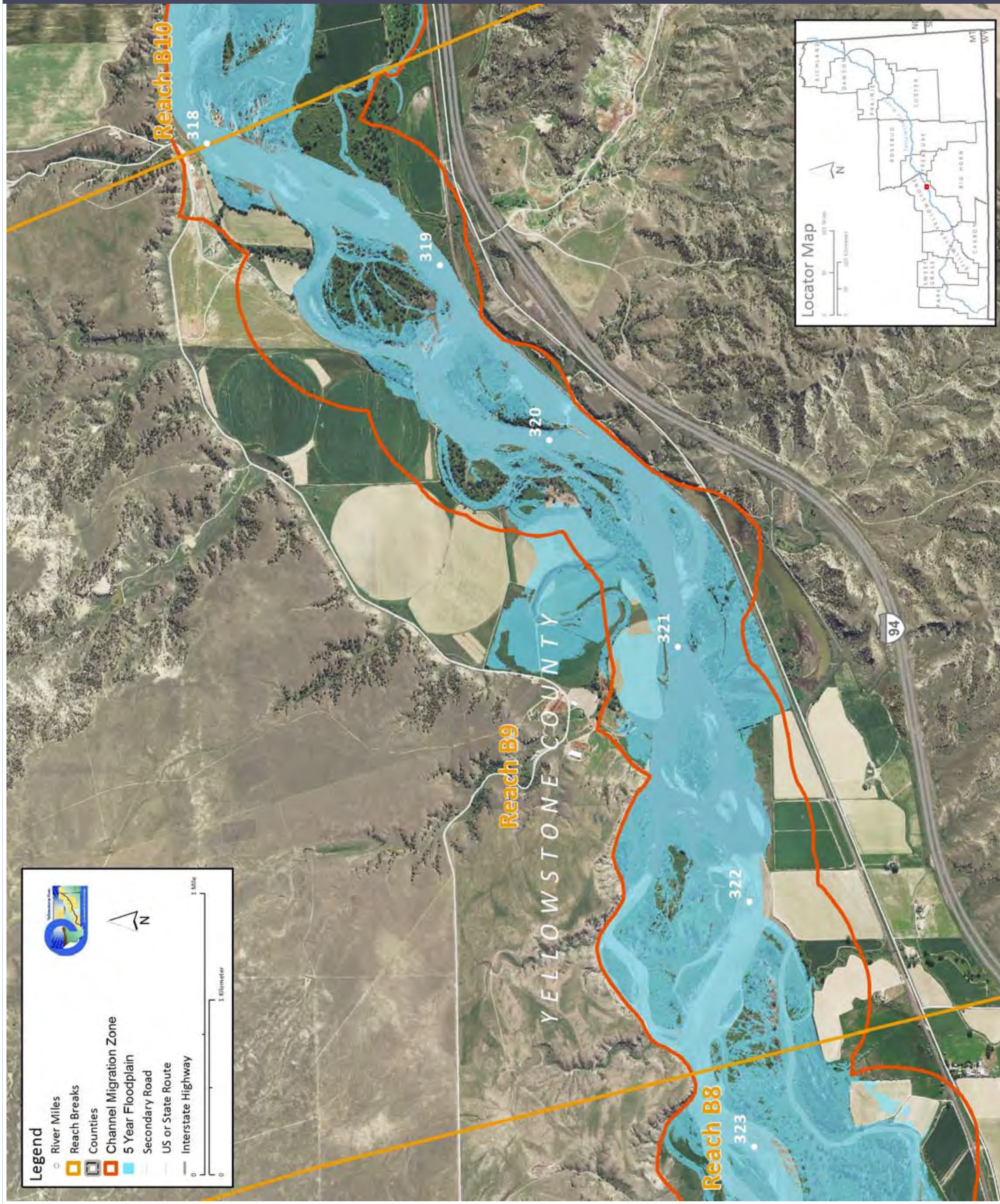
1950	1976	2001	Change 1950-2011
47.7	28.0	21.0	-26.7

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	318
Classification	PCM: Partially confined meandering	**Downstream River Mile**	310.8
General Location	Waco	**Length**	7.20 mi (11.59 km)

Narrative Summary

Reach B10 is located in lower Yellowstone County and contains the Captain Clark Fishing Access Site. The Reach is 7.2 miles long and is a Partially Confined Meandering reach type, (PCM), indicating the presence of a primary meandering channel thread with substantial valley wall influence on the river. The Captain Clark Fishing Access Site is located in the middle of the reach.

There are about 1,150 feet of rock riprap and 800 feet of flow deflectors in the reach, which collectively armor about 3% of the total bankline. About one half of the armor is protecting the active railroad, and the other half is protecting agricultural land. High resolution 2011 imagery shows the complete flanking of the mapped flow deflectors since 2001. The river has since eroded over 100 feet of bank behind the flanked barbs, eroding into a series of old corrals. The barbs are readily visible in the river.

One abandoned side channel that is about 3,300 feet long at RM 315R appears to be very old, however has several crossings that currently form plugs along its course. The channel is still within the 5-year floodplain, so the plugs have likely affected its function as a flood channel, and perhaps historically as a seasonal channel. This historic side channel is located landward (south) of the Fishing Access Site, which is on an old island. The lower end of this old channel supports a high density of Russian olive.

Reach B10 has lost almost 5.5 miles of side channel length since 1950. In the uppermost portion of the reach, the main river channel flipped from the south side of the corridor to the north sometime between 1976 and 2001, progressively abandoning a mile long channel and focusing the river into a single thread that flows along the north valley bluff line. This is where the flow deflectors described above have been flanked. This pattern has been common all through the reach; major secondary channels from the 1950s have been abandoned and the river has shifted to much more of a single thread meandering river. Some of the 1950's channels have potentially been blocked, and others appear to have been passively abandoned.

On the south side of the river at RM 312.5, the rail line currently isolates about 42 acres of historic 100-year floodplain. The river is currently against the rail line at this location, so that the separation between the river and the isolated remnant is only about 200 feet. This area is also adjacent to about 20 acres of mapped emergent wetland.

Overall, land uses in reach B10 are primarily agricultural, with about 860 acres of flood irrigated land mapped as of 2011. About one third of that irrigated acreage is within the CMZ. The railroad has encroached into 19 acres of the CMZ. In total, just under 7% of the CMZ has been restricted, and all of that restriction is due to bank armor protecting the rail line.

The modern 5-year floodplain contains about 72acres of flood-irrigated ground. Reach B10 also supports almost 40 acres of mapped wetlands per valley mile, which is a relatively high density for the corridor.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 30,200 cfs to 24,500 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,070 cfs to 2,090 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B10 include:
•Active and passive abandonment of over five miles of anabranching channel length since 1950
•Bank armor flanking associated with flow consolidation into single thread.

Recommended Practices for Reach B10 include:
•Removal of flanked flow deflectors at RM318
•Side channel reactivation throughout reach
•Floodplain reconnection at Rm 312.5R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	55,500	49,400	-11.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	97,200	93,600	-3.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	703.2	814.4	728.5	769.4	66.2	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	1,153	1.5%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	807	1.1%	0	
Total	**1,960**	**2.6%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	3,344	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	293.6	154.2	6.66 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	11.3	6.2		
Acres/Year/Valley Mile	1.9	1.0		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	202.4	19%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	111.7	7%	

Restricted Migration Area	Acres	% of CMZ	
	163.7	7%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	4,202.4	4,263.9	Flood (Ac)	637.0	858.1	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	43.9	58.2	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	8.2	Pivot (Ac)	0.0	0.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	54.7	169.9				

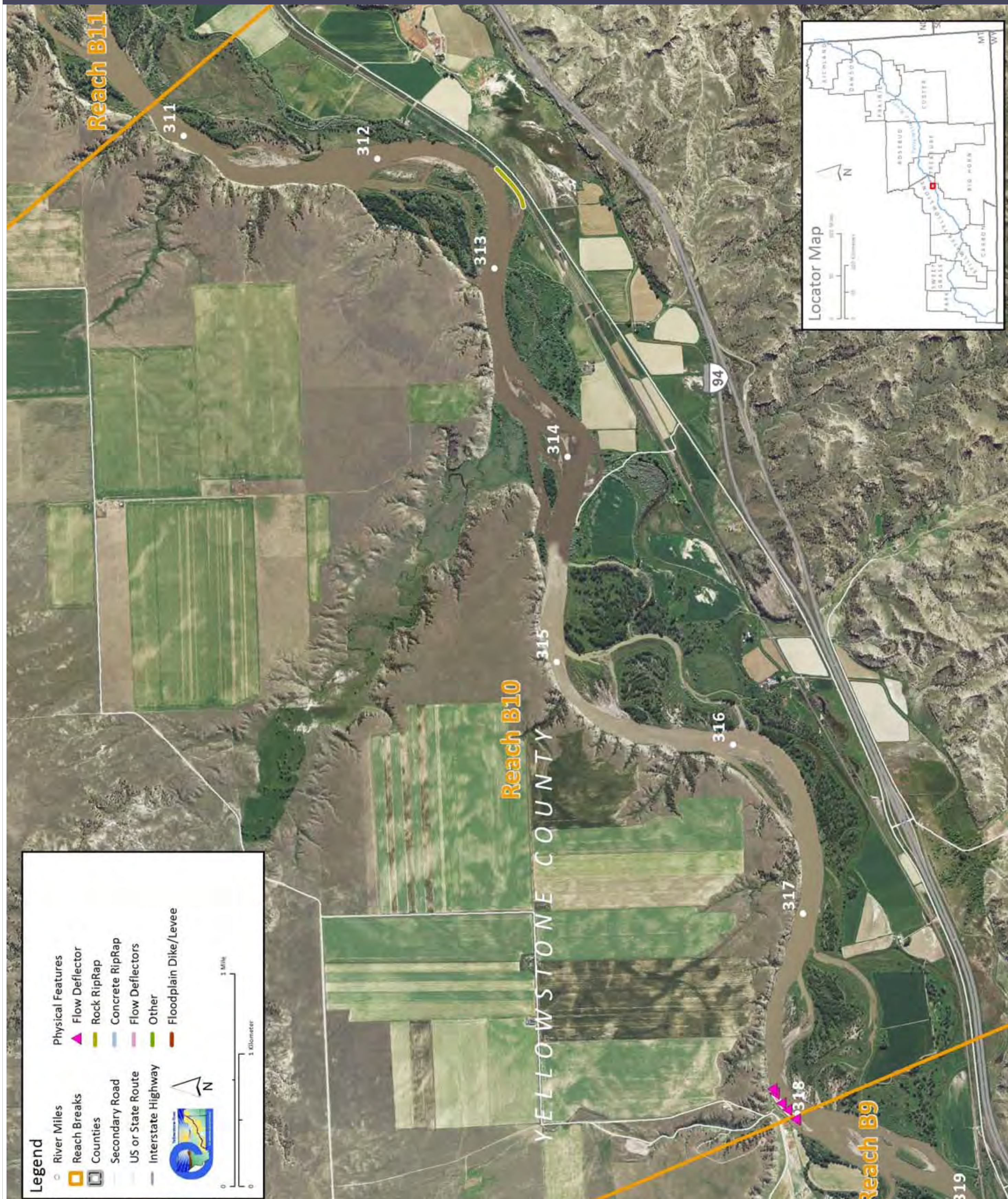
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	24.9	3.7	28.5	3.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	19.7	3.3	**239.3**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	113.2	18.9		
Scrub/Shrub	106.4	17.8		

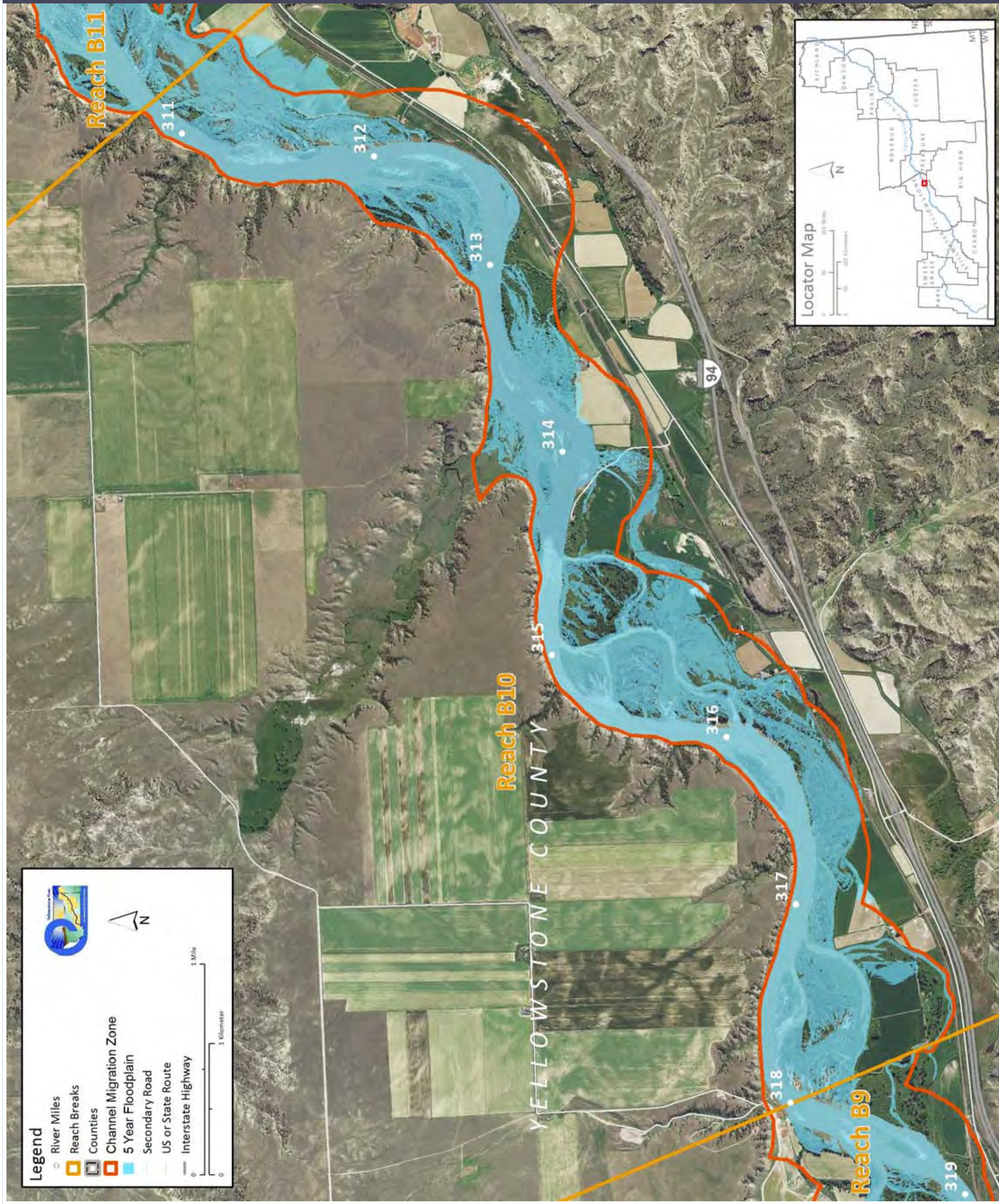
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	38.8	1.5%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	6.3	6.2	8.4	2.2	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	310.8
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	302.7
General Location	To Custer Bridge	**Length**	8.10 mi (13.04 km)

Narrative Summary

Reach B11 is located in lower Yellowstone County. The Reach is 8.1 miles long and is a Partially Confined Anabranching reach type, (PCA), indicating the presence of forested islands with substantial valley wall influence on the river. Custer Bridge and the town of Bighorn are at the lower end of the reach.

There are about 2,600 feet of rock riprap and 1,200 feet of flow deflectors in the reach, which collectively armors about 4% of the total bankline. All of the armor is protecting agricultural land, both irrigated and non-irrigated. Most of the rock riprap was built between 1950 and 1976, whereas the flow deflectors were built between 1995 and 2001.

One side channel that is about 1,000 feet long at RM 305R appears to have been blocked as a seasonal channel by three different plugs that were all in place in 1950. Hydraulic modeling results show that under undeveloped conditions, the channel conveyed water at a 2-year discharge, but now it doesn't convey flow at the 5-year discharge. The blocked channel now has dense stands of Russian olive on its lower end.

Since 1950, the bankfull area of the channel has increased by about 60 acres in Reach B11 indicating some enlargement of the main channel between 1950 and 2001. This is interesting because there was also a net increase in riparian area due to erosional processes of about 75 acres, which may appear contradictory. In reviewing the GIS data, it is apparent that much of the channel migration in Reach B11 was through unvegetated farm fields such that the channel was able to enlarge, and the area created by the migration was then colonized by riparian vegetation, resulting in a net gain in riparian area, along with an increase in overall channel size. The total riparian recruitment acreage in the reach was 483 acres; 334 of those acres of recruitment were in 1950s channel areas, and 149 acres of eroded floodplain have been colonized by woody riparian species. The increase in riparian area is most evidenced by riparian shrub, which increased from 219 acres in 1950 to 462 acres in 2001. Reach B11 consequently has a robust riparian corridor with active recruitment associated with channel migration.

Reach B11 experienced a major avulsion between 1976 and 1002, when the river jumped about 1,600 feet to the northwest between RM 305 and RM 306, relocating into a relatively small developing side channel. The avulsed channel has since been migrating back to the southeast, creating a large sediment deposit downstream at RM305 where the river corridor is tightly confined by the valley wall to the northwest and bank armored fields to the southeast. This section of river appears quite unstable.

Most of the floodplain isolation has been related to more frequent flooding; whereas 2% of the 100-year floodplain has become isolated due to human development, about 17% of the 5-year floodplain is no longer inundated at that frequency. Much of the loss of 5-year floodplain was in the blocked channel at RM 305R described above. The 100-year isolated floodplain is behind the active rail line and Interstate about 1,000 feet south of the river at RM308.5R. Emergent wetlands have been mapped in this isolated floodplain area, which is about 21 acres in size. Hydraulic modeling indicates that this area would also be inundated at a 5-year event, making it a good potential candidate for restoring floodplain connectivity through the rail line and frontage road, or for simple wetland restoration.

The mapped land uses in Reach B11 indicate that flood irrigation in the dominant land use, with about 1,500 acres of ground in flood irrigation and 100 in pivot. The town of Bighorn contributes to about 70 acres of urban/exurban development, and the proximity of the rail line to the river corridor is evidenced by 191 acres of transportation footprint. The most common developed land use in the Channel Migration Zone (CMZ) is flood irrigation (431 acres). About 17% of the CMZ has been isolated due to physical features such as bank armor and floodplain dikes, and most of that is riprap protection against irrigated lands (11% of CMZ). Most of these restrictions are in the lower reach near the town of Bighorn.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 30,200 cfs to 24,500 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,080 cfs to 2,100 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B11 include:
•Side channel blockage prior to 1950
•Channel instability caused by avulsion at RM 305

Recommended Practices for Reach B11 include:
•Side channel reactivation at RM 305R
•Floodplain reconnection at Rm 308.5R
•Russian olive removal
•Channel Migration Zone (CMZ) management due to extent of CMZ restricted (17%)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	55,500	49,400	-11.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	97,200	93,600	-3.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	916.2	948.6	928.3	976.4	60.2	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	2,570	3.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	1,169	1.4%	0	
Total	**3,739**	**4.4%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	1,002	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	252.0	259.1	74.5 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	9.7	10.4		
Acres/Year/Valley Mile	1.3	1.4		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)					The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	206.3	17%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	33.3	2%	

Restricted Migration Area	Acres	% of CMZ	
	511.3	17%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	5,117.4	4,940.7	Flood (Ac)	1,189.9	1,490.7	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	54.3	74.4	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	2.2	24.7	Pivot (Ac)	0.0	101.8	
Urban (Ac)	68.1	45.0				
Transportation (Ac)	88.0	191.3				

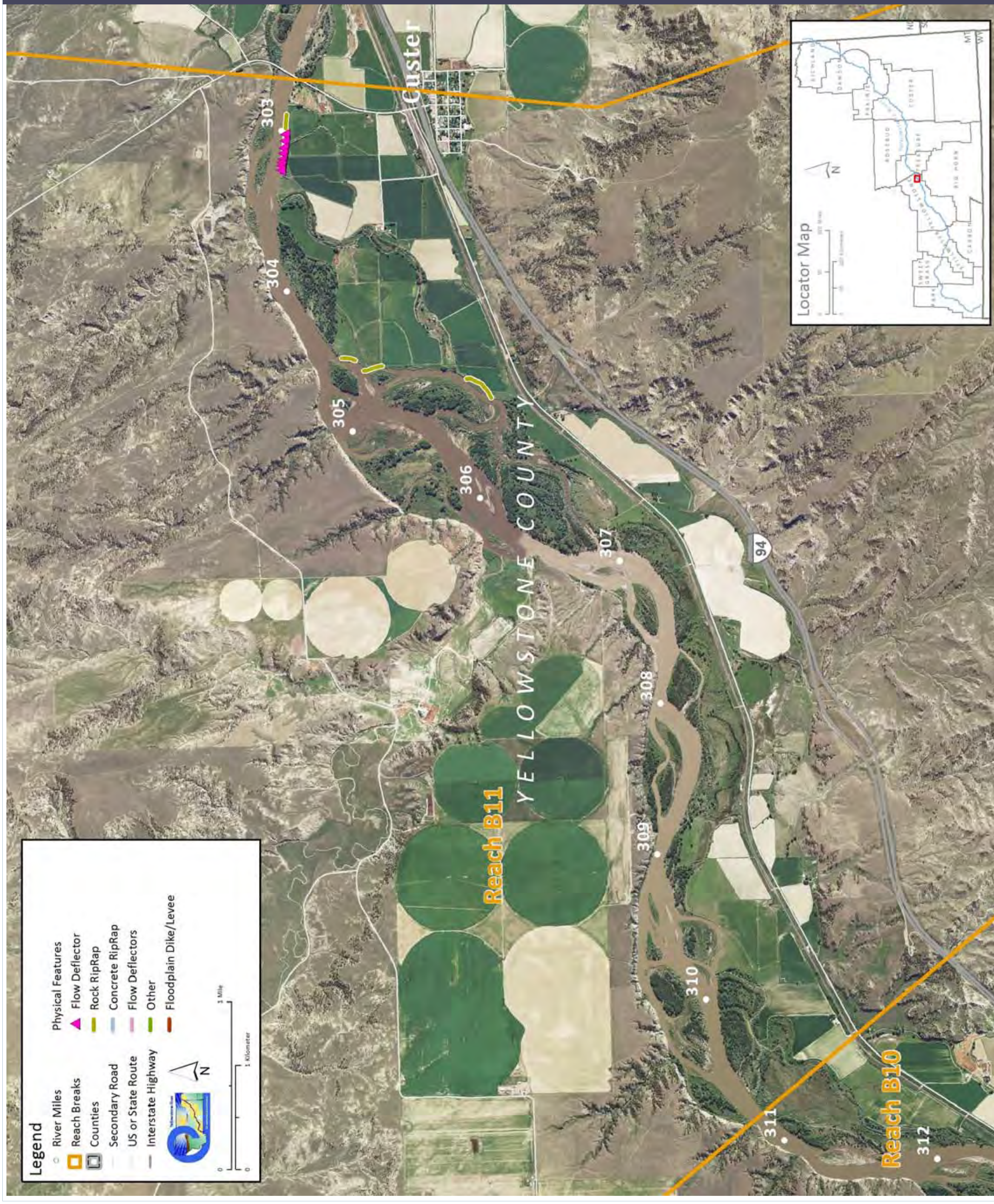
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	9.9	0.2	10.1	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	17.6	2.4	**221.4**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	160.7	21.8		
Scrub/Shrub	43.0	5.8		

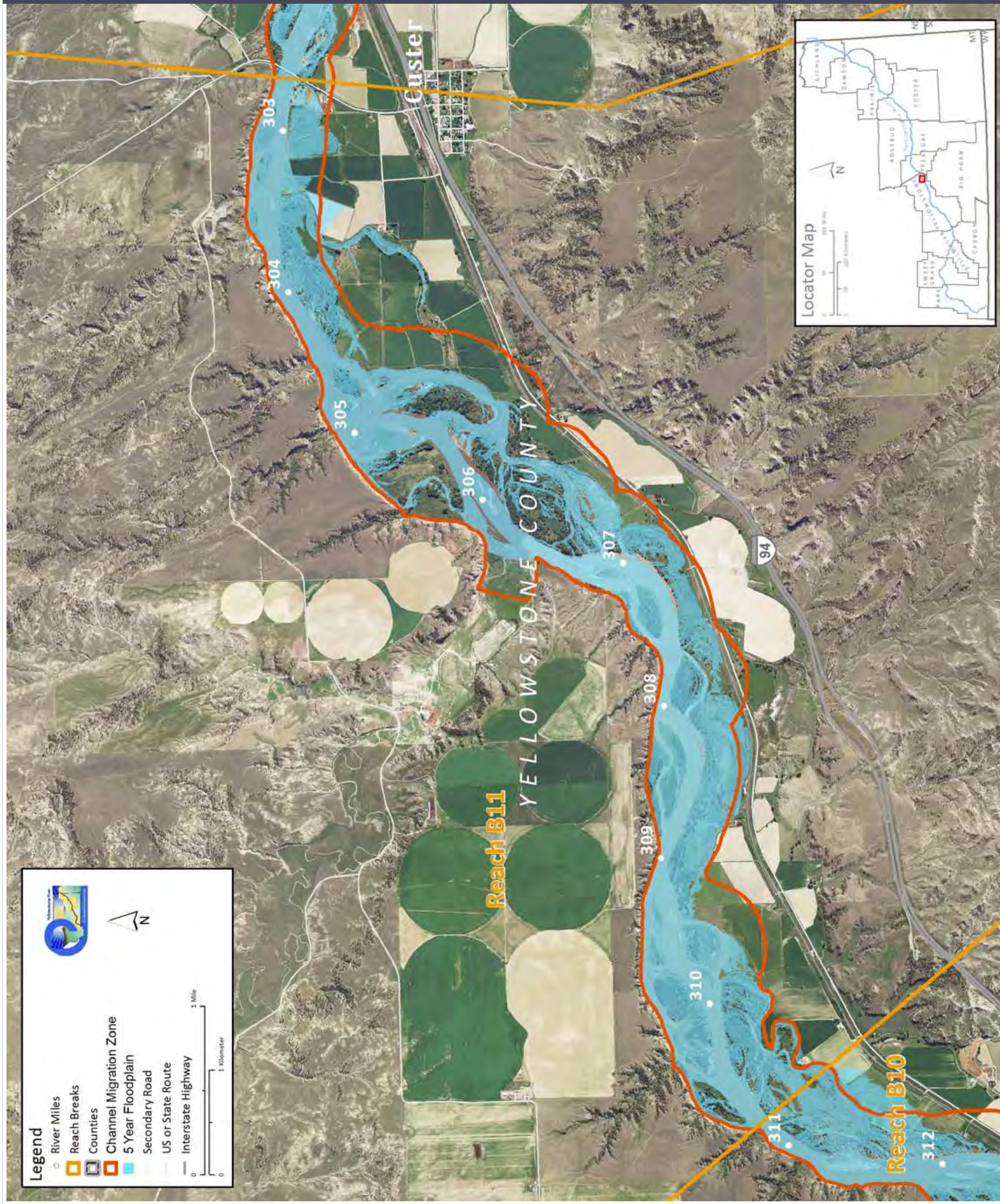
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	30.6	0.8%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	14.7	11.1	9.9	-4.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Yellowstone	**Upstream River Mile**	302.7
Classification	UA: Unconfined anabranching	**Downstream River Mile**	298.1
General Location	To Bighorn River confluence	**Length**	4.60 mi (7.40 km)

Narrative Summary

Reach B12 is located in lowermost Yellowstone County and extends to the mouth of the Bighorn River. The Reach is 4.6 miles long and is an Unconfined Anabranching reach type, (UA), indicating the presence of forested islands with minimal valley wall influence on the river. These reach types tend to be the most dynamic of all reach types, with typically high rates of bank migration.

There are about 7,800 feet of rock riprap in the reach, which collectively armors about 16% of the total bankline. Most of the armor (7,700 feet) is protecting the rail line, with the remainder protecting non-irrigated agricultural land. At two locations (RM 301.5 and RM 299), the river is flowing along bank armor that is right on the railroad prism. One segment of bank armor right at the Bighorn River confluence is actively flanking and will likely be eroded out shortly. Most of the rock riprap was in place in 1950. About 3 miles of transportation encroachment due to the railroad was mapped in the reach.

No blocked side channels have been mapped in Reach B12.

Floodplain turnover rates have dropped in this reach, from 1.9 acres/year/valley mile between 1950 and 1976 to 1.3 acres/year/valley mile between 1976 and 2001. There has been a net gain of about 68 acres of riparian vegetation due to the erosion of cleared land and colonization of new channel area by woody species. Between 1950 and 2001, there was a total of 214 acres of riparian recruitment in the reach, most of which was colonization of area that was channel in 1950.

Whereas 9% of the 100-year floodplain has become isolated due to human development, about 21% of the 5-year floodplain is no longer inundated at that frequency. All of the 100-year floodplain isolation is due to the railroad. These areas are very proximal to the river at RM299 and 302, and could potentially be considered for floodplain and/or wetland restoration.

Land use is dominated by agriculture, with 137 acres of pivot irrigation development since 1950. Almost 50 of those acres of pivot are within the Channel Migration Zone (CMZ). Almost 9% of the Channel Migration Zone (CMZ) has been restricted, and the vast majority of that restriction is due to rock riprap protection of the railroad (8%).

Reach B12 supports 144 acres of wetland, which at over 35 acres per valley mile is a relatively high concentration of wetlands on the river. There are also 33 acres of mapped Russian olive.

Contrary to most other Reaches, Reach B11 has seen an increase in forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 33 acres per valley mile of such forest, and that number increased to 36 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 30,200 cfs to 24,500 cfs, a drop of about 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 11%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,090 cfs to 2,100 cfs with human development, a reduction of 32%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846 cfs under unregulated conditions to 2,227cfs under regulated conditions at the Billings gage, a reduction of 42%.

CEA-Related observations in Reach B12 include:
•Active flanking of bank armor at mouth of Bighorn River
•Channel instability caused by avulsion at RM 305

Recommended Practices for Reach B12 include:
•Bank armor maintenance where active flanking is occurring at mouth of Bighorn River at RM 298.3R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	55,500	49,400	-11.0%
100 Year (cfs)	97,200	93,600	-3.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	526.7	605.1	528.2	552.8	26.1

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	7,778	16.2%	0
Concrete Riprap	0	0.0%	0
Flow Deflectors	0	0.0%	0
Total	**7,778**	**16.2%**	**0**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	190.0	119.1
Acres/Year	7.3	4.8
Acres/Year/Valley Mile	1.9	1.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat): 67.61 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	141.9	21%
100 Year	89.6	9%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	146.9	9%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	2,985.1	2,805.0
Ag. Infrastructure (Ac)	10.9	42.9
Exurban (Ac)	0.0	0.0
Urban (Ac)	14.6	14.6
Transportation (Ac)	60.1	130.2

	1950	2011
Flood (Ac)	498.4	556.0
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	136.8

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
		0.6	0.6	0.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	5.6	1.5
Emergent	104.4	27.8
Scrub/Shrub	34.3	9.1

Total Wetland Acres **144.3**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

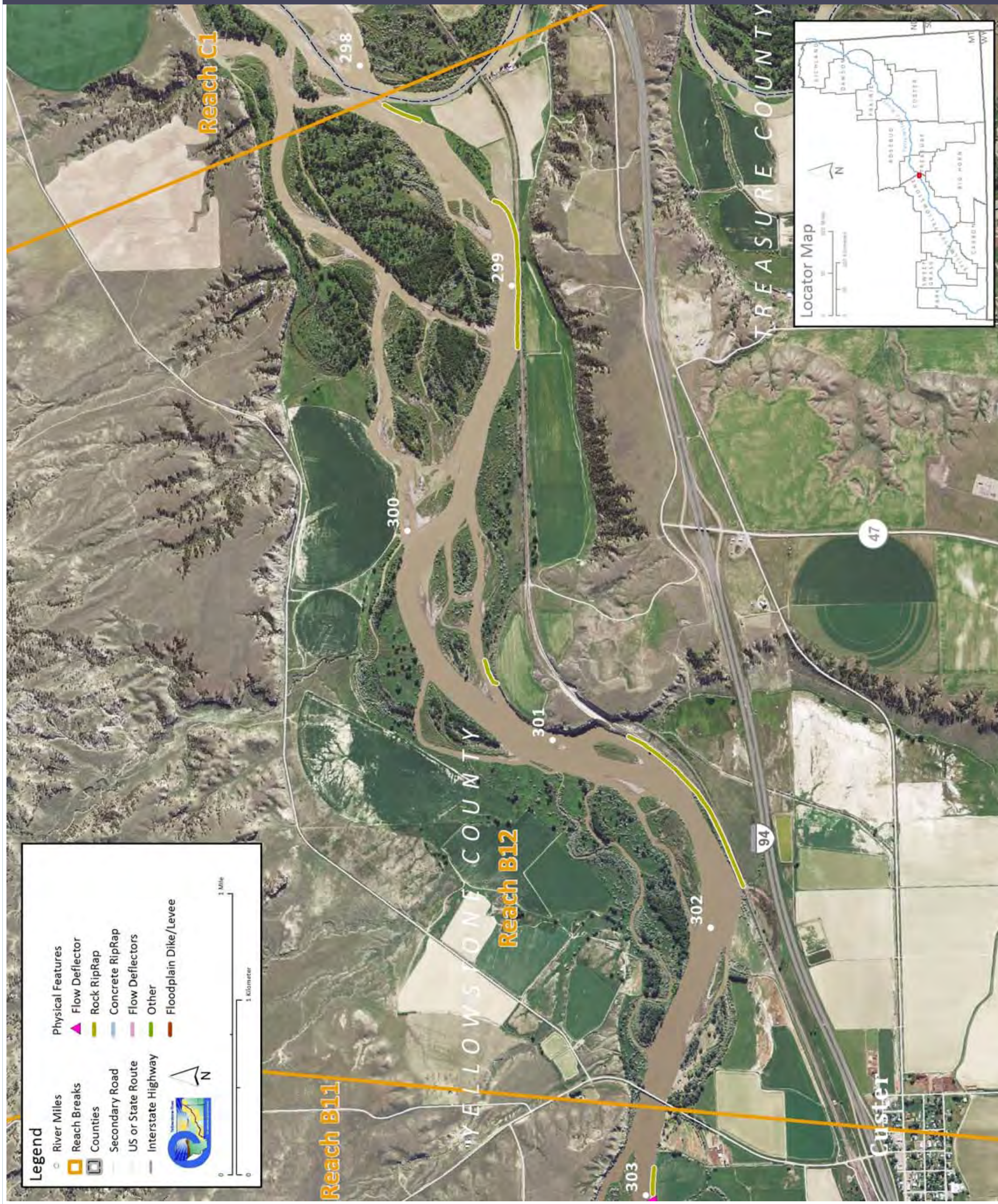
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	32.5	1.6%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

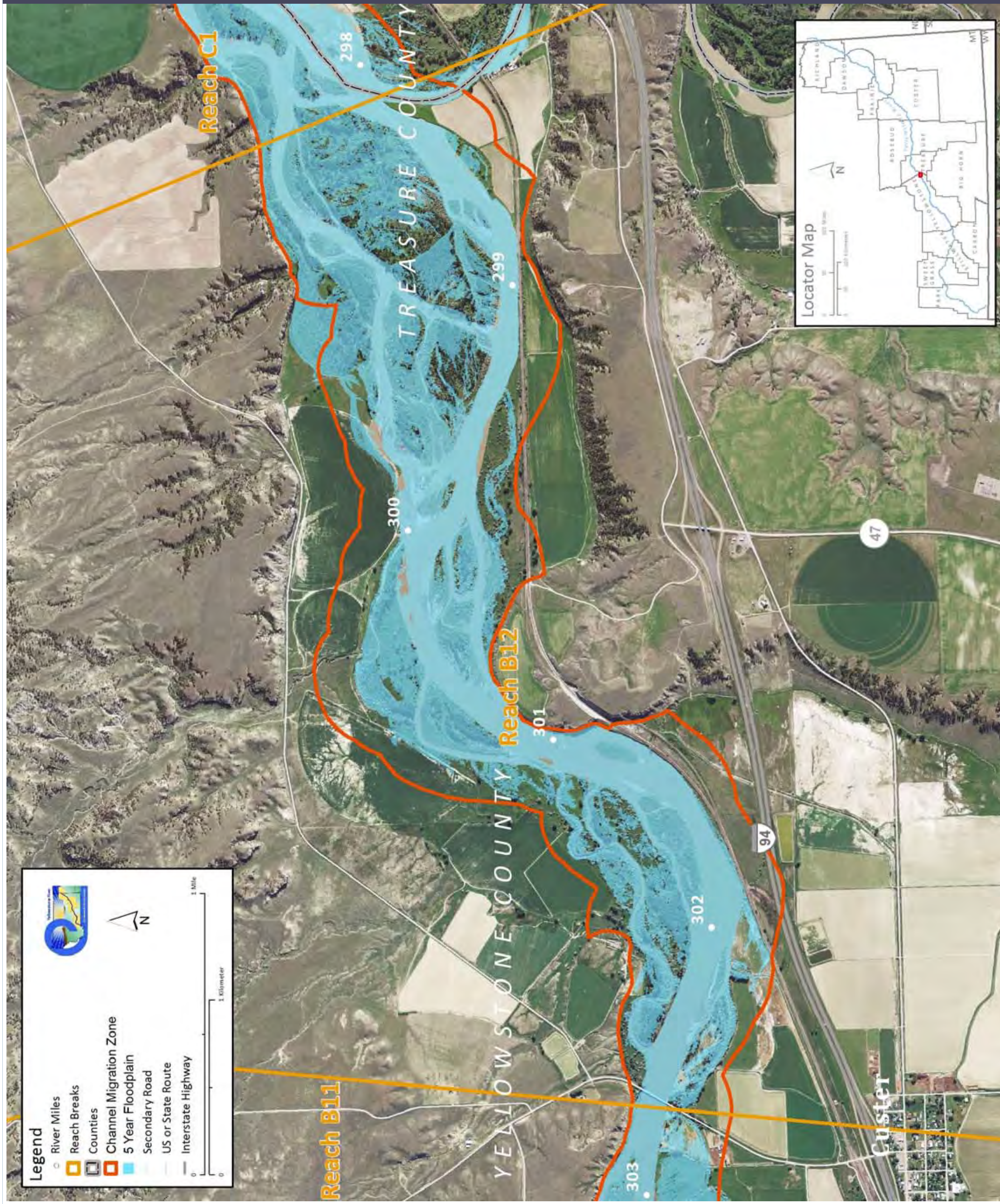
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	33.0	42.0	36.1	3.1

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	298.1
Classification	UA: Unconfined anabranching	**Downstream River Mile**	292.3
General Location	From Bighorn confluence	**Length**	5.80 mi (9.33 km)

Narrative Summary

Reach C1 is located just downstream of the Bighorn River confluence. The Reach is 5.8 miles long and is an Unconfined Anabranching reach type, (UA), indicating the presence of forested islands with minimal valley wall influence on the river. These reach types tend to be the most dynamic of all reach types, with typically high rates of bank migration. At Rm 296.5 for example, the river has migrated over 250 feet to the southeast between 2001 and 2011, indicating a migration rate of over 25 feet per year.

There are about 2,300 feet of rock riprap in the reach, which collectively armors about 4% of the total bankline. About two 1,000 feet of armor is protection the rail line and another 500 feet is protecting agricultural ground. The remainder is protecting the Rancher's Ditch Diversion Structure at RM 295.5.

The Rancher's Ditch diversion dam is located approximately 2.5 miles downstream of the Bighorn River confluence. The dam was constructed in the early part of the 20th century and feeds a canal that flows on the north side of the river. There is a large, vegetated island in the Yellowstone River at the point of diversion, and diversion dams block channels on both sides of the island. The 2011 imagery shows that the south channel is becoming progressively abandoned, so that most flow goes over the main diversion structure on the north channel.

Since 1950, there has been over 7,000 feet of side channel blocked by floodplain dikes in the reach. These channels are on the lower end of the reach on the left (northwest) bank at RM 293. Even though side channels have been blocked, there has been a net gain of side channel length in the reach; since 1950, the total anabranching channel length has increased by 3,800 feet.

Since 1950, Reach C1 has experienced over 300 acres of new riparian recruitment, with most of that colonization occurring in old 1950s channel area. In balancing the amount of riparian area eroded out to the colonization acreage, there has still been a net gain of 118 acres of riparian area in the reach associated with channel movement. This reflects erosion of non-wooded lands and colonization of resulting open bar surfaces by woody vegetation, as well as the fact that the channel has gotten smaller since 1950; the bankfull area dropped by almost 50 acres (6%) between 1950 and 2001.

Whereas 8% of the 100-year floodplain has become isolated due to human development, about 47% (633 acres) of the 5-year floodplain is no longer inundated at that frequency. About 80 acres of historic 100-year floodplain area has become isolated by the railroad, and another 42 acres due to flow alterations. The loss of 5-year floodplain shows the strong imprint of flow alterations below the mouth of the Bighorn River and of development of those areas that are less frequently inundated; about 216 acres of currently flood irrigated floodplain areas are in the historic 5-year floodplain footprint.

Land use is dominated by agriculture, with 1,212 acres of pivot irrigation development since 1950. About 15 of those acres of pivot are within the Channel Migration Zone (CMZ). Approximately 7% of the Channel Migration Zone (CMZ) has been restricted, with about half of the restrictions due to riprap along the railroad, and the other half due to floodplain dikes protecting irrigated lands.

There are several corrals associated with an animal handling facility at RM 296.8R. The river is migrating in the direction of these corrals and is currently about 600 feet from the facility.

Reach C1 supports over 40 acres per valley mile of mapped wetland, which is a relatively high wetland density for the river. There are also over 100 acres of Russian olive mapped in the reach, occupying 2.6% of the total floodplain area.

Reach C1 has seen a substantial loss in forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 48 acres per valley mile of such forest, and that number decreased to 20 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 60,800 cfs to 47,100 cfs, a drop of about 23%. The 2-year flood, which strongly influences overall channel form, has dropped by 20%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,600 cfs to 2,950 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C1 include:
•Blocking of over a mile of side channel by floodplain dikes

Recommended Practices for Reach C1 include:
•Fish Passage at Ranchers Ditch Diversion: Structures block two channels at the diversion.
•Watercraft Passage at Ranchers Ditch Diversion
•Irrigation Infrastructure Management at Ranchers Ditch Diversion
•Side channel reactivation at RM 293

•Nutrient management at corrals associated with animal handling facility at RM 296.8R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	60,800	47,100	-22.5%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	119,000	99,900	-16.1%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	775.2	765.3	696.4	728.8	-46.4	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	2,306	3.7%	406	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**2,306**	**3.7%**	**406**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	7,171	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	131.9	116.5	118.18 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	5.1	4.7		
Acres/Year/Valley Mile	1.1	1.0		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	27.4	54.2	1.9	83.5	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	633.4	46%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	152.2	8%	

Restricted Migration Area	Acres	% of CMZ	
	113.0	6%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	4,744.8	4,661.6	Flood (Ac)	1,894.6	963.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	50.9	40.2	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	4.8	Pivot (Ac)	0.0	1,212.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	85.4	154.3				

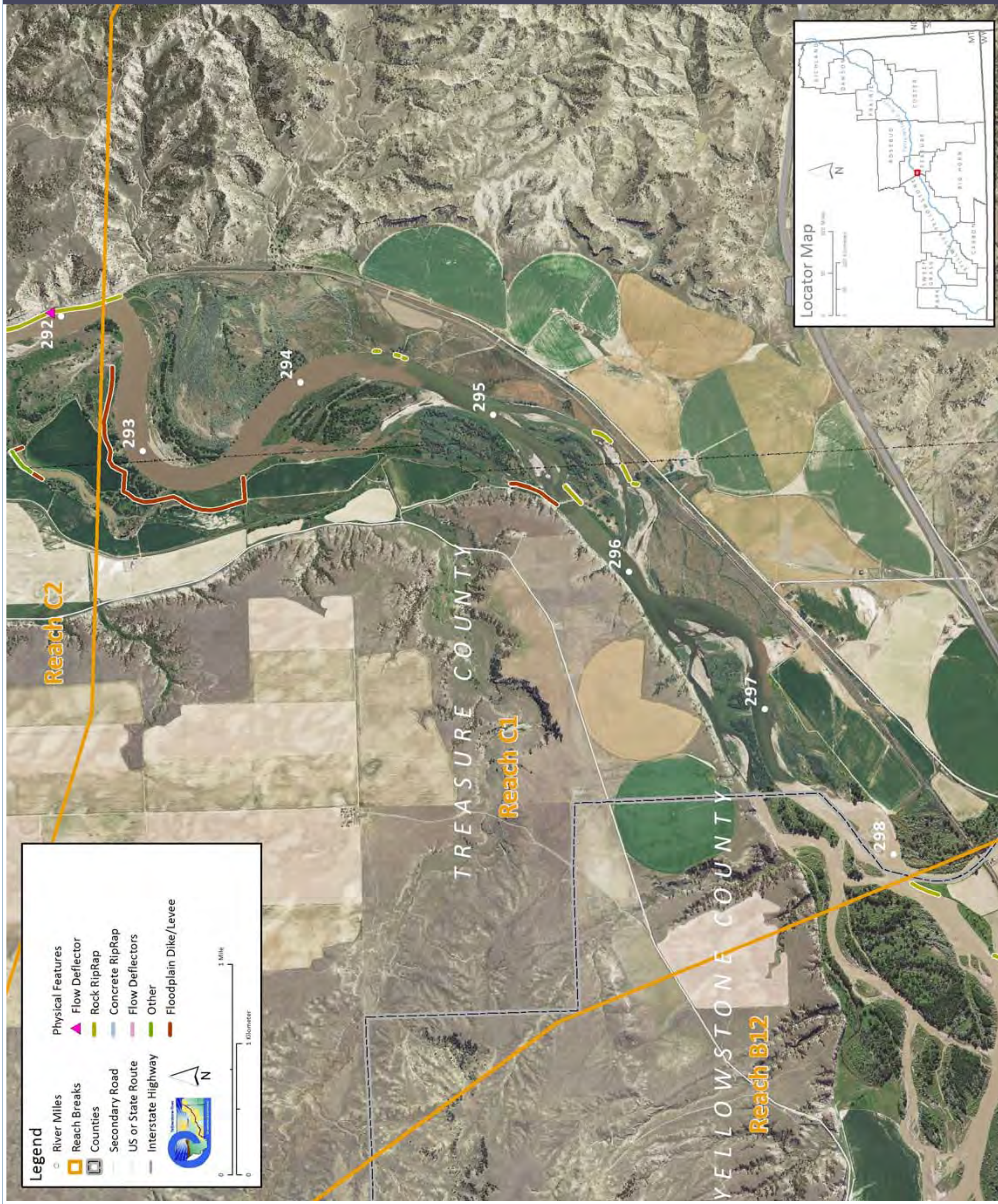
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	31.9	5.7	37.5	5.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	2.4	0.5	**197.1**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	121.5	25.8		
Scrub/Shrub	73.2	15.5		

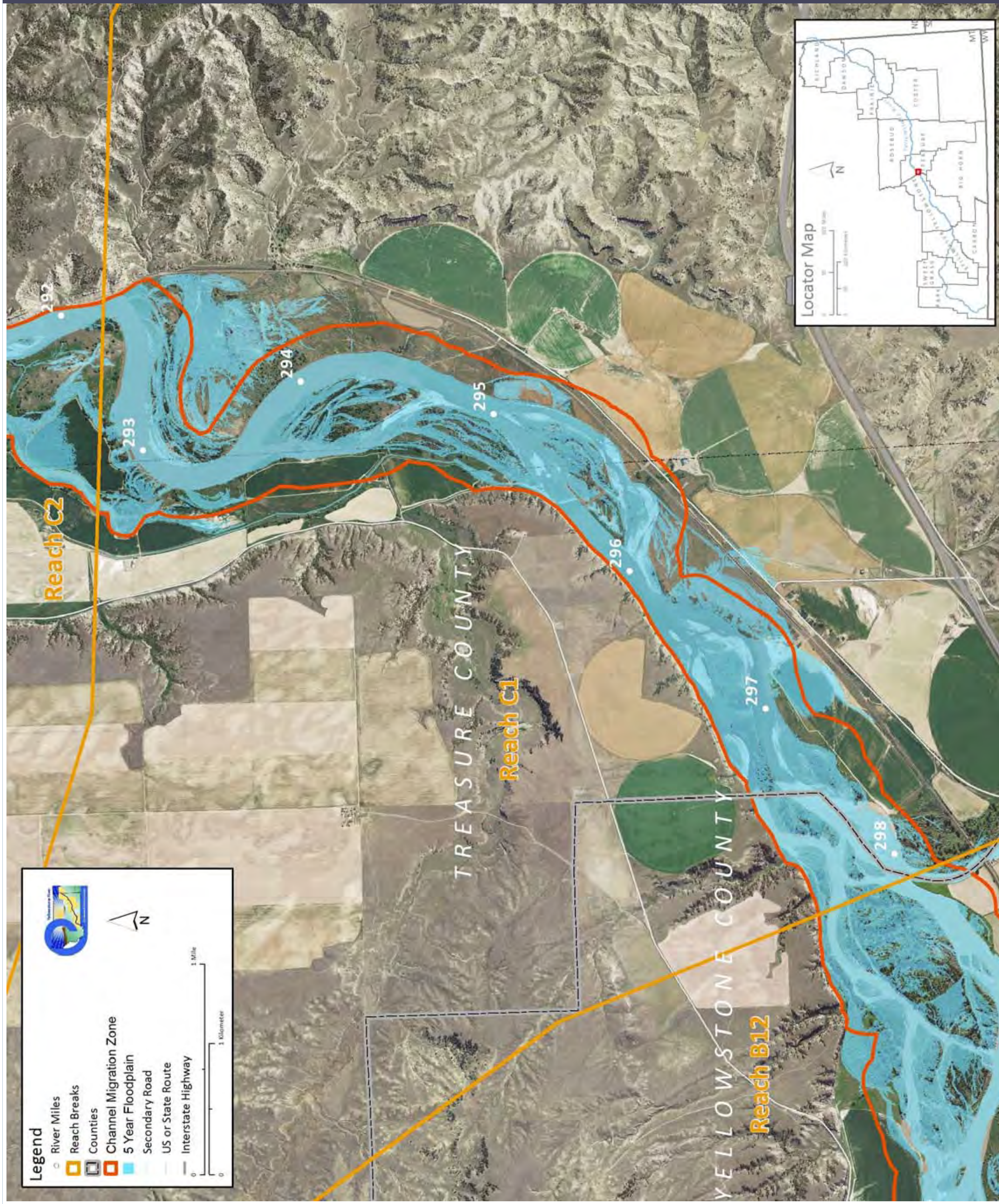
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	104.5	2.6%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	48.3	20.7	19.9	-28.4	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	292.3
Classification	PCB: Partially confined braided	**Downstream River Mile**	286.8
General Location	To Myers Bridge	**Length**	5.50 mi (8.85 km)

Narrative Summary

Reach C2 is located just upstream of Myers Bridge. The Reach is 5.5 miles long and is a Partially Confined Braided (PCB) reach type indicating some valley wall influence on a channel with fairly extensive low flow channels and open gravel bars. The reach follows the southern bluff line along the entire reach, which is almost entirely armored to protect the railroad.

There are over five miles of bank armor in the reach, most of which is rock riprap protecting the rail line. A total of 46% of the bank is armored. Since 2001, 1,200 feet of flow deflectors have been built on the right bank just above Myers Bridge.

About two miles of side channel have been blocked in Reach C2. In the upper end of the reach, two large side channels were blocked by a several thousand foot long floodplain dike sometime after 1976, and the old island in between these side channels is now cleared and farmed. The heads of these channels are at RM 293, and removal of the plugs at their heads could potentially reactivate over a mile of side channel connectivity. A second channel on the north side of the river at RM 289 appears relatively old, but has access roads crossing it that appear to block seasonal access. Similar to upstream, the isolation of this ~9,000 ft long side channel has prompted clearing and farming of the old island area that is currently accessible. In total, about 18% (162 acres) of the mapped 1950s riparian vegetation in the reach has been cleared and converted to irrigation.

Land use is dominated by agriculture, with 137 acres of pivot irrigation development since 1950. There are several corrals associated with an animal handling facility at RM 289.5L. The corrals are on the edge of a blocked historic side channel that drains to the river. Dikes, levees, and irrigation-related riprap have collectively isolated just over 10% of the Channel Migration Zone in Reach C2.

Over 600 acres of 100-year floodplain has been isolated by human development, and all of that isolation is due to agricultural development on the north side of the river. The isolation reflects 23% of the total 100-year floodplain. The 5-year floodplain is even more affected; 59% of the historic 5-year floodplain is no longer inundated at that frequency. The loss of 5-year floodplain shows the strong imprint of flow alterations below the mouth of the Bighorn River and consequent development of those areas that are less frequently inundated; about 550 acres of currently flood irrigated areas are in the historic 5-year floodplain footprint.

Since 1950, Reach C2 has experienced about 190 acres of new riparian recruitment, with most of that colonization occurring in old 1950s channel area. There has been a net gain of 40 acres of riparian area in the reach associated with channel movement. This reflects encroachment of vegetation into the channel that has experienced a 20% reduction in channel forming (2-year) flow. There are about 46 acres of Russian olive in the reach.

Reach C2 was sampled as part of the fisheries study. A total of 32 fish species were sampled in the reach and one of those species was sauger, which has been identified by the Montana Natural Heritage Program as a Species of Concern (SOC).

Reach C2 has seen a substantial loss in forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 37 acres per valley mile of such forest, and that number decreased to 6 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 60,900 cfs to 47,100 cfs, a drop of about 23%. The 2-year flood, which strongly influences overall channel form, has dropped by 20%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,610 cfs to 2,950 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C2 include:
•Blocking of over a mile of side channel by floodplain dikes
•Riparian clearing and irrigation development in isolated 5-year floodplain
•Loss of area at low risk of cowbird parasitism with riparian clearing

Recommended Practices for Reach C2 include:
•Side channel reactivation at RM 293
•Side channel reactivation RM 289
•Nutrient management at corrals associated with an animal handling facility at RM 288.8L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	60,900	47,100	-22.7%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	119,000	100,000	-16.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	596.8	631.0	578.5	590.0	-6.8	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	25,536	43.9%	10	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	1,256	2.2%	1,256	
Total	**26,792**	**46.0%**	**1,266**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	1,014	10,614	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	112.9	81.5	38.77 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	4.3	3.3		
Acres/Year/Valley Mile	0.8	0.6		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-22.4	9.7	68.5	55.8	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	959.1	59%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	624.5	18%	

Restricted Migration Area	Acres	% of CMZ	
	167.6	10%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	5,141.4	5,310.8	Flood (Ac)	2,464.8	2,393.8	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	68.7	189.6	Sprinkler (Ac)	0.0	79.1	
Exurban (Ac)	0.0	4.8	Pivot (Ac)	0.0	137.6	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	56.9	53.6				

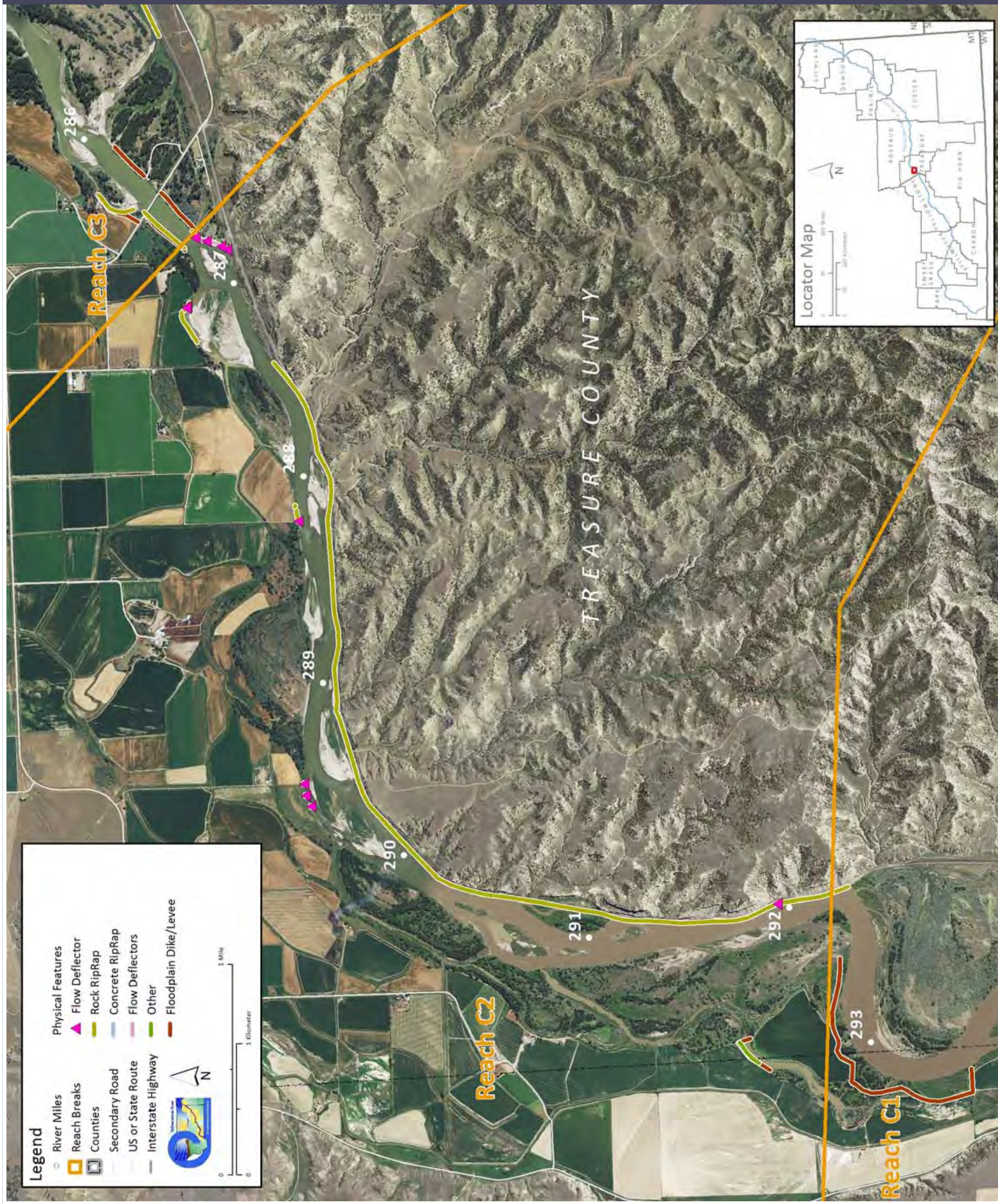
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	161.7	0.0	161.7	18.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	2.3	0.4	**104.1**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	68.1	12.7		
Scrub/Shrub	33.6	6.3		

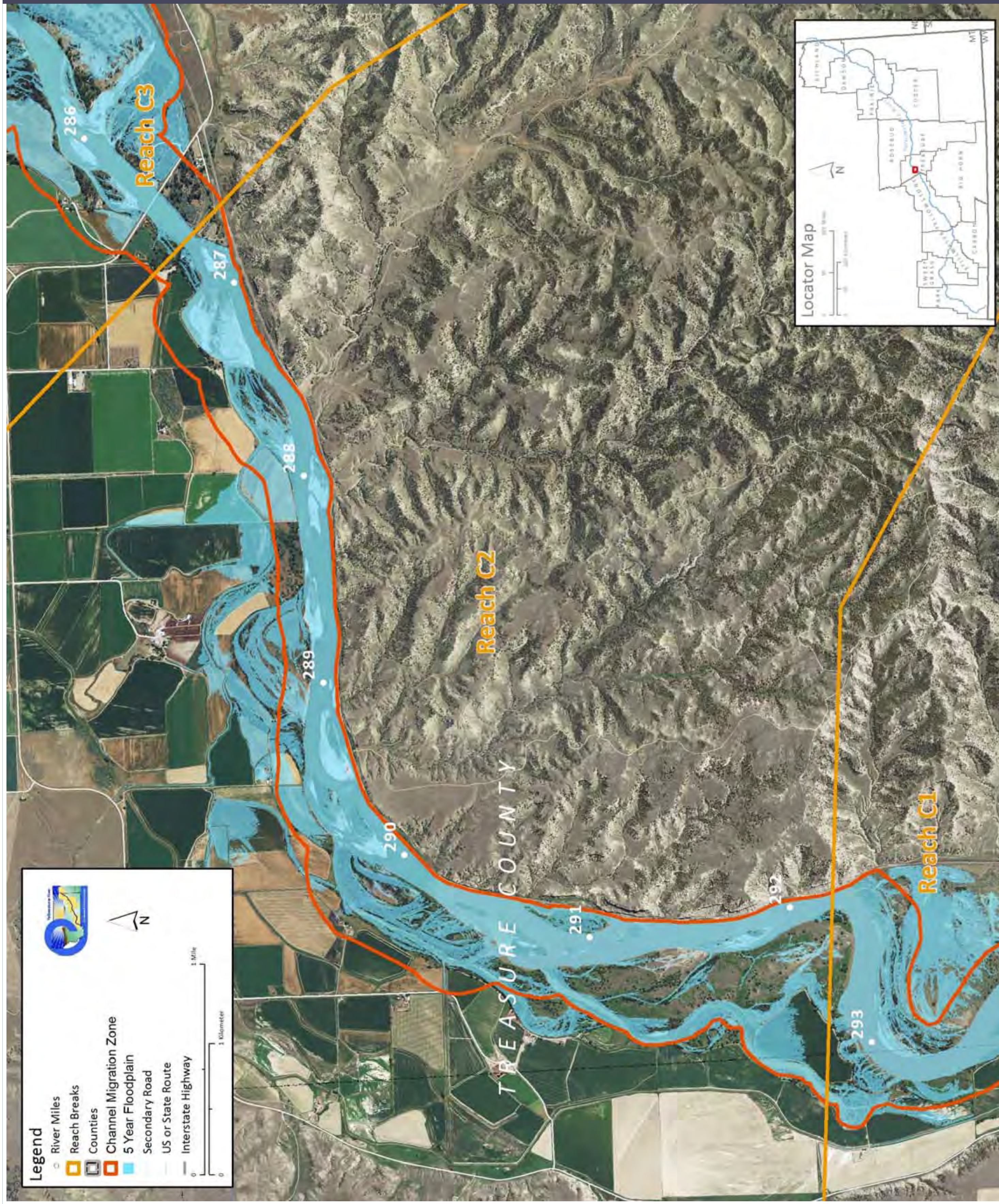
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	45.8	0.9%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	36.8	6.5	6.0	-30.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	286.8
Classification	UA: Unconfined anabranching	**Downstream River Mile**	282
General Location	To Yellowstone Diversion	**Length**	4.80 mi (7.72 km)

Narrative Summary

Reach C3 is located in Treasure County, between Myers Bridge and the Yellowstone Ditch Diversion, at the head of the Mission Valley. The reach is a 4.4 mile long Unconfined Anabranching reach type, extending from RM 282.0 to RM 286.4. In this area the alluvial valley bottom is approximately 2.5 miles wide, and this broad valley configuration is due to the presence of relatively erodible Cretaceous-age Bearpaw Shale in the valley walls and valley floor on the west limb of the Porcupine Dome. The Bearpaw Shale consists of dark gray shale that is approximately 800 feet thick. The unit is commonly exposed in the valley walls where the Yellowstone valley bottom is anomalously wide, such as in the Mission and Hammond Valleys, indicating that it is erodible in comparison to the resistant sandstones that typically form the valley margin. Upstream of Myers Bridge, the river has undercut its right bank where Bearpaw Shale underlies Hell Creek sandstone. The rail line follows the river's edge on the sandstone, and land sliding on the shale horizon has resulted in extensive bank armoring to protect the rail (Womack, 2001).

This reach was used by Koch (1977) to exemplify an especially dynamic river segment where the channel crosses the valley from one valley wall to another. Koch (1977) and Womack (2001) noted that in these areas, the Yellowstone River exhibits a particularly rich and diverse riparian zone.

There are over two miles of bank armor in the reach, all of which is rock riprap. A total of 25% of the bank is armored. In addition, approximately 31,000 linear feet of transportation encroachments and floodplain dikes were mapped in the reach. These floodplain features include floodplain dikes at Myer's bridge and the Yellowstone Ditch Diversion, and a long segment of railroad grade that is on a high terrace margin adjacent to an anabranching channel thread. Several of the floodplain dikes are protected by riprap. Land use is dominated by agriculture, with 33 acres of pivot irrigation development since 1950. Physical features such as bank armor, dikes, and levees have isolated 19% of the Channel Migration Zone in Reach C3.

The Yellowstone Ditch Diversion Dam is located at the lower end of Reach C3 at River Mile 282. The structure was built in 1909.

Even though each C3 has extensive armoring and diking throughout the reach, it has maintained substantial side channel connectivity.

Over 300 acres of 100-year floodplain has been isolated by human development, and all of that isolation is due to agricultural development on the north side of the river. The isolation reflects 12% of the total 100-year floodplain. The 5-year floodplain is even more affected; 65% of the historic 5-year floodplain is no longer inundated at that frequency. The loss of 5-year floodplain shows the strong imprint of flow alterations below the mouth of the Bighorn River and consequent development of those areas that are less frequently inundated; about 700 acres of currently irrigated areas are in the historic 5-year floodplain footprint.

Reach C3 shows a net encroachment of 192 acres of woody vegetation into the active channel corridor, suggesting that hydrologic alterations may have driven some channel narrowing since 1950. This is also supported by the loss of 121 acres of bankfull area between 1950 and 2001. This reflects encroachment of vegetation into the channel that has experienced a 20% reduction in channel forming (2-year) flow. There are about 21 acres of Russian olive in the reach. The reach supports about 30 acres of wetland per valley mile, which is a relatively dense wetland concentration for the corridor.

Reach C3 was sampled as part of the fisheries study. A total of 32 fish species were sampled in the reach and one of those species was sauger, which has been identified by the Montana Natural Heritage Program as a Species of Concern (SOC).

Reach C3 was sampled as part of the avian study. A total of 39 bird species were identified in the reach. The average species richness in Reach C3 was 8.1, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. Three bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, the Chimney Swift, the Ovenbird and the Plumbeous Vireo. One species identified as a Species of Concern (SOC) was identified, the Read-headed Woodpecker. In contrast to most other reaches, Reach C3 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 65 acres per valley mile of such forest, and that number increased to 82 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 23%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,610 cfs to 2,950 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C3 include:
•Influence of flow alterations on floodplain inundation and riparian extent
•Increase in area at low risk of cowbird parasitism with riparian encroachment

Recommended Practices for Reach C3 include:
•Fish passage at Yellowstone Ditch Diversion RM 282
•Watercraft passage at Yellowstone Ditch Diversion at RM 282

•Irrigation diversion infrastructure management at Yellowstone Ditch Diversion at RM 282
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	60,900	47,100	-22.7%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	119,000	100,000	-16.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	723.7	682.3	598.0	603.1	-120.6	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	12,618	25.4%	62	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**12,618**	**25.4%**	**62**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	178.8	94.8	192.11 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	6.9	3.8		
Acres/Year/Valley Mile	2.2	1.2		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-70.2	56.5	-4.4	-18	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	1,197.5	65%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	313.7	12%	

Restricted Migration Area	Acres	% of CMZ	
	476.5	19%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,275.6	3,177.4	Flood (Ac)	1,881.6	1,777.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	41.3	108.4	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	7.8	Pivot (Ac)	0.0	33.2	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	38.9	47.7				

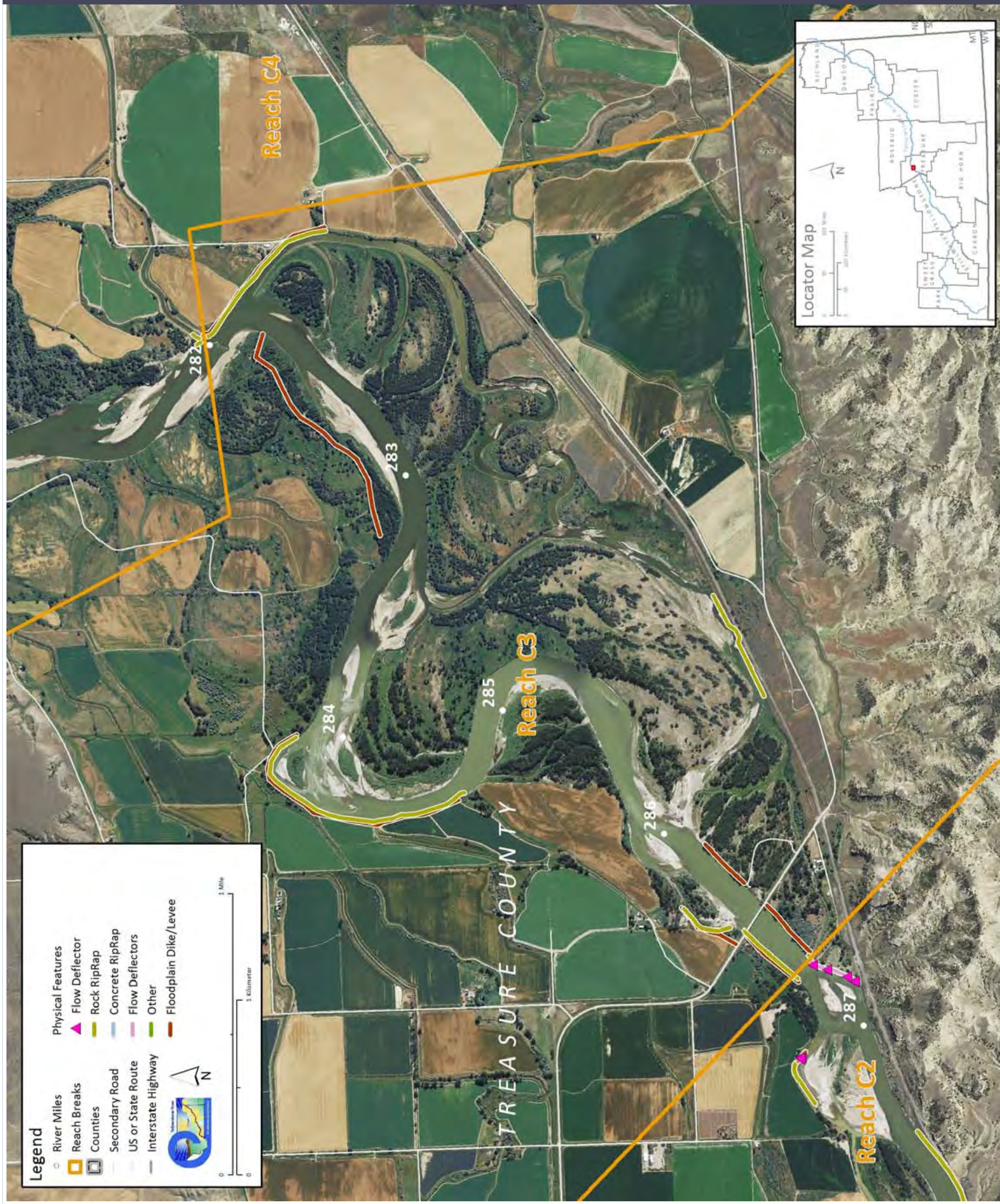
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	75.3	2.4	77.7	8.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	6.4	2.0	**120.2**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	90.6	28.7		
Scrub/Shrub	23.2	7.4		

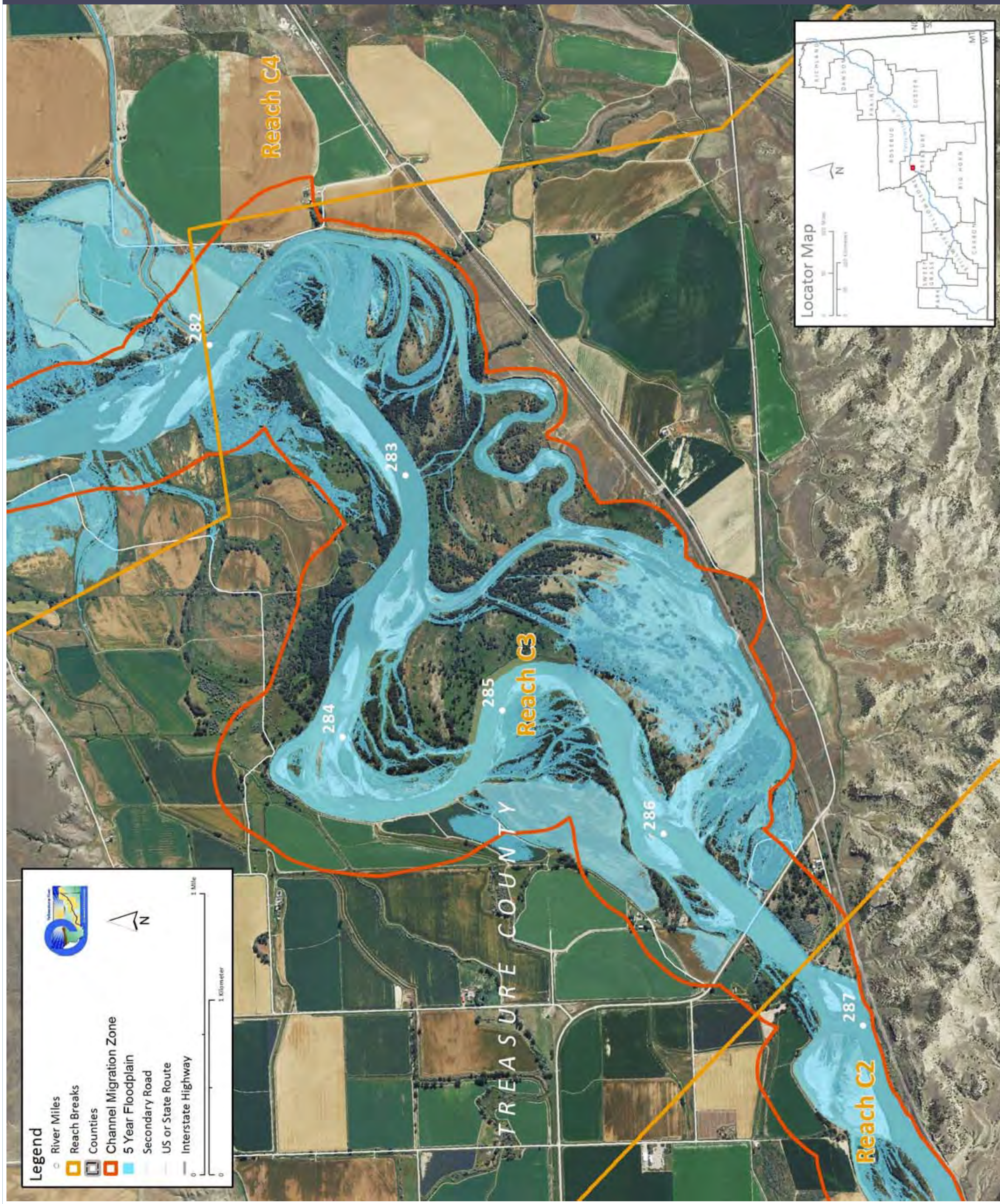
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	21.2	0.6%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	64.9	69.7	81.8	16.9	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	282
Classification	PCB: Partially confined braided	**Downstream River Mile**	278.2
General Location	Below Yellowstone Diversion	**Length**	3.80 mi (6.12 km)

Narrative Summary

Reach C4 is located in Treasure County, below Yellowstone Diversion Dam. Amelia Island Fishing Access Site is located in the middle of the reach. The reach is a 3.8 mile long Partially Confined Braided reach type, indicating some influence of the valley wall along with fairly common mid-channel bars. Within this reach the river trends to and along the north valley wall near Hysham.

There are almost 5,000 feet of bank armor in the reach, all of which is rock riprap protecting flood irrigated fields at RM 279. Channel migration at the upstream end of this armor will pose risk of flanking as the bankline continues to erode to the south. A total of 13% of the bank is armored. Land use is dominated by agriculture, with 371 acres of pivot irrigation development since 1950. Physical features such as bank armor, dikes, and levees have isolated 9% of the Channel Migration Zone in Reach C4. All of the armor is protecting agricultural land. There are 22 acres of land in the CMZ under pivot irrigation.

Reach C4 has lost 8,200 feet of side channel length since 1950; however none of those lost channels were mapped as intentionally blocked.

Reach C4 shows a reduction in floodplain turnover rates from 3.4 acres/valley mile/year from 1950-1976 to 1.8 acres/valley mile/year from 1976-2001. There has also been a net loss of 15.5 acres of mid-channel bars since 1950, and a 10 acre increase in bank-attached bars, indicating a loss in overall low flow channel complexity. About 120 acres of riparian area has been cleared for irrigation, which is 18% of the total mapped 1950 riparian zone. There are 34 acres of Russian olive in the reach.

Over 300 acres of 100-year floodplain has been isolated by human development, and all of that isolation is due to agricultural development on the south side of the river. The isolation reflects 20% of the total 100-year floodplain. The 5-year floodplain is even more affected; 35% of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, which is due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 160 acres of flood irrigated land and 40 acres of pivot within the historic 5-year floodplain.

Reach C4 was sampled as part of the avian study. A total of 39 bird species were identified in the reach. Three bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were also found, the Chimney Swift, and the Ovenbird. In contrast to most other reaches, Reach C4 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 43 acres per valley mile of such forest, and that number increased to 138 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 23%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,620 cfs to 2,960 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C4 include:
•Influence of flow alterations on floodplain inundation and riparian extent
•Increase in area at low risk of cowbird parasitism with riparian encroachment

Recommended Practices for Reach C4 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	60,900	47,100	-22.7%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	120,000	100,000	-16.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	341.3	398.9	397.1	391.2	49.9	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	4,971	12.5%	595	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**4,971**	**12.5%**	**595**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	88.4	46.0	12.38 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	3.4	1.8		
Acres/Year/Valley Mile	1.4	0.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	0	10.1	-15.5	-5.4	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	363.6	35%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	324.1	20%	

Restricted Migration Area	Acres	% of CMZ	
	114.4	9%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	2,756.2	2,680.3	Flood (Ac)	1,279.5	807.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	66.2	36.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	370.8	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	30.9	30.9				

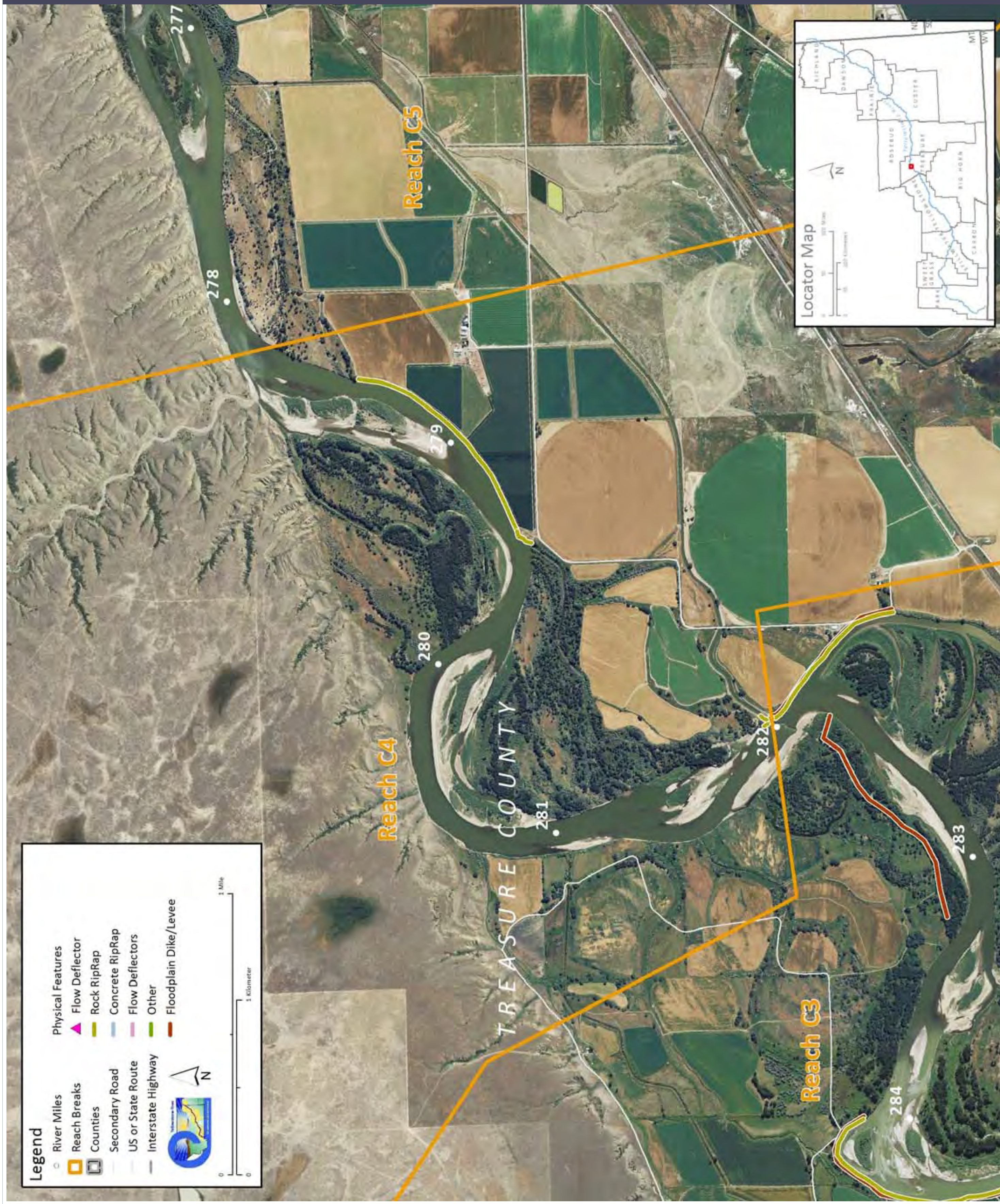
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	116.0	3.3	119.3	18.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	1.8	0.8	**57.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	30.7	12.9		
Scrub/Shrub	25.1	10.6		

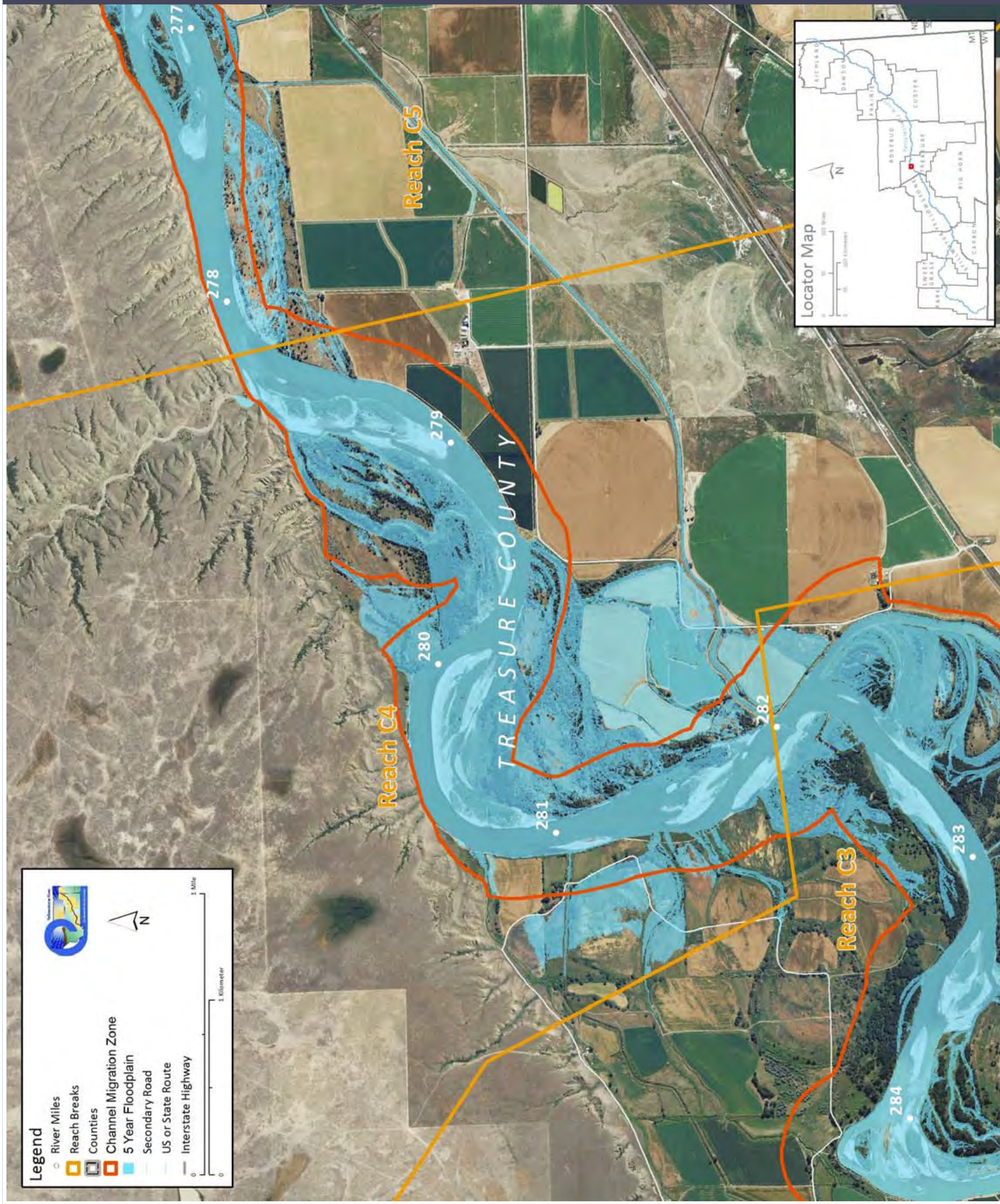
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	33.9	1.6%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	43.3	53.7	138.1	94.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives — Reach C5

County	Treasure	**Upstream River Mile**	278.2
Classification	PCS: Partially confined straight	**Downstream River Mile**	275
General Location	Hysham	**Length**	3.20 mi (5.15 km)

Narrative Summary

Reach C5 is located north of Hysham. The reach is a 3.2 mile long Partially Confined Straight reach type, as the river flows straight eastward along the northern bluff line.

There is no mapped bank armor in the reach.

One side channel in the upper part of the reach has had land use encroachment and appears to have potentially been blocked prior to 1950. It is a small seasonal channel, however, and thus may have decayed naturally.

Land use is dominated by agriculture, with 181 acres of pivot irrigation development since 1950. There are about 260 acres of flood irrigated land within the CMZ, but due to the lack of bank armor, none of the CMZ has become restricted.

Two ice jams have been recorded in Reach C5. The first was in January 1997, and the second was a break-up event in mid-March of 2003.

Reach C5 shows a net loss of 15 acres of gravel bars 1950. Most of that loss has been associated with mid-channel bars. About 23 acres of riparian area has been cleared for irrigation, which is 6% of the total mapped 1950 riparian zone. There are 22 acres of Russian olive in the reach.

About 19% of the total 100-year floodplain has become isolated due to human development. The 5-year floodplain is even more affected; 68% of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 380 acres of flood irrigated land within the historic 5-year floodplain. The vast majority of isolated 5-year floodplain area is within flood irrigated fields south of the river. The isolation is due to flow alterations.

Reach C5 was sampled as part of the avian study. A total of 35 bird species were identified in the reach. One bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) was found, the Ovenbird. Reach C5 has seen a decrease in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 41 acres per valley mile of such forest, and that number increased to 26 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 23%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,630 cfs to 2,960 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C5 include:
•Influence of flow alterations on floodplain inundation

Recommended Practices for Reach C5 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	60,900	47,100	-22.7%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	120,000	100,000	-16.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	317.0	321.7	312.7	318.9	1.8	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	0	0.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**0**	**0.0%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	8,829	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	33.5	24.0	14.76 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	1.3	1.0		
Acres/Year/Valley Mile	0.4	0.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-5.7	3.3	-12.1	-14.5	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	635.6	68%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	321.5	19%	

Restricted Migration Area	Acres	% of CMZ	
			Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,273.5	3,245.1	Flood (Ac)	1,866.0	1,492.2	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	66.1	69.8	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	14.6	Pivot (Ac)	0.0	181.2	
Urban (Ac)	29.6	29.5				
Transportation (Ac)	32.6	32.6				

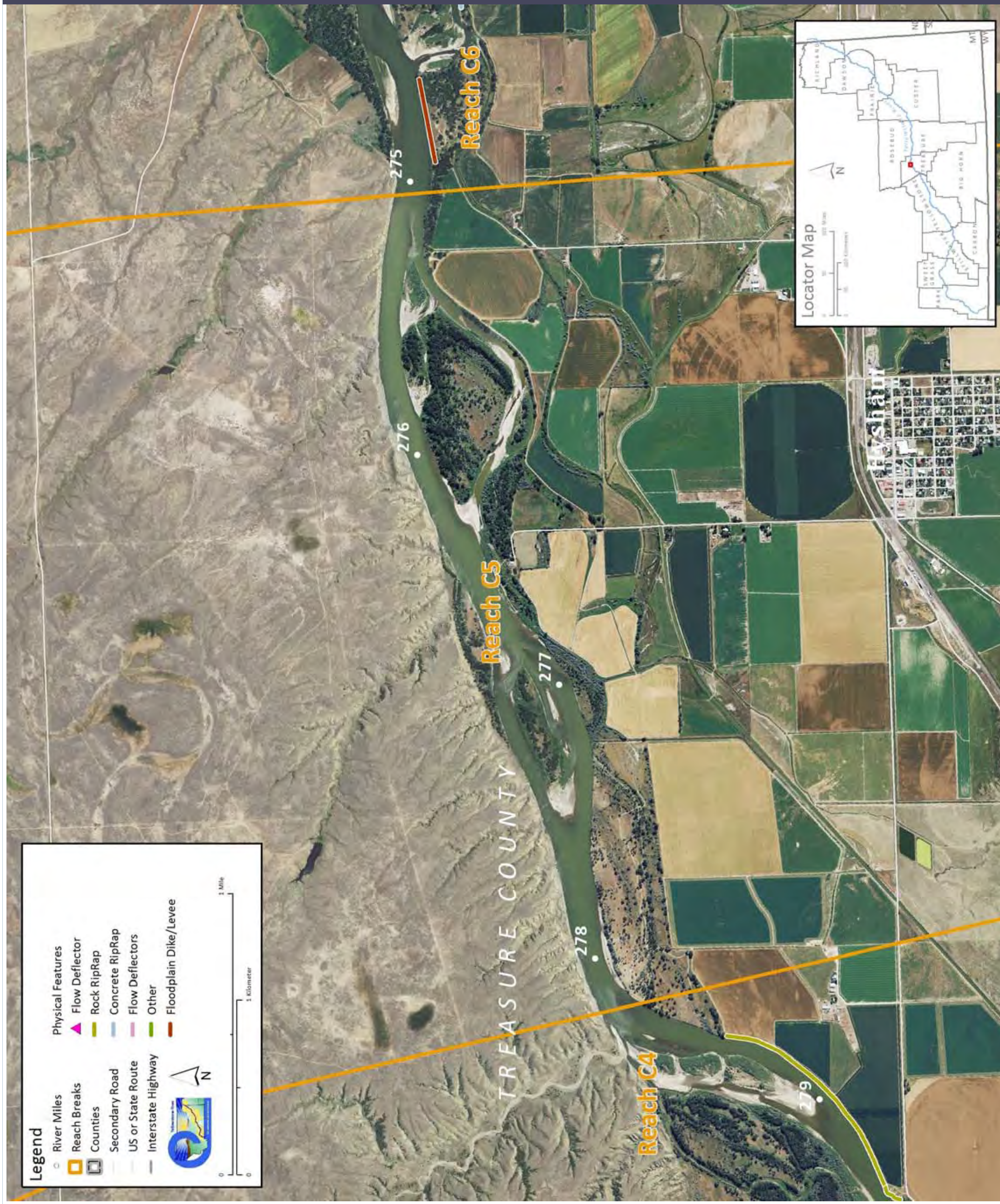
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	22.8	0.0	22.8	6.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	13.6	4.5	**64.0**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	43.6	14.4		
Scrub/Shrub	6.9	2.3		

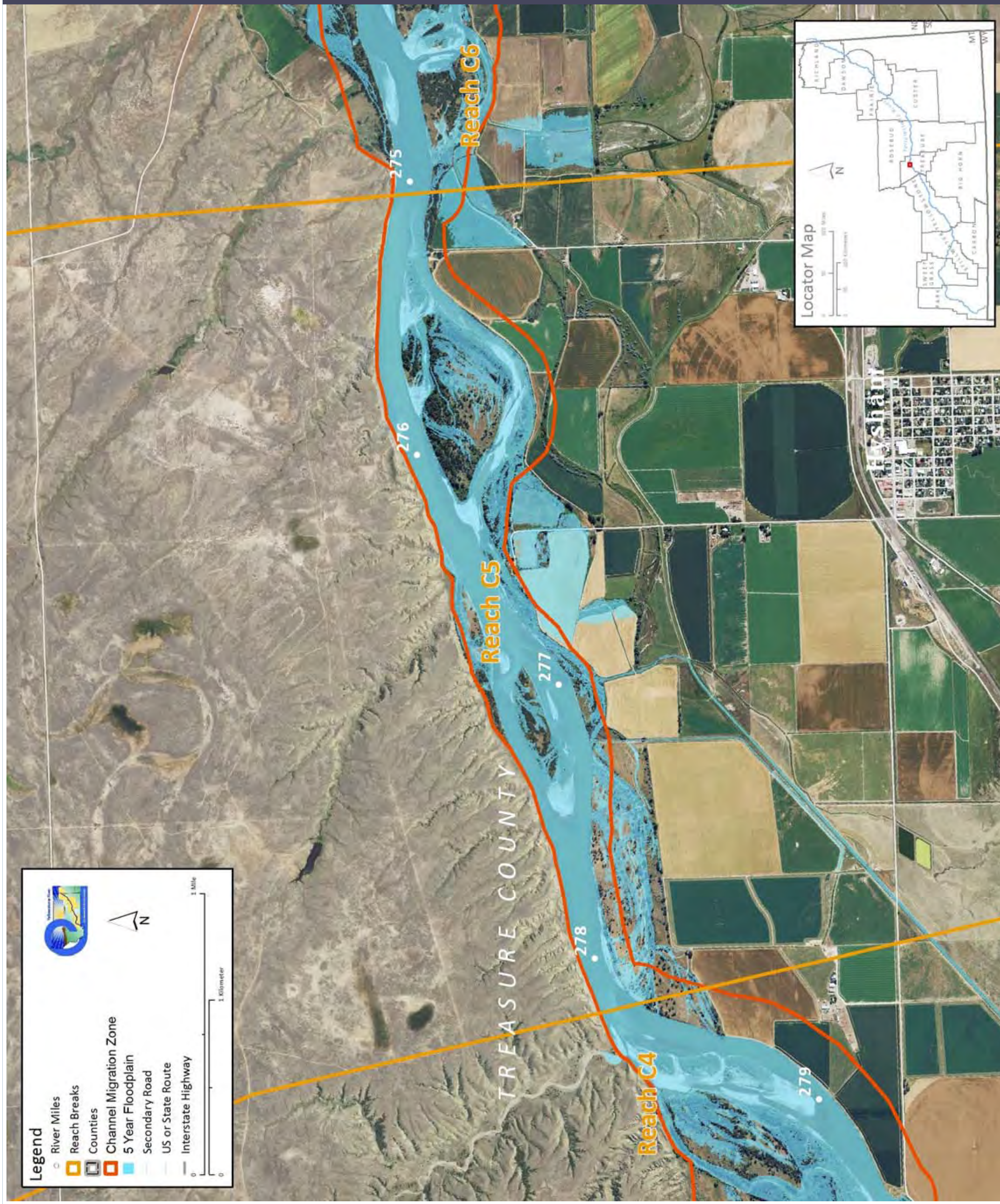
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	22.4	0.8%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	41.2	21.1	26.4	-14.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	275
Classification	UA: Unconfined anabranching	**Downstream River Mile**	269.4
General Location	Mission Valley	**Length**	5.60 mi (9.01 km)

Narrative Summary

Reach C6 is located in the Mission Valley north of Hysham. The reach is a 5.6 mile long Unconfined Anabranching reach type, indicating minimal valley wall influence and extensive side channels and forested islands. In this area the alluvial valley bottom is approximately 2.5 miles wide, and this broad valley has formed in the relatively erodible Cretaceous-age Bearpaw Shale.

There are just over 3,000 feet of bank armor in the reach, which covers 5.1% of the total bankline. About 600 feet of a floodplain dike at RM 273.2R appears to have been eroded out since 2001.

Almost 11,000 feet of side channels have been blocked by physical features in the reach since 1950. One floodplain dike that blocked a side channel at RM 227.8L in 2001 was eroded out and has since been rebuilt. Additional side channel length has been lost passively, overall, there has been about a three mile reduction in side channel length in this reach since 1950.

About 20% of the total 100-year floodplain has become isolated due to human development. The 5-year floodplain is even more affected; 70% of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 650 acres of flood irrigated land and 200 acres of pivot land within the historic 5-year floodplain. The vast majority of isolated 5-year floodplain area is within irrigated fields south of the river, and the isolation appears to be due to both flow alterations and agricultural dikes.

Land use is dominated by agriculture, with 188 acres of pivot irrigation development since 1950. There are about 260 acres of flood irrigated land within the CMZ, but due to the lack of bank armor, none of the CMZ has become restricted.

Riparian mapping data show a net gain of 158 acres of woody vegetation into the active channel corridor since 1950. This has occurred both on migrating point bars that have become vegetated, as well as within abandoned side channels. The total area of open timber increased by approximately 250 acres since 1950. There are 40 acres of Russian olive in the reach.

Reach C6 was sampled as part of the fisheries study. A total of 26 fish species were sampled in the reach.

Reach C6 was sampled as part of the avian study. A total of 32 bird species were identified in the reach. Two bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were found, the Ovenbird, and the Chimney Swift. In contrast to most reaches, Reach C6 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 55 acres per valley mile of such forest, and that number increased to 106 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 23%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,630 cfs to 2,960 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C6 include:
•Active and passive loss of thousands of feet of side channel
•Reconstruction of side-channel blockage following its failure post-2001.

Recommended Practices for Reach C6 include:
•Side channel reactivation at RM 275R and RM 271L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	61,000	47,000	-23.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	120,000	100,000	-16.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	654.7	611.0	545.8	548.9	-105.8	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	2,478	4.1%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	574	1.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**3,052**	**5.1%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	10,910	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	123.2	92.5	158.33 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	4.7	3.7		
Acres/Year/Valley Mile	1.4	1.1		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-9.2	7.6	0.3	-1.4	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	1,663.9	70%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	731.8	20%	

Restricted Migration Area	Acres	% of CMZ	
	176.0	8%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,400.5	3,584.1	Flood (Ac)	1,754.0	1,365.9	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	34.4	48.3	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	187.6	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	16.0	16.6				

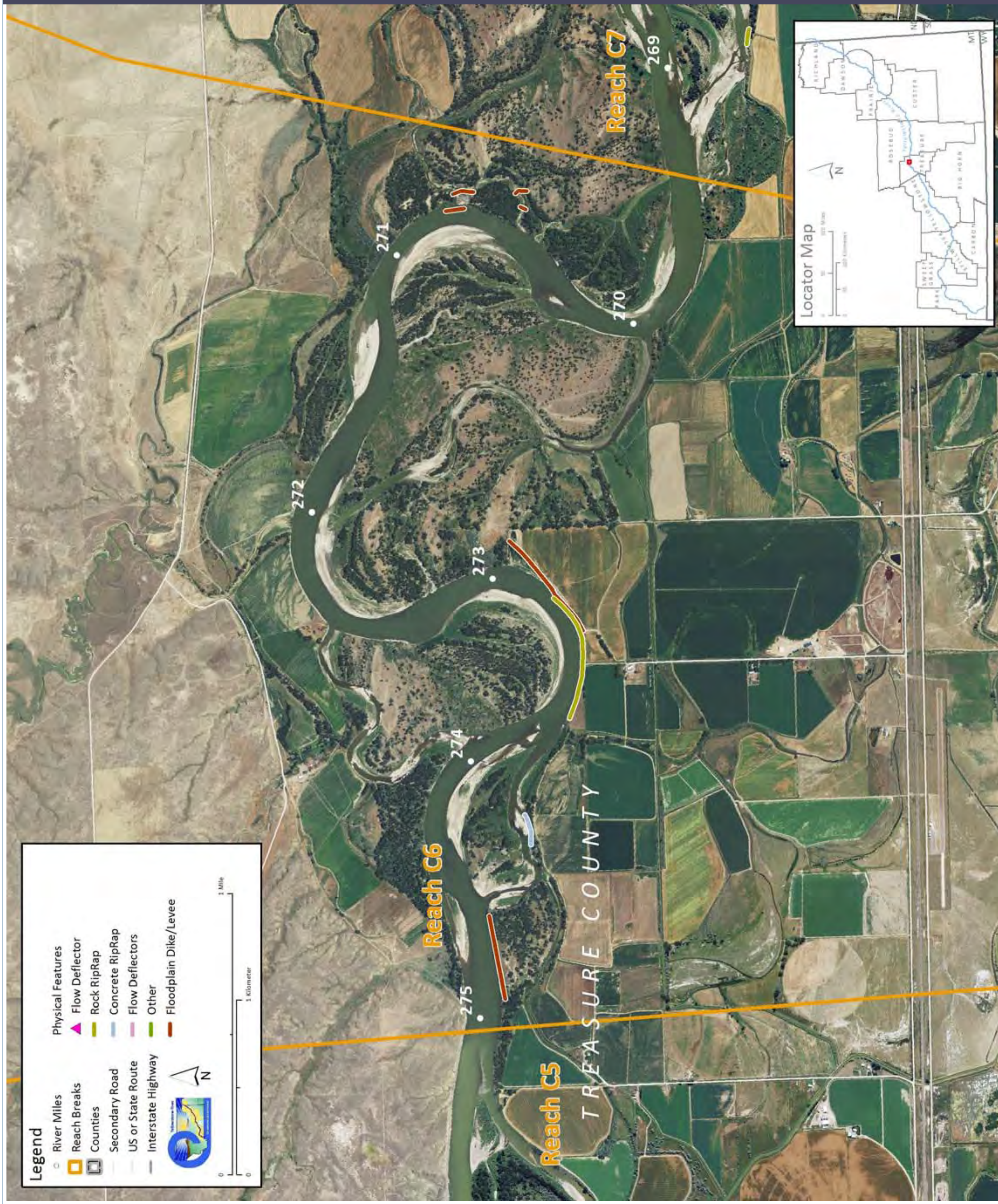
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	5.9	0.0	5.9	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	19.0	5.5	**130.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	89.1	25.8		
Scrub/Shrub	22.5	6.5		

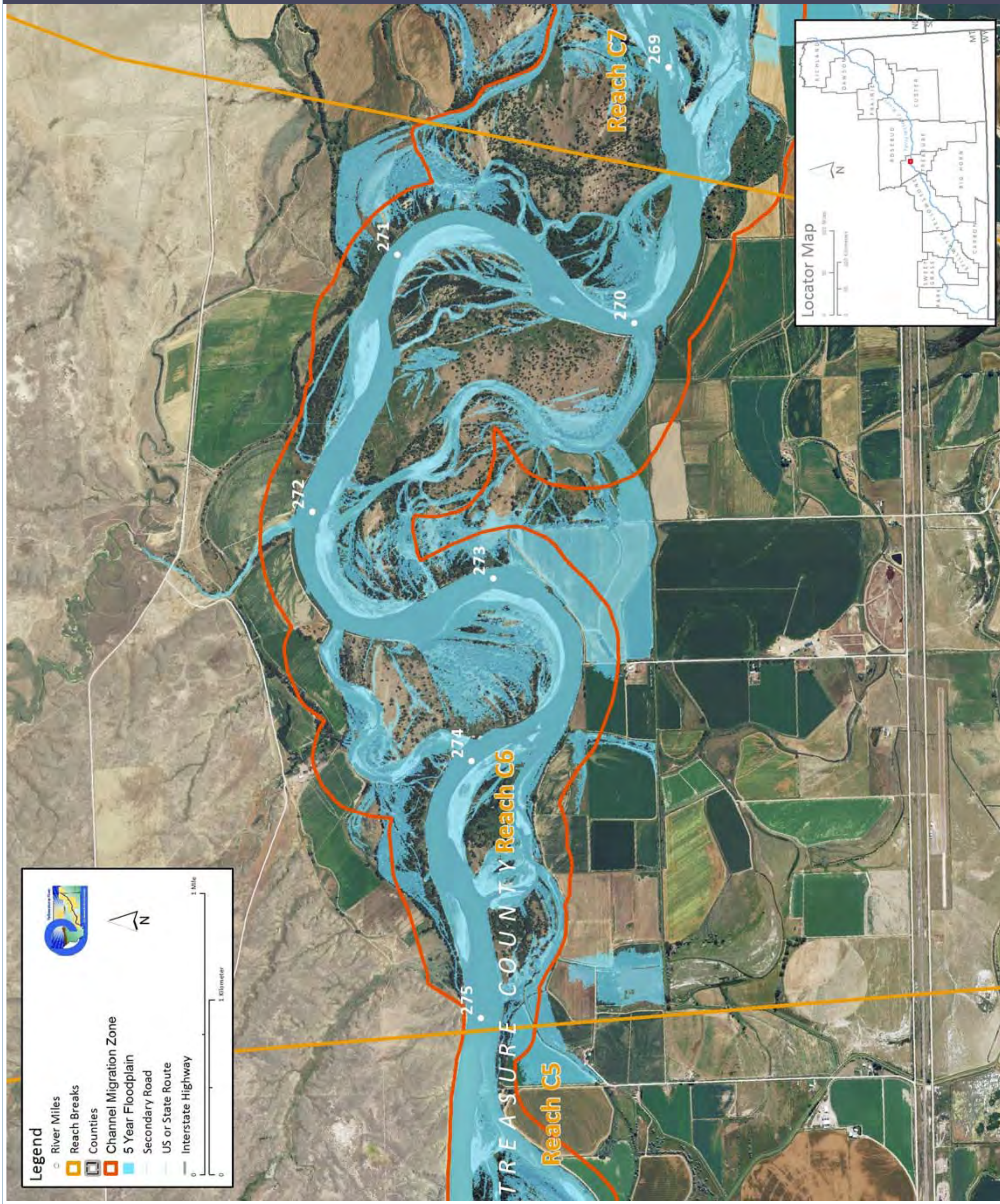
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	40.0	0.9%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	54.8	86.2	106.1	51.3	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	269.4
Classification	UA: Unconfined anabranching	**Downstream River Mile**	260.3
General Location	Mission Valley	**Length**	9.10 mi (14.65 km)

Narrative Summary

Reach C7 is 9.1 miles long and is located in the Mission Valley downstream of Hysham. It is an Unconfined Anabranching reach type, which indicates little in the way of valley wall influence coupled with extensive side channels and forested islands. The Mission Valley owes its width to the presence of the Bearpaw Shale in the valley wall. Because this Cretaceous-age shale is relatively erodible and prone to mass failure, over time the river has been able to erode the valley wall more easily than in other reaches, creating the large distinct valleys present today. Because the Mission and Hammond Valleys are so wide, the river developed a complex series of channels and an expansive riparian forest. These reaches are especially rich in terms of aquatic and riparian habitat extent, diversity, and geomorphic complexity.

Just over 2,000 feet of rock riprap lines the banks in Reach C7, protecting 2.3% of the bankline.

Prior to 1950 about 4,200 feet of side channel had been blocked in Reach C7, and since then, floodplain dikes have blocked another three miles of side channel. Blocked side channels are located at RM 270.8L, RM 263.5R, and RM261R. RM Even with all of the blockages, Reach C7 still has on the order of 17 miles of functional side channel length.

Reach C7 appears to be experiencing an active major avulsion just north of Sanders, where an anabranching channel has been developing into a primary channel over the last decade. As rerouting of the river would shorten the main thread by approximately 1.5 miles, an avulsion is very likely to occur in this area over the next decade. The rate at which the anabranching side channel fully captures the main thread will depend on flood events, as floods will accelerate the avulsion process. This avulsion would take pressure off of the main channel to the south, which is currently threatening the rail line at RM264.8R and RM 266.2R.

About 9% of the total 100-year floodplain has become isolated due to human development in Reach C7. The 5-year floodplain is even more affected; 41% of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 95 acres of flood irrigated land and 56 acres of pivot land within the historic 5-year floodplain. Much of the isolated 5-year floodplain area is within the active stream corridor and riparian zone however, exemplifying the potential impacts of flow alterations on frequent floodplain inundation.

Land use is dominated by agriculture, with 277 acres of pivot irrigation development since 1950. There are about 350 acres of flood irrigated land and 31 acres of pivot within the CMZ, but only 4% of the CMZ is restricted by physical features.

Riparian mapping data show a net gain of 780 acres of woody vegetation into the active channel corridor since 1950. This has occurred both on migrating point bars that have become vegetated, as well as within abandoned side channels. Reach C7 has about 90 acres of wetland per valley mile, which makes it one of the most concentrated wetland areas in the corridor. There are also 164 acres of Russian olive in the reach.

Reach C7 was sampled as part of the fisheries study. A total of 27 fish species were sampled in the reach, including Sauger, which are recognized by the Montana Natural Heritage Program as a Species of concern (SOC).

Reach C7 was sampled as part of the avian study. A total of 69 bird species were identified in the reach. Four bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were found, the Black and White Warbler, the Plumbeous Vireo, the Ovenbird, and the Chimney Swift. Two Species of Concern (SOC) were identified, the Black Billed Cuckoo and the Bobolink. Brown Headed Cowbirds were also present. Reach C7 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 86 acres per valley mile of such forest, and that number increased to 102 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 23%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,680 cfs to 2,990 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C7 include:
•Active and passive loss of thousands of feet of side channel

Recommended Practices for Reach C7 include:
•Side channel reactivation at RM 270.8L, RM 263.5R, and RM261R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	61,100	47,000	-23.1%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	120,000	100,000	-16.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,264.9	1,329.6	1,230.4	1,217.0	-47.9	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	2,173	2.3%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**2,173**	**2.3%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	4,230	15,593	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	447.8	278.9	169.5 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	17.2	11.2		
Acres/Year/Valley Mile	2.8	1.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-116	58.7	-33.6	-91	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	1,107.4	41%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	378.0	9%	

Restricted Migration Area	Acres	% of CMZ	
	172.8	4%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	6,777.9	6,695.6	Flood (Ac)	3,276.6	1,951.2	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	77.0	128.1	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	7.5	Pivot (Ac)	0.0	276.3	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	101.9	104.3				

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	29.7	0.4	30.1	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

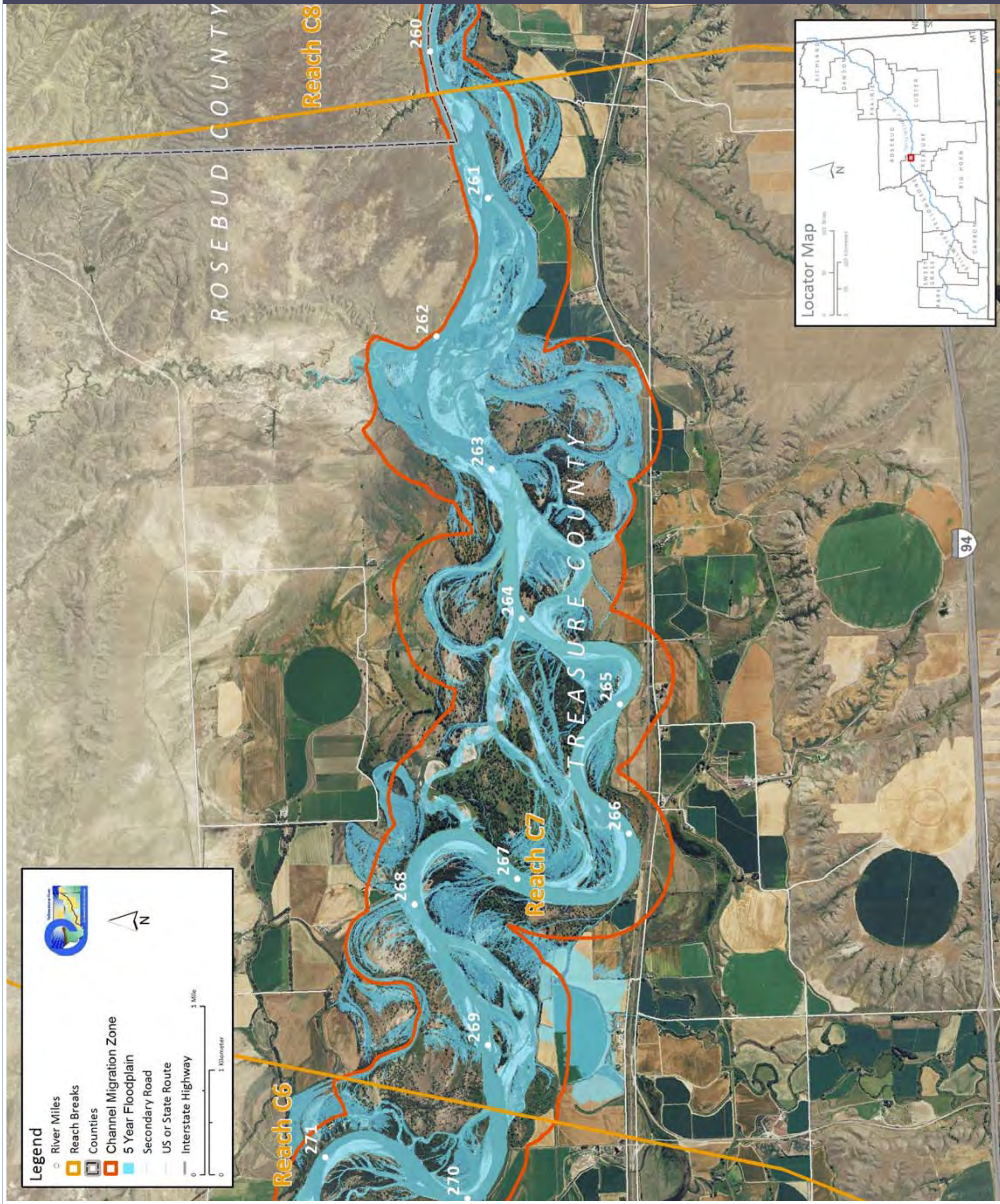
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	15.7	2.5	**552.3**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	406.2	65.4		
Scrub/Shrub	130.4	21.0		

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	164.4	2.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	86.2	76.9	100.3	14.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)

CHANNEL MIGRATION ZONE MAP



County	Treasure	**Upstream River Mile**	260.3
Classification	PCS: Partially confined straight	**Downstream River Mile**	253.8
General Location	Rosebud/Treasure County Line	**Length**	6.50 mi (10.46 km)

Narrative Summary

Reach C8 is 9.1 miles long and is located on the Rosebud/Treasure County line. It is a Partially Confined Straight reach type, as the river flows straight eastward along the northern bluff line.

There is approximately 4,100 feet of rock riprap in the reach, 800 feet of which was built since 2001. About 6% of the total bankline is armored.

Prior to 1950 about 2,300 feet of side channel had been blocked in Reach C8, and since then, floodplain dikes have blocked another 8,500 feet of side channel. Blocked side channels are located at RM 260R and RM 257R. Side channels have also been passively lost; since 1950, there has been a total loss of 2.6 miles of side channel in Reach C8. About four miles of active side channel remain.

About 35% of the total 100-year floodplain has become isolated due to human development. Most of the isolation is due to flow alterations. The 5-year floodplain is even more affected; 55% of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 240 acres of flood irrigated land within the historic 5-year floodplain. Most of the isolated 5-year floodplain area is occupied by flood irrigated fields south of the river.

Land use is dominated by agriculture, with 342 acres of pivot irrigation development since 1950. There are about 178 acres of flood irrigated land and 12 acres of pivot within the CMZ, and 10% of the CMZ is restricted by physical features.

Riparian recruitment analyses show that between 1950 and 2001, there was 193 total acres of riparian colonization in the reach. Taking into account losses due to erosion, there was still a net gain of 94 acres of woody vegetation into the active channel corridor since 1950. This has occurred both on migrating point bars that have become vegetated, as well as within abandoned side channels. The extent of closed timber has increased from 293 acres in 1950 to 604 acres in 2001. There are 43 acres of Russian olive in the reach.

Reach C8 was sampled as part of the fisheries study. A total of 30 fish species were sampled in the reach, including Sauger, which are recognized by the Montana Natural Heritage Program as a Species of concern (SOC).

Reach C8 was sampled as part of the avian study. A total of 37 bird species were identified in the reach. Two bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were found, the Ovenbird and the Chimney Swift. Reach C8 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 51 acres per valley mile of such forest, and that number increased to 61 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 23%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,680 cfs to 2,990 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-Related observations in Reach C8 include:
•Active and passive loss of thousands of feet of side channel

Recommended Practices for Reach C8 include:
•Side channel reactivation at RM 260R and RM 257R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	61,100	47,000	-23.1%
100 Year (cfs)	120,000	100,000	-16.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	679.9	688.1	620.0	621.9	-58.0

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	4,093	6.0%	807
Concrete Riprap	0	0.0%	0
Flow Deflectors	52	0.1%	52
Total	**4,145**	**6.1%**	**859**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	2,323	8,494

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	140.4	52.4
Acres/Year	5.4	2.1
Acres/Year/Valley Mile	0.9	0.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

93.58 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	36.5	28	26.7	91.2

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	670.6	55%
100 Year	897.7	35%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	166.5	10%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	6,145.6	6,109.7
Ag. Infrastructure (Ac)	39.5	104.7
Exurban (Ac)	0.0	0.0
Urban (Ac)	0.0	0.0
Transportation (Ac)	98.0	97.9

	1950	2011
Flood (Ac)	2,808.1	2,783.3
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	341.9

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	75.4	0.0	75.4	9.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	3.8	0.6
Emergent	112.2	18.7
Scrub/Shrub	9.6	1.6

Total Wetland Acres **125.6**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

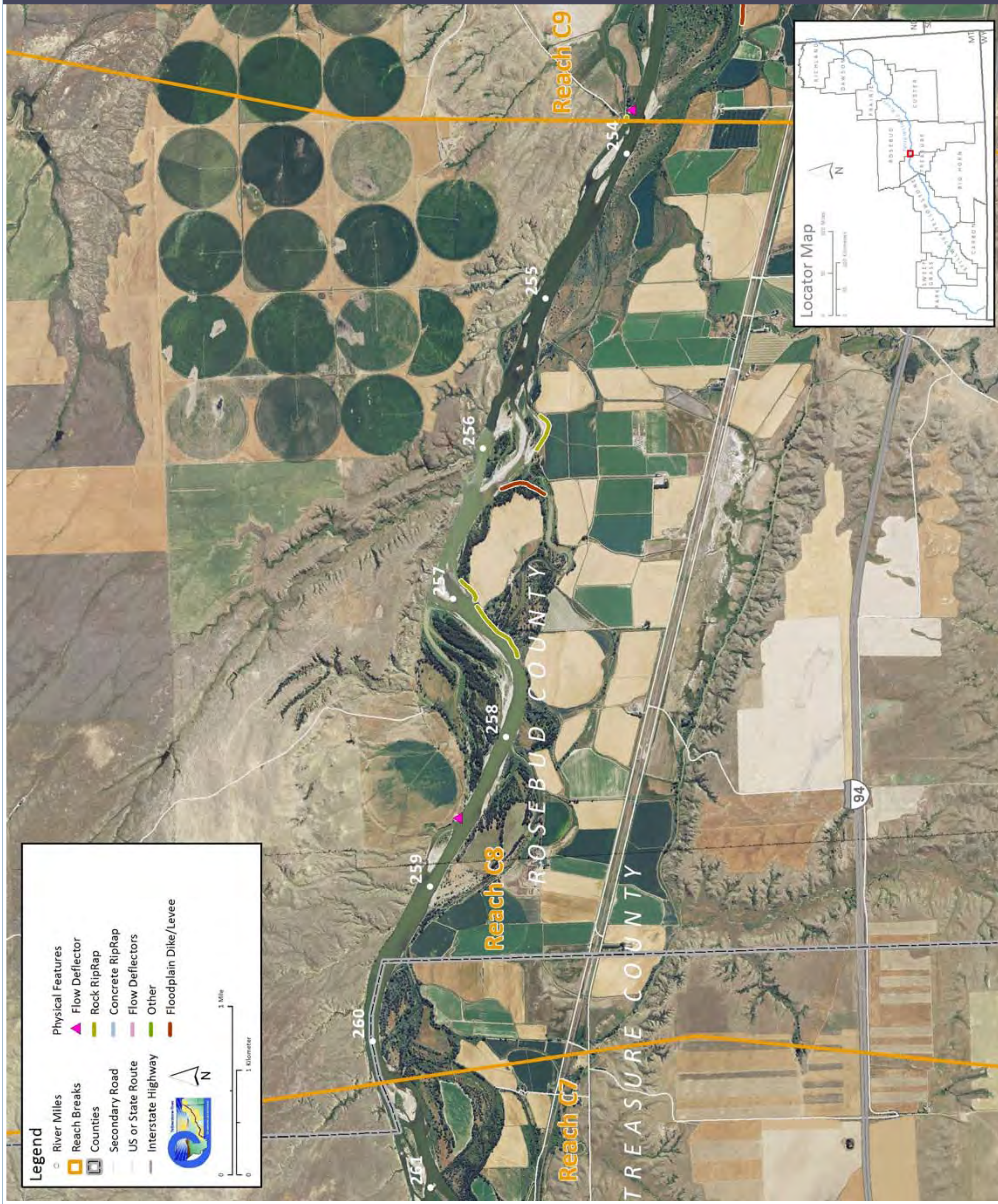
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	43.4	0.9%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

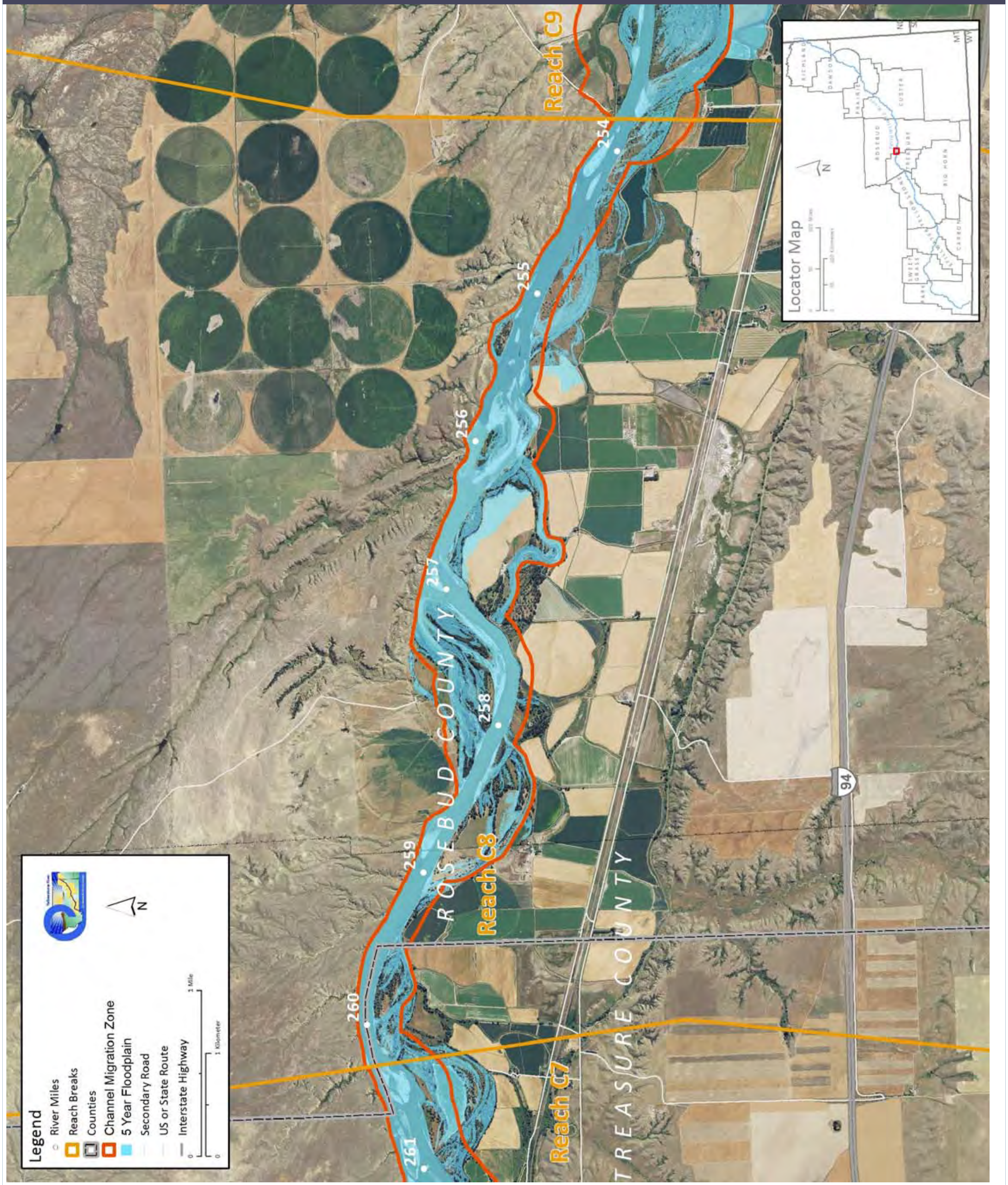
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	50.7	36.3	60.9	10.3

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Rosebud	**Upstream River Mile**	253.8
Classification	UA: Unconfined anabranching	**Downstream River Mile**	243.1
General Location	Hammond Valley	**Length**	10.70 mi (17.22 km)

Narrative Summary

Reach C9 is 10.7 miles long and is located in the Hammond Valley upstream of Forsyth. The Hammond Valley is an unusually wide segment of the Yellowstone River corridor, similar to the Mission Valley near Hysham. These two valleys owe their shape to the presence of the Bearpaw Shale in the valley wall, which is relatively erodible and prone to mass failure. Because the Mission and Hammond Valleys are so wide, the river has developed a complex series of channels and an expansive riparian forest. These reaches are especially rich in terms of aquatic and riparian habitat extent, diversity, and geomorphic complexity. Reach C9 is an Unconfined Anabranching (UA) reach type, which is typically the most complex and dynamic reach type on the river.

Flow alterations in Reach C9 have been driven primarily by changes in flows on the Bighorn River and water use for irrigation. The 2-year discharge, which is an important flow statistic because it approximately defines the channel capacity, has dropped by 14,400 cfs, or 23.5%, due to flow alterations on the river. That reduction in flow has been accompanied by a reduction in the bankfull channel area, or channel size, by 209 acres since 1950.

There is over 10,000 feet of rock riprap in Reach C9, as well as 1,100 feet of flow deflectors. This reach experienced severe bank erosion during the 2011 flood when some banks migrated several hundred feet. In response to that erosion, several thousand feet of bank armor were constructed after 2001, mostly on the south side of the river. This riprap represents both new projects and extensions on older projects. Some flow deflectors in the reach were flanked during the flood and now sit in the middle of the river. Other impacts in Reach C9 include almost four miles of side channel that have been blocked by dikes. This loss is due to the blockage of one very long side channel on the north side of the corridor that was clearly active in 1950, but by 1976 was plugged on its upper end.

The combination of bank armoring and reduced energy due to flow alterations has resulted in a reduced floodplain turnover rate in Reach C9 from 22.2 acres per year to 12.9 acres per year. The area of open bar habitat mapped under low flow conditions dropped by almost 100 acres since 1950, reflecting riparian expansion into the channel, reduced sediment recruitment from banks, and reduced sediment loading from the Bighorn River.

Over 40% of the land area that was historically inundated by a 5-year flood now remains dry during that frequency event. Most of these isolated areas currently typically flood irrigated fields, some of which were riparian forest in the 1950s. The vast majority of irrigated land in Reach C9 is under flood irrigation (3,900 acres) while 515 acres are under pivot. In the upstream end of the reach, pivots on either side of the river extend into the Channel Migration Zone. About 6% of the total CMZ has been restricted by physical features.

There are several animal handling facilities in Reach C9 that are adjacent to the main river channel or smaller side channels, tributaries, or swales. These are located at RM 252L (side channel), RM 248L (tributary), and RM 245R (main channel).

Reach C9 was sampled as part of the avian study. A total of 73 bird species were identified in the reach. Five bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were found, the Black and White Warbler, Dickcissel, Plumbeous Vireo, Ovenbird, and Chimney Swift. Three Species of Concern (SOC) were identified, the Black-billed Cuckoo, Bobolink, and Red-headed Woodpecker. With the expansion of agriculture in the reach, the extent of forest at low risk of cowbird parasitism dropped from 108 acres per valley mile in 1950 to 64 acres per valley mile in 2001.

Reach C9 has 74 acres of mapped Russian olive, which appears to be concentrated on the banks of isolated side channels and sloughs, but also distributed through cottonwood forest in the downstream portion of the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,720 cfs to 3,020 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46%.

CEA-related observations in Reach C9 include:
- Reduced floodplain and riparian turnover rates due to flow alterations and bank armoring
- Lost side channel extent due to side channel plugs
- Expansion of Russian olive into abandoned side channels and riparian forest
- 5-year floodplain isolation due to agricultural dikes and flow alterations
- Encroachment of pivot irrigation into Channel Migration Zone
- Increased risk of cowbird parasitism with agricultural expansion

Recommended Practices for Reach C9 include:
- Side channel reactivation at RM 252L
- Nutrient management associated with animal handling facilities at RM 252L, RM 248L, and RM 245R.
- Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	61,300	46,900	-23.5%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	121,000	101,000	-16.5%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,562.4	1,537.8	1,336.0	1,353.3	-209.1	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	10,283	9.1%	4,427	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	1,113	1.0%	160	
Total	**11,396**	**10.1%**	**4,587**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	19,348	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	576.1	323.2	384.59 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	22.2	12.9		
Acres/Year/Valley Mile	2.9	1.7		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-71.6	17	-44.2	-98.8	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	2,045.9	43%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	300.4	5%	

Restricted Migration Area	Acres	% of CMZ	
	333.2	6%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	8,021.5	8,458.6	Flood (Ac)	3,895.4	3,498.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	88.2	312.0	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.9	27.5	Pivot (Ac)	0.0	515.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	115.4	104.6				

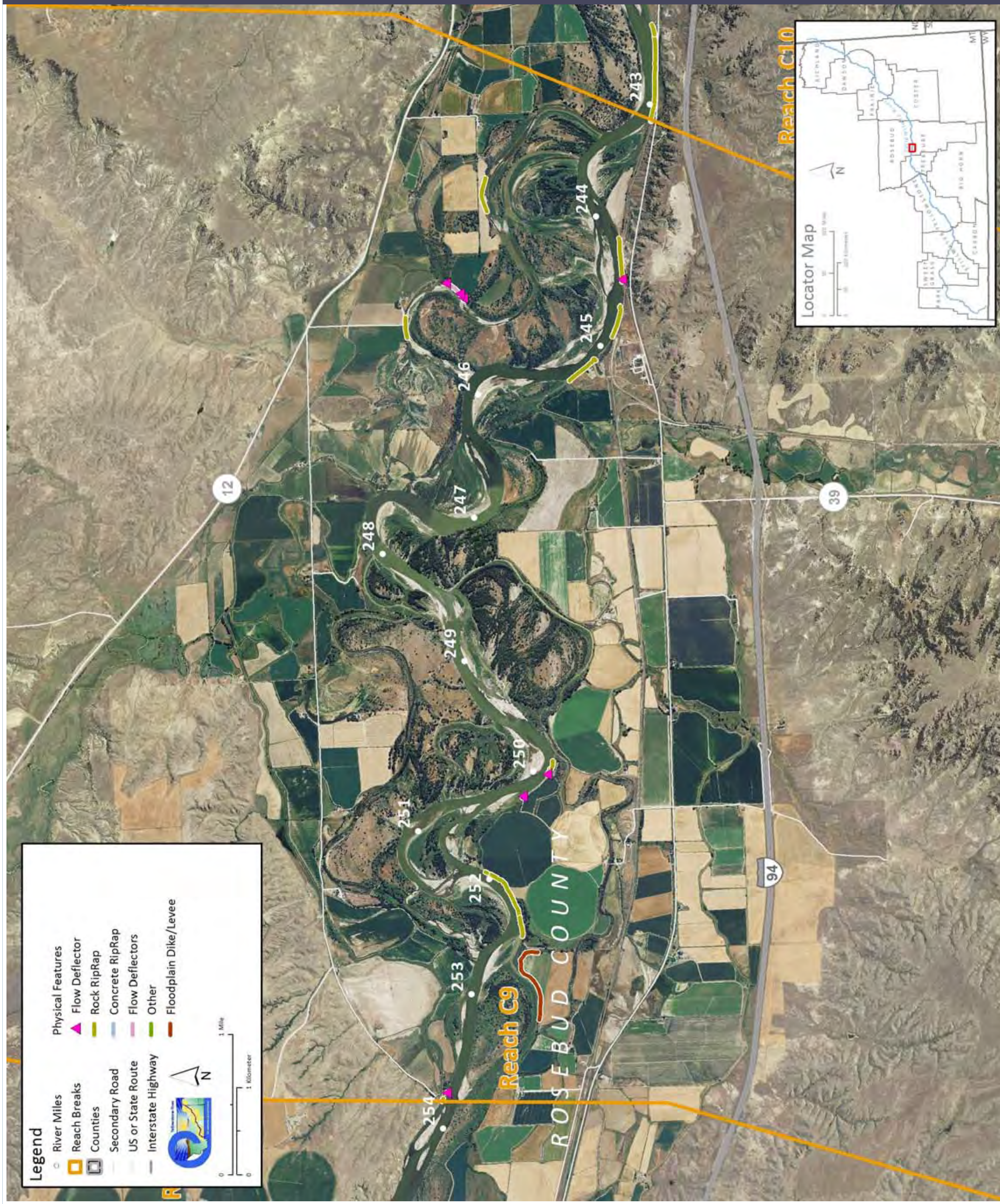
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	253.9	0.0	253.9	8.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	29.2	3.8	**582.1**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	308.5	40.0		
Scrub/Shrub	244.4	31.7		

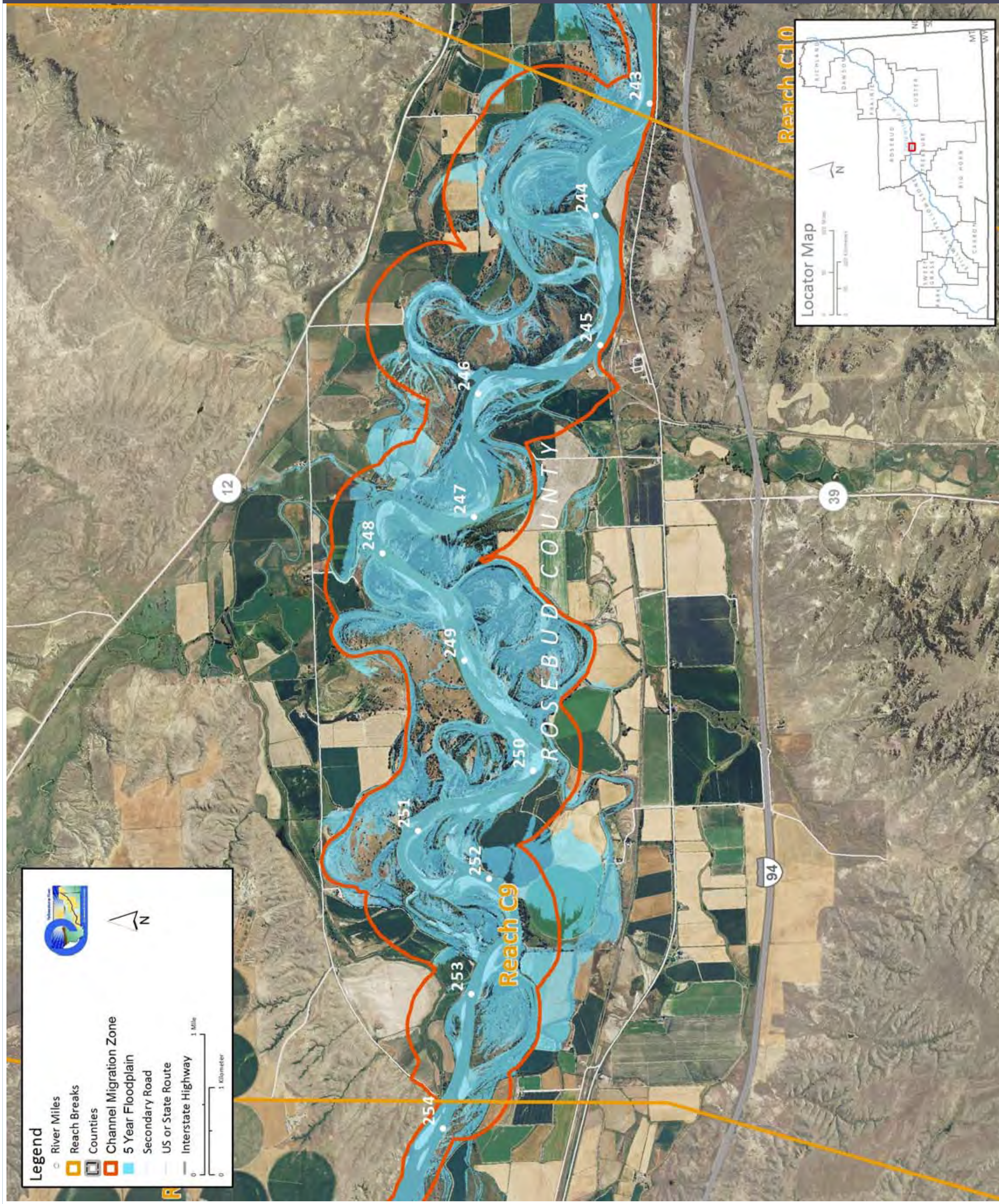
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	74.0	0.7%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	108.0	65.4	64.1	-44.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Rosebud	**Upstream River Mile**	243.1
Classification	PCM: Partially confined meandering	**Downstream River Mile**	236.3
General Location	Forsyth	**Length**	6.80 mi (10.94 km)

Narrative Summary

Reach C10 is 6.8 miles long and is located at Forsyth. It is a Partially Confined Meandering reach type, as the river flows within a primary meandering thread that is partially confined by the northern bluff line at the Forsyth Bridge.

There is approximately three miles of rock riprap in the reach, 500 feet of which was built since 2001. About a mile of armor is protecting the active rail line on the south side of the river, and another 3,700 feet are protecting the city of Forsyth. Just below Cartersville Dam, a ~330 ft long stretch of bank armor was flanked sometime between 2001 and 2011. The river has since migrated to the south about 50 feet past the abandoned armor. As of 2011 there were 1,600 feet of flow deflectors mapped in the reach. About 22% of the total bankline is armored by either rock riprap or flow deflectors. There is also about a mile of floodplain dikes/levees in the reach, which are located on the south bank at Forsyth.

Cartersville Dam is located at RM238.5 in the town of Forsyth. This diversion dam was constructed in the early 1930's and consists of a rock rubble riprap core that is capped by concrete. The structure is 800 feet long, spanning the width of the Yellowstone River. The river flows within a single thread at the structure, flowing along the northern bluff line of the Yellowstone River valley. Because of its impacts on the Yellowstone River fishery, efforts have begun to develop suitable alternatives and bypass designs to promote fish passage at Cartersville.

About 20% of the total 100-year floodplain has become isolated due to human development. The isolation is due to a combination of floodplain dikes that protect the city of Forsyth and the active railroad. The 5-year floodplain is even more affected; 50% of the historic 5-year floodplain is no longer inundated at that frequency. Most of the isolated 5-year floodplain area is occupied by flood irrigated fields north of the river, and by urban development in Forsyth. At RM 238 the river is migrating northward, and has reached the toe of the abandoned Milwaukee Rail Line embankment. Migration through this grade will increase floodplain access on the north side of the river downstream of Cartersville Dam. As this is an urban reach, strategic floodplain reconnection in this area could be beneficial.

One ice jam was reported in Reach C10 in February of 1996. No damages were reported.

Land use is dominated by agriculture (~4,700 acres), with 280 acres of pivot irrigation development since 1950. There is about 850 acres of urban/exurban development in the reach. About 4% of the CMZ is restricted by physical features, and most of that area is in town.

There are 250 acres of Russian olive in the reach, most of which is dispersed in riparian areas. Russian olive densities are especially high downstream of Cartersville Diversion dam on the south bank of the river near the water treatment plant.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,730 cfs to 3,020 cfs with human development, a reduction of 36%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320cfs under regulated conditions, a reduction of 46%.

CEA-Related observations in Reach C10 include:
- Floodplain isolation due to urban/exurban development.
- Extensive Russian olive colonization in urbanized reach

Recommended Practices for Reach C10 include:
- Floodplain reconnection at RM 238L behind abandoned Milwaukee rail line.
- Diversion structure management at Cartersville Dam
- Watercraft passage at Cartersville Dam
- Fish Passage at Cartersville Dam
- Flanked bank armor removal at RM238.4R
- Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	61,300	46,900	-23.5%
100 Year (cfs)	121,000	101,000	-16.5%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
647.9	683.5	628.3	629.8	-18.2

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	14,306	19.8%	493
Concrete Riprap	0	0.0%	0
Flow Deflectors	1,648	2.3%	-262
Total	**15,953**	**22.1%**	**231**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	92.4	61.3
Acres/Year	3.6	2.5
Acres/Year/Valley Mile	0.6	0.4

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

32.02 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	-11.2	-7	-11	-29.2

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	1,118.9	50%
100 Year	635.9	20%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
72.6	4%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	5,392.3	4,716.9
Ag. Infrastructure (Ac)	28.7	103.6
Exurban (Ac)	0.0	141.6
Urban (Ac)	483.8	728.0
Transportation (Ac)	107.1	247.6

	1950	2011
Flood (Ac)	904.3	874.1
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	278.3

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
0.0	20.5	20.5	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	11.6	1.9
Emergent	89.6	14.8
Scrub/Shrub	30.1	5.0

Total Wetland Acres **131.2**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
250.5	5.7%

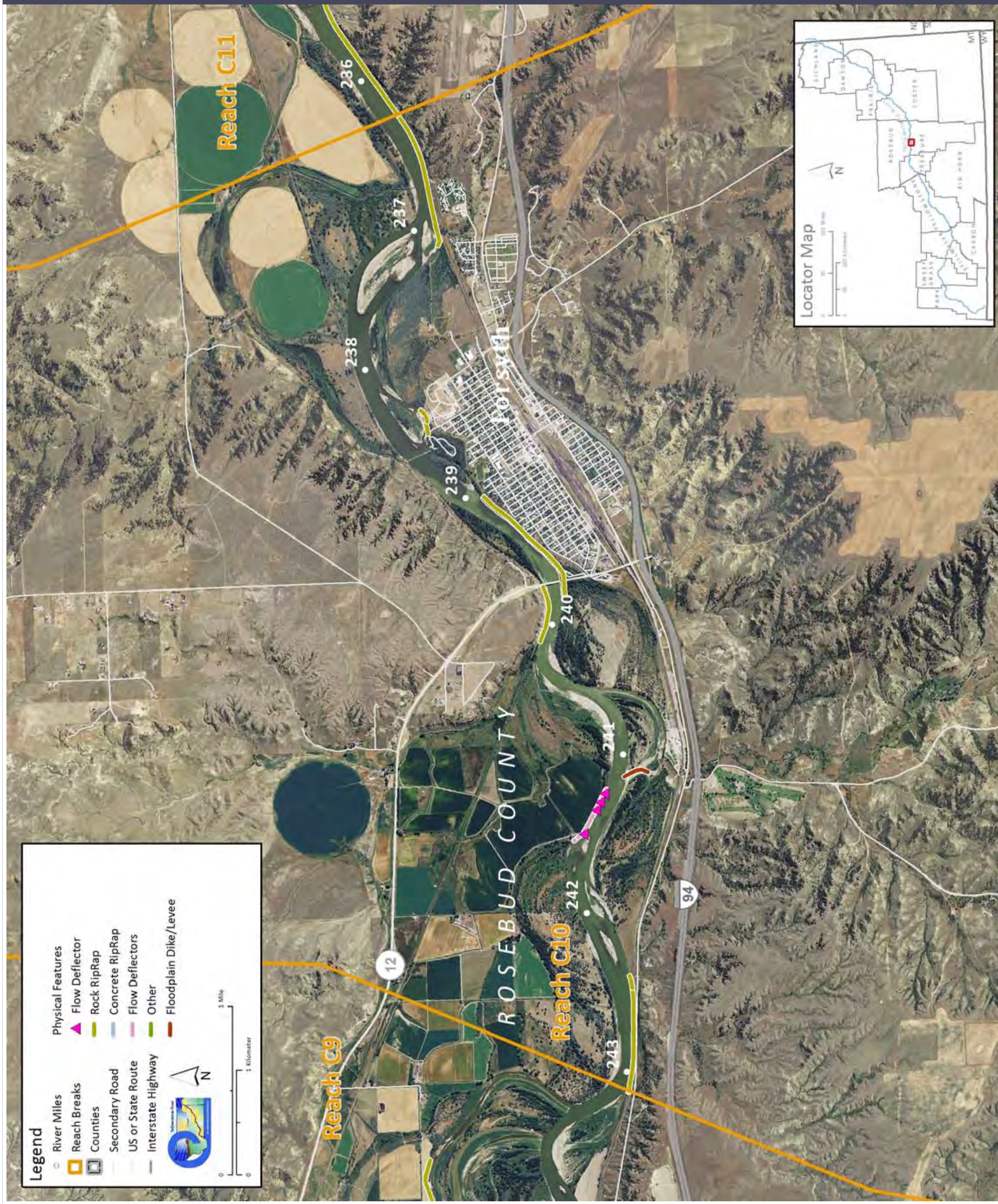
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

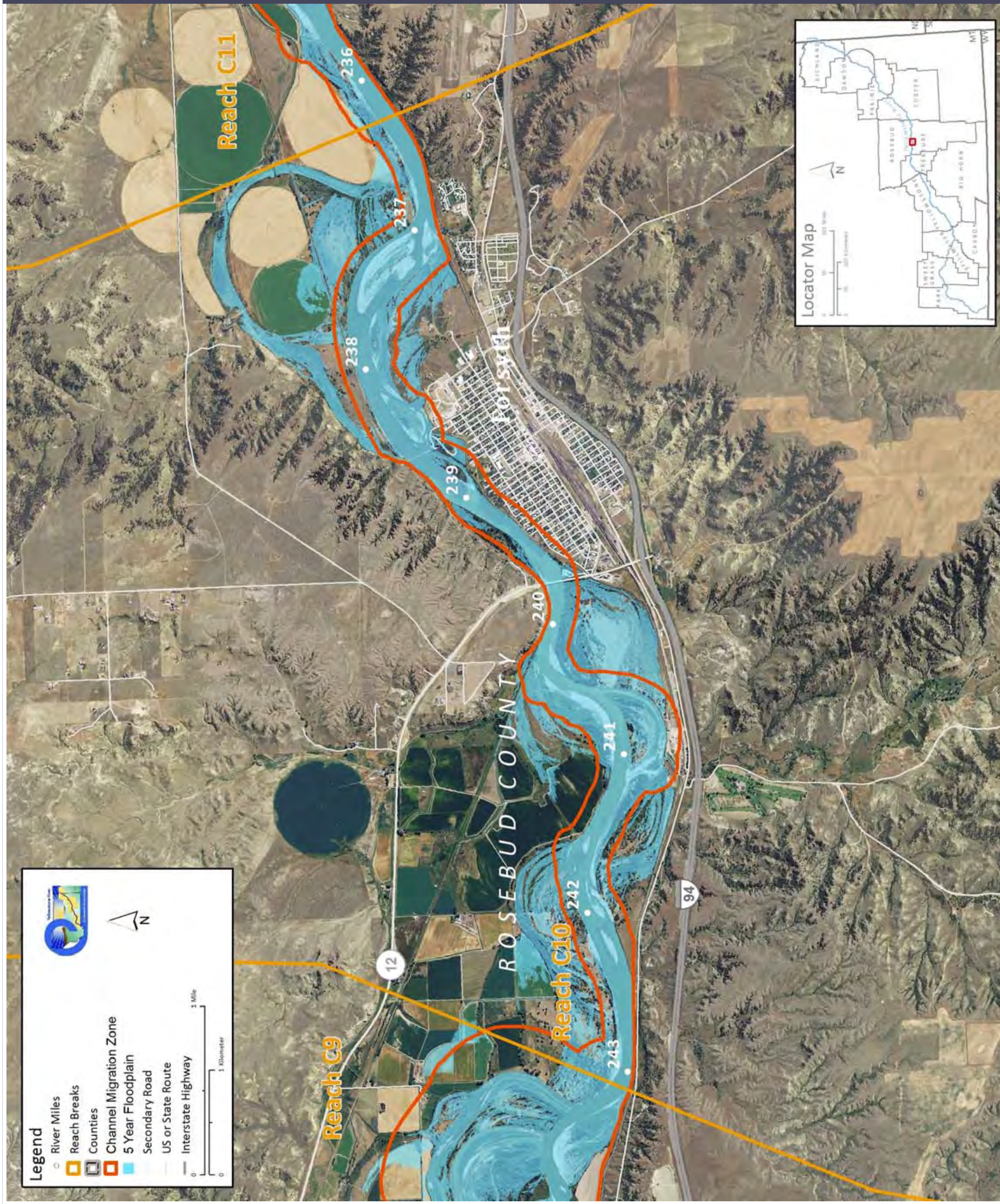
1950	1976	2001	Change 1950-2011
82.0	15.1	20.2	-61.8

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Rosebud	**Upstream River Mile**	236.3
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	225
General Location	Forsyth to Cartersville Bridge	**Length**	11.30 mi (18.19 km)

Narrative Summary

Reach C11 is located in Rosebud County, just downstream from the community of Forsyth. The reach is an 11.3 mile long Partially Confined Meandering channel type, extending from RM 225.0 to RM 236.3. The partial confinement is imposed by bedrock bluffs south of the river. The floodplain area north of the river has become isolated by about 9 miles of abandoned railroad grade. Rosebud Creek enters the Yellowstone River in the lowermost end of the reach from the south, and Little Porcupine Creek and Horse Creek flow in from the north. The Far West fishing access is located on the north bank at the downstream end of the reach. Reach C11 is relatively dynamic with most erosion and bank migration occurring on the downstream limbs of major meanders.

In Reach C11, the river commonly runs along the southern bluff line that is made up of Cretaceous age Lance Formation and Hell Creek Formation. The BNSF line follows this edge of the valley, and as a result much of the bluff line is armored. According to Womack (2001), the Hell Creek Formation in this area consists of resistant cemented sandstone that forms a 12 foot cap over claystone, which is subject to small slumps on the very steep slope below the rail line, thus driving the need for bank armor. Bank migration is also very active in the reach; at RM 229 for example, the river has migrated almost 700 feet southward since 1950 and is now within 100 feet of the rail line.

As of 2011 there were over 4.5 miles of bank armor protecting about 20% of the total bankline in Reach C11, and almost all of that armor is rock riprap protection against the active rail line. Since 2001, about 1,500 feet of flow deflectors have been built in the reach as well to protect irrigated fields on the north bank. Physical features mapping indicates the loss of 500 feet of car bodies between 2001 and 2011 at RM230.1L; where the bank has eroded behind the car bodies which are now up to 70 feet out in the river. A ~500 ft long stretch of rock riprap on the north side of the river at RM 226.6R is currently protecting flood irrigated land, but is becoming flanked on its upstream end.

Reach C11 has seen major losses of side channels due to small floodplain dikes. Since 1950, 4.3 miles of side channel have been blocked. Three major side channels have dikes blocking them; at RM232R across from the mouth of Porcupine Creek, at RM 230L below the mouth of Horse Creek, and at RM 229 R. All of these channels appear to have good potential for reactivation. There are other older dikes that block swales that could also be potentially reactivated (e.g. RM234R).

Similar to other reaches downstream of the Bighorn River confluence, the river channel has become smaller in Reach C11 since 1950. In 2001, the bankfull footprint was about 130 acres smaller than it was in 1950, and riparian mapping shows over 200 acres of riparian encroachment into old channel areas. Floodplain turnover rates are also lower; from 1950-1975 the average annual rate of floodplain turnover was 9.3 acres per year, and since 1975 it has been 6.4 acres per year.

On the north side of the river, the abandoned Milwaukee rail line isolates extensive historic floodplain area. At the 100 year event, 767 acres of contiguous area is isolated by the old rail line embankment, accounting for 17% of the mapped 100-year floodplain area. Just upstream of the mouth of Horse Creek, however, the river has migrated through the embankment. That erosion through the embankment will continue as the river is actively flanking rock riprap at the mouth of Horse Creek. The active BNSF line also isolates pockets of historic floodplain on the south side of the river.

A total of 328 acres of land that would normally be in the river’s natural Channel Migration Zone (CMZ) have become restricted by physical features, which represents about 9% of the total CMZ area.

Land uses in Reach C11 are predominantly agricultural, with some conversion from flood irrigation to pivot since 1950. As of 2011 there were about 450 acres under pivot irrigation in the reach, and 76 of those acres are within the 5-year floodplain. Pivot irrigation has also encroached into the CMZ; about 65 acres that were developed for pivot are within the CMZ footprint. This area under pivot is at RM 227.5R, where a large pivot field has been developed in the core of a major meander. Irrigation development included riparian clearing; between 1950 and 2011 about 124 acres of riparian area was cleared for irrigation, which is 8% of the total 1950s riparian area.

Reach C11 hosts a relatively dense concentration of wetlands; there are almost 40 acres of wetland per valley mile in the reach, most of which is emergent marshes and wet meadows. There are also 183 acres of mapped Russian olive in the reach, which is distributed throughout the riparian zone and locally concentrated in blocked side channels.

Reach C11 was sampled as part of the fisheries study. A total of 27 species were sampled in the reach, including Sauger and Blue Sucker, both of which have been identified as Species of Concern by the Montana Natural Heritage Program.

Reach C11 was also sampled as part of the avian study. A total of 42 bird species were identified in the reach, including three Species of Concern: The Chimney Swift, Ovenbird, and Plumbeous Vireo. Reach C11 has seen a reduction in the extent of riparian forest considered at low risk of cowbird parasitism. In 1950, there were 31.3 acres of such forest per valley mile, and by 2001 that forest extent had dropped to 19.8 acres per valley mile.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,820 cfs to 3,060 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,300 cfs under unregulated conditions to 3,370cfs under regulated conditions, a reduction of 47%.

Fall and winter base flows have increased in Reach C11 by about 60%.

CEA-Related observations in Reach C11 include:
•Extensive floodplain isolation by the abandoned Milwaukee rail line on the north bank.
•Extensive blocking of side channels
•A regionally high extent of Russian olive possibly associated with the loss of side channels.
•Extensive armoring with CMZ encroachment
•Flanking of car bodies
•Active flanking of riprap

Recommended Practices for Reach C11 include:
•Removal of car bodies in river at RM 230.1L
•Side channel reactivation at RM 232R, RM 230L, and RM 229 R.
•Floodplain reconnection behind abandoned railroad grade RM231L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	61,800	47,200	-23.6%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	120,000	99,000	-17.5%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,314.1	1,280.1	1,149.5	1,190.3	-123.8	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	22,607	18.8%	816	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	1,511	1.3%	1,511	
Total	**24,118**	**20.1%**	**2,328**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	22,745	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	241.5	159.1	211.61 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	9.3	6.4		
Acres/Year/Valley Mile	1.1	0.7		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-50.3	41.6	44.5	35.9	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	1,289.7	51%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	1,123.9	25%	

Restricted Migration Area	Acres	% of CMZ	
	328.1	9%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	8,045.7	8,737.7	Flood (Ac)	3,056.3	2,655.9	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	67.8	86.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	451.4	
Urban (Ac)	2.0	2.0				
Transportation (Ac)	148.6	123.6				

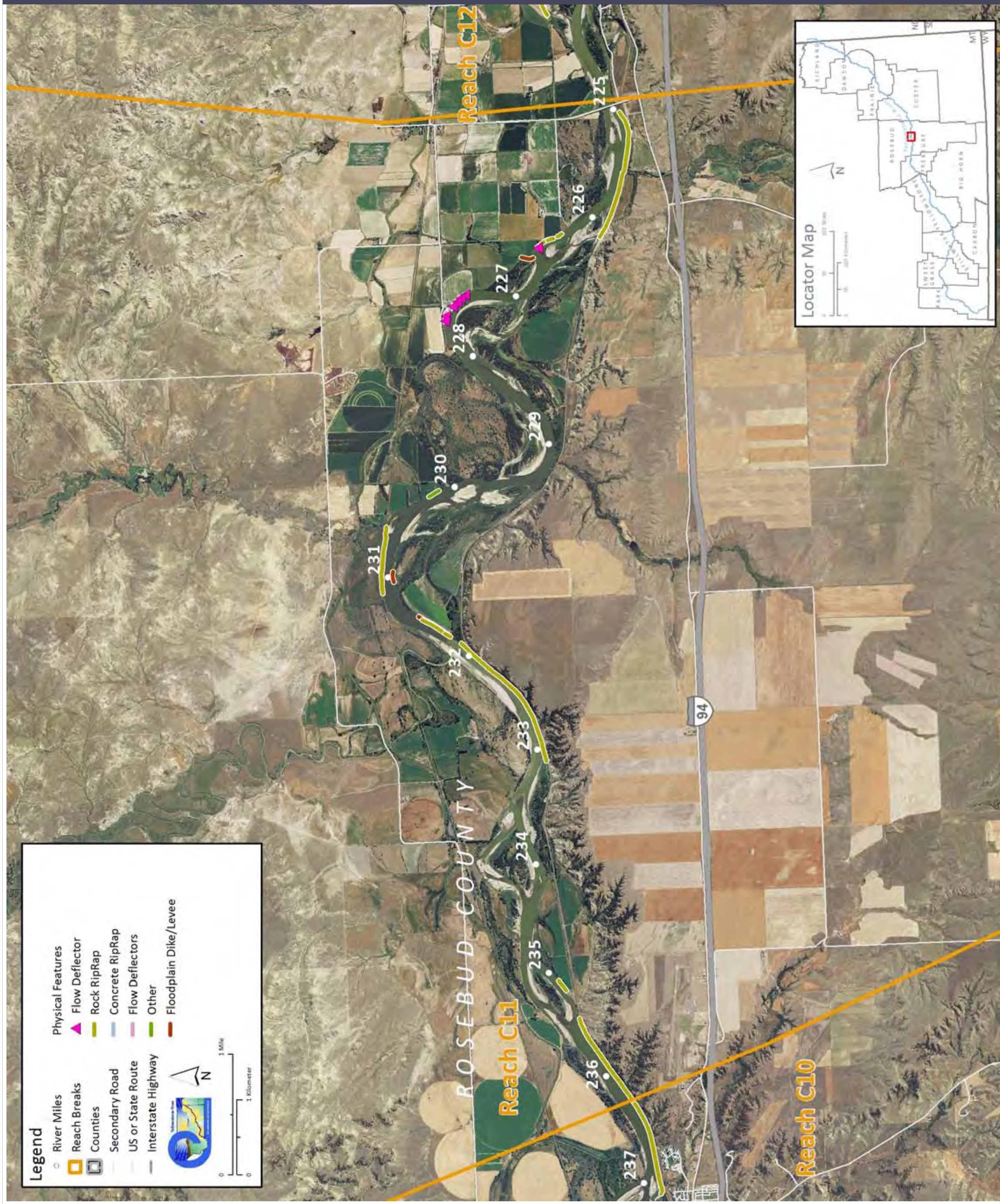
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	123.5	1.7	125.1	8.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	51.2	5.8	**356.8**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	230.5	26.1		
Scrub/Shrub	75.1	8.5		

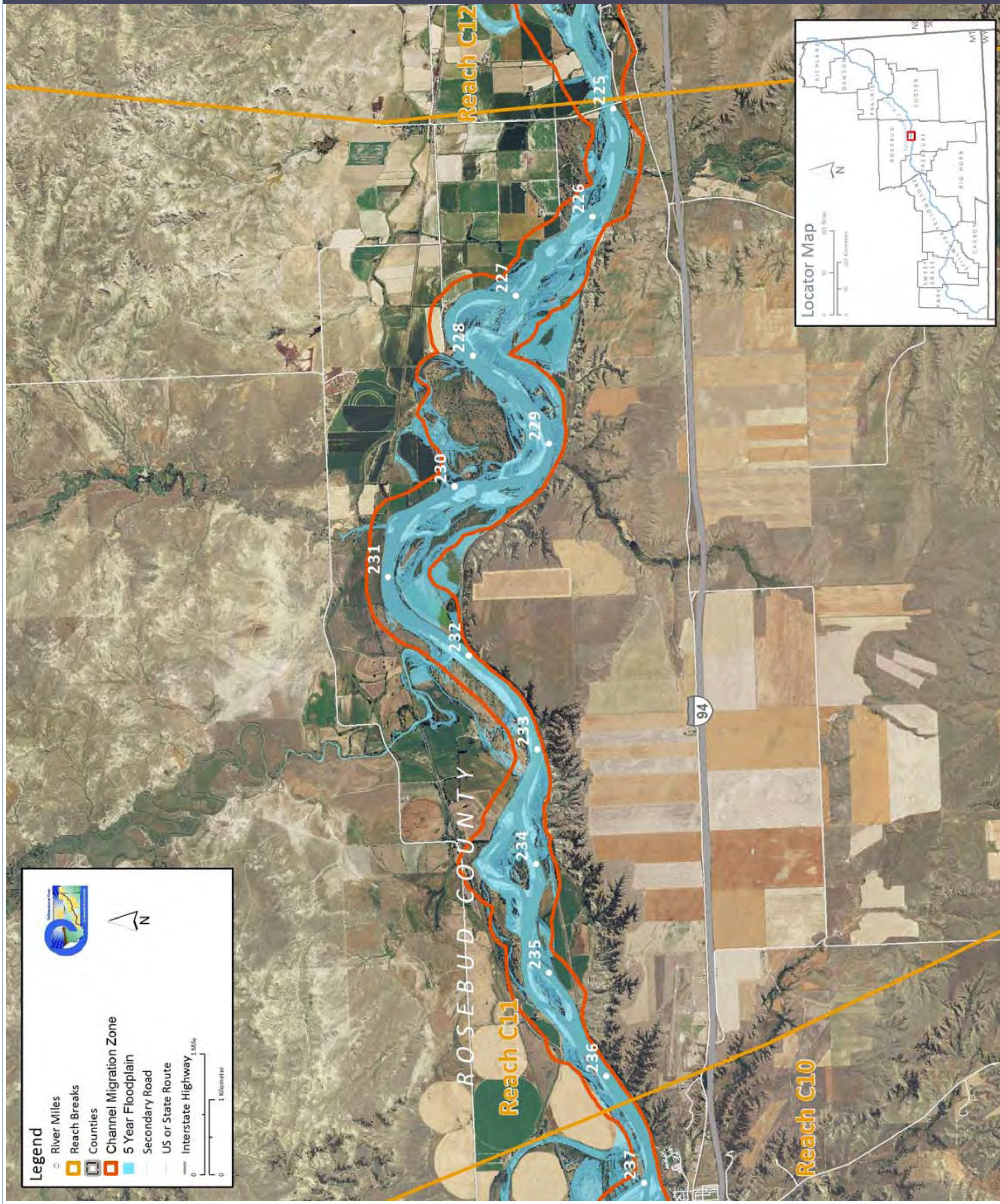
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	182.6	2.3%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	31.3	22.5	19.8	-11.5	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Rosebud	**Upstream River Mile**	225
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	214.8
General Location	Rosebud	**Length**	10.20 mi (16.42 km)

Narrative Summary

Reach C12 is 10.2 miles long and extends from the Rosebud Bridge at RM 225 downstream to RM 215. The reach classified as Partially Confined Meandering with Islands (PCM/I), indicating some influence of the valley wall, a main meandering channel thread, and numerous meander cutoffs that have generated large islands. The reach is relatively dynamic; at RM 221.5 for example the river has migrated over 900 feet to the northwest since 1950. At RM 217.2R, the river migrated over 300 feet between 2001 and 2011. Most of the rapid migration is on the outer edges (apexes) and downstream limbs of large meanders.

As of 2011 there were 4,700 feet of bank armor protecting about 4% of the total bankline in Reach C12, and almost all of that armor is rock riprap. About one half of the armor was built between 2001 and 2011. One short section (200ft) of flow deflectors was also built between 2001 and 2011. The bank armor is protecting agricultural land and the active rail line. Almost 2,000 feet of the mapped bank armor is north of the town of Rosebud on a channel that has been largely abandoned. This channel abandonment has focused flows in the south channel, which currently flows against the town of Rosebud which has minimal erosion protection.

Prior to 1950, about ½ miles of side channel in Reach C12 were blocked. One short channel is just upstream of the town of Rosebud, and a much longer channel is on the south side of the river at RM 219R.

Similar to other reaches downstream of the Bighorn River confluence, the river channel has become smaller in Reach C12 since 1950. In 1950, the bankfull footprint was about 56 acres larger than it was in 2001, and riparian mapping shows over 211 acres of riparian encroachment into old channel areas. Some of that encroachment has been onto mid-channel bars; there was a net loss of 36 acres of open bars since 1950. Floodplain turnover rates are also lower; from 1950-1975 the average annual rate of floodplain turnover was 8.9 acres per year, and since 1975 it has been 5.8 acres per year.

Over a thousand acres of the 100-year floodplain has become isolated from the river, most of which is north of the abandoned rail line. Several pockets of historic 100-year floodplain have also been isolated on the south side of the river between the rail line and bluff area. In total, 29% of the entire historic 100-year floodplain has become isolated. Isolation of the 5-year floodplain has been even more substantial; 1,340 acres or 47% of the 5-year floodplain has become isolated at that event. Much of this isolated 5-year floodplain is on flood irrigated fields north of the river.

A total of 216 acres of land that would normally be in the river's natural Channel Migration Zone (CMZ) have become restricted by physical features, which represents about 6% of the total CMZ area. At Rosebud, 59 acres of urban/exurban land has been mapped within the CMZ.

Land uses in Reach C12 are predominantly agricultural, with some conversion from flood irrigation to pivot since 1950. As of 2011 there were about 430 acres under pivot irrigation in the reach, and 197 of those acres are within the 5-year floodplain. Pivot irrigation has also encroached into the CMZ; about 200 acres that were developed for pivot are within the CMZ footprint. Irrigation development largely occurred prior to 1950, but additional development since then has included riparian clearing; between 1950 and 2011 about 45 acres of riparian area was cleared for irrigation, which is 5% of the total 1950s riparian area.

One animal handling facility was mapped at RM 222L that extends to the river bank.

There are 206 acres of mapped Russian olive in the reach, which is distributed throughout the riparian zone.

Reach C12 was sampled as part of the fisheries study. A total of 37 species were sampled in the reach, including Sauger and Blue Sucker, both of which have been identified as Species of Concern by the Montana Natural Heritage Program.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 17% and the 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,830 cfs to 3,060 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,310 cfs under unregulated conditions to 3,380cfs under regulated conditions, a reduction of 46%.

Fall and winter base flows have increased in Reach C12 by about 60%.

CEA-Related observations in Reach C12 include:
•Extensive floodplain isolation by the abandoned Milwaukee rail line on the north bank.
•Blocking of side channels

Recommended Practices for Reach C12 include:
•Side channel reactivation at RM 219 R.
•Floodplain reconnection behind abandoned railroad grade RM220L
•Nutrient management at Animal Handling Facility at RM 222L

- Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	61,900	47,300	-23.6%
100 Year (cfs)	120,000	98,900	-17.6%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
1,087.9	1,069.8	1,020.0	1,033.1	-54.8

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	4,510	4.2%	1,833
Concrete Riprap	0	0.0%	0
Flow Deflectors	192	0.2%	192
Total	**4,702**	**4.4%**	**2,025**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
9,079	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	230.2	145.9
Acres/Year	8.9	5.8
Acres/Year/Valley Mile	1.1	0.7

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

211.32 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	-40	49.8	-45.7	-36

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	1,339.7	47%
100 Year	1,237.1	29%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
216.0	6%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	7,038.5	7,052.1
Ag. Infrastructure (Ac)	76.1	128.5
Exurban (Ac)	0.0	1.6
Urban (Ac)	61.1	59.5
Transportation (Ac)	162.9	136.7

	1950	2011
Flood (Ac)	3,834.0	2,866.5
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	429.5

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
45.4	2.5	47.9	5.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	23.3	2.9
Emergent	122.7	15.3
Scrub/Shrub	84.4	10.6

Total Wetland Acres **230.4**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
205.6	2.8%

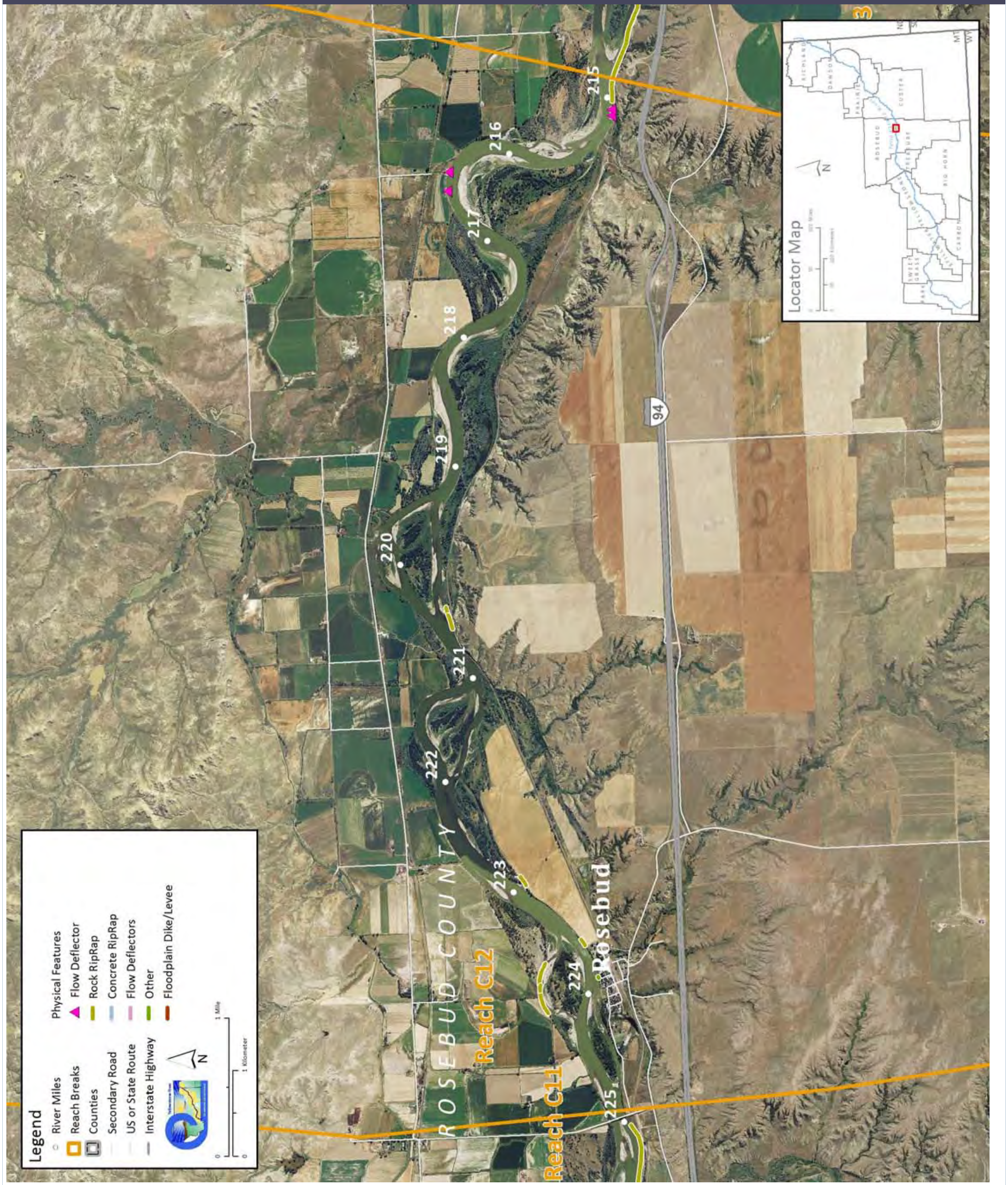
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

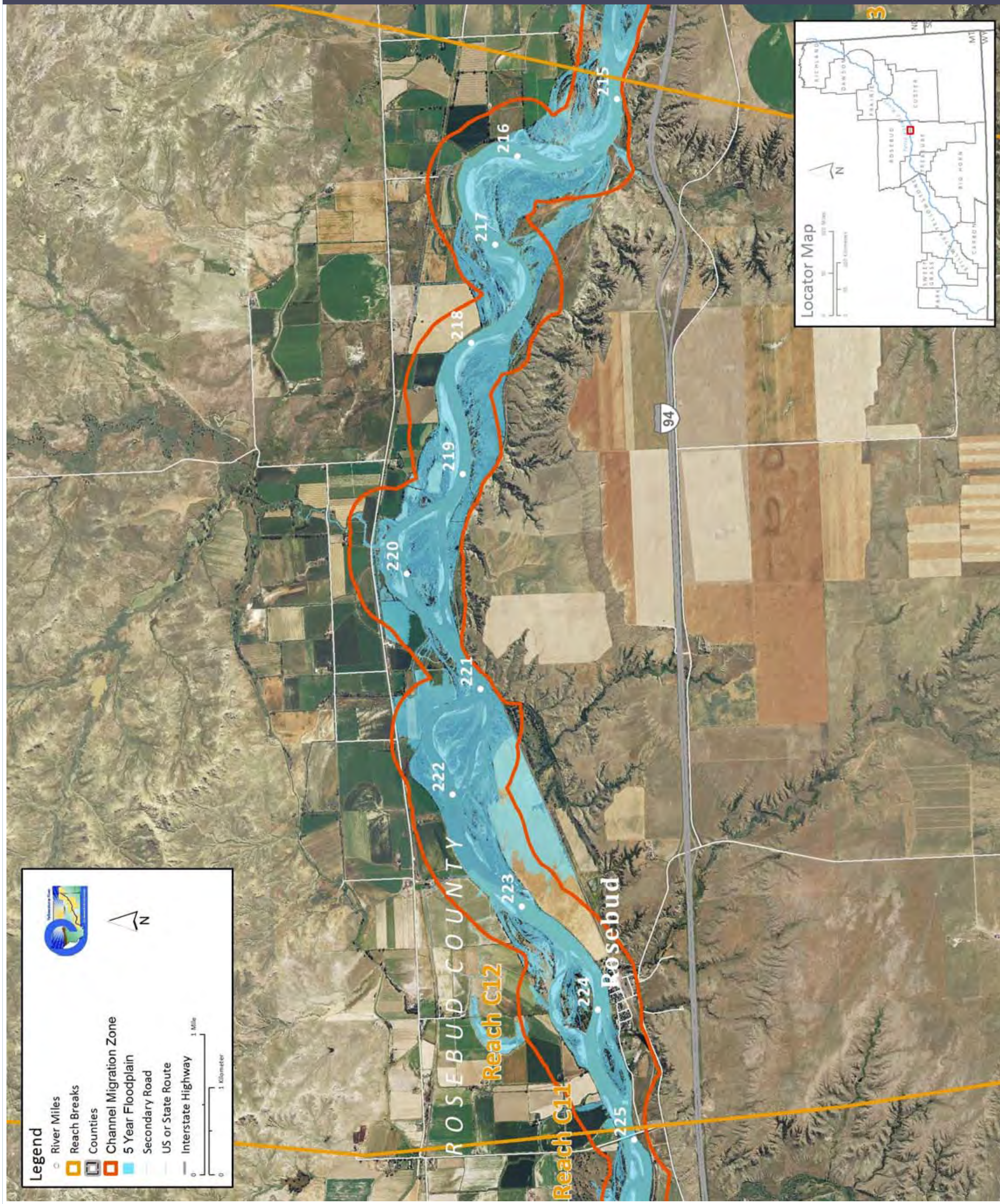
1950	1976	2001	Change 1950-2011
18.8	14.2	31.0	12.2

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Rosebud	**Upstream River Mile**	214.8
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	208.1
General Location	Hathaway	**Length**	6.70 mi (10.78 km)

Narrative Summary

Reach C13 is 6.7 miles long and extends from RM 215 to RM 208 in Rosebud County. The reach classified as Partially Confined Meandering with Islands (PCM/I), indicating some influence of the valley wall, a main meandering channel thread, and numerous meander cutoffs that have generated large islands. Within this reach the river crosses the valley bottom from the southern bluff line in the upper portion of the reach to the northern bluff line downstream. The length of river between bluff lines is about three miles. Reach C13 locally exhibits very rapid meander migration; at RM 211 for example, the river has migrated 960 feet to the northwest over the last 50 years. At this location the river is now within 65 feet of the abandoned Milwaukee rail line which forms a defacto flood control levee on the north side of the river.

As of 2011 there were about three miles of riprap and flow deflectors protecting 26% of the total bankline in Reach C13, including 13,400 feet of rock riprap, 750 feet of concrete riprap, and 4,600 feet of flow deflectors. Most of the rock riprap is protecting the rail line on the south bluff line and the abandoned rail line on the north bluff line. Another 1,350 feet of bankline is protected by old car bodies at RM 201R. All of the flow deflectors, concrete riprap, and car bodies are protecting irrigated fields. Between 2001 and 2011, about 4,000 feet of flow deflectors that were mapped at RM 212.3R were evidently destroyed. It is difficult to tell from the imagery alone whether all of these flow deflectors were flanked, however at RM 212.0, flow deflectors are sitting in the river about 60 feet off of the bank.

Since 1950, a side channel that is about 4,600 feet long was blocked at RM 211.5R. This channel cuts through the core of a large meander, and appears to be naturally reactivating as the bendway translates down the river valley.

Similar to other reaches downstream of the Bighorn River confluence, the river channel has become smaller in Reach C13 since 1950. In 1950, the bankfull footprint was about 76 acres larger than it was in 2001, and riparian mapping shows about 120 acres of riparian encroachment into old channel areas. Floodplain turnover rates are also slightly lower; from 1950-1975 the average annual rate of floodplain turnover was 5.0 acres per year, and since 1975 it has been 4.1 acres per year.

Over 600 acres of the 100-year floodplain has become isolated from the river due to flow alterations, agricultural development, and the abandoned railroad grade. In total, 20% of the entire historic 100-year floodplain has become isolated. Isolation of the 5-year floodplain has been even more substantial; 921 acres or 45% of the 5-year floodplain has become isolated at that frequency event. Much of this isolated 5-year floodplain is on flood irrigated fields both north and south of the river.

One ice jam was reported in the reach as a break-up event that occurred on March 15, 2011. No damages were reported.

A total of 221 acres of land that would normally be in the river’s natural Channel Migration Zone (CMZ) have become restricted by physical features, which represents about 11% of the total CMZ area.

Land uses in Reach C13 are predominantly agricultural, with some conversion from flood irrigation to pivot since 1950. As of 2011 there were about 330 acres under pivot irrigation in the reach. Irrigation development largely occurred prior to 1950, but additional development since then has included riparian clearing; between 1950 and 2011 about 133 acres of riparian area was cleared for irrigation, which is 11% of the total 1950s riparian area.

There are 216 acres of mapped Russian olive in the reach, which is notably concentrated in abandoned side channels. Reach C13 also has fairly extensive mapped wetlands; there are over 32 mapped wetland acres per valley mile in the reach, most of which is emergent marsh and wet meadows in floodplain swales.

Reach C13 was sampled as part of the fisheries study. A total of 27 species were sampled in the reach, including Sauger and Blue Sucker, both of which have been identified as Species of Concern by the Montana Natural Heritage Program.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 18% and the 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,840 cfs to 3,070 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,320 cfs under unregulated conditions to 3,380cfs under regulated conditions, a reduction of 47%.

Fall and winter base flows have increased in Reach C13 by about 60%.

CEA-Related observations in Reach C13 include:
•Floodplain isolation by the abandoned Milwaukee rail line on the north bank.
•Blocking of side channels
•Post-1950s riparian clearing for irrigation development

Recommended Practices for Reach C13 include:

- Removal of flanked barb at RM 212.
- Side channel reactivation at RM 211.6 R.
- CMZ Management due to extent of CMZ restriction (11%)

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	61,900	47,300	-23.6%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	120,000	98,800	-17.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	783.2	689.3	711.3	707.5	-75.7	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	13,403	18.8%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	744	1.0%	0	
Flow Deflectors	4,567	6.4%	-3,969	
Total	**18,714**	**26.3%**	**-3,969**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	4,575	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	129.8	103.2	117.07 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	5.0	4.1		
Acres/Year/Valley Mile	0.8	0.7		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	18.4	23.4	-51	-9.1	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	920.7	45%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	640.6	20%	

Restricted Migration Area	Acres	% of CMZ	
	222.1	11%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	6,899.7	6,620.2	Flood (Ac)	3,571.5	2,411.6	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	60.1	132.9	Sprinkler (Ac)	0.0	0.1	
Exurban (Ac)	0.0	23.8	Pivot (Ac)	0.0	327.6	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	104.8	242.3				

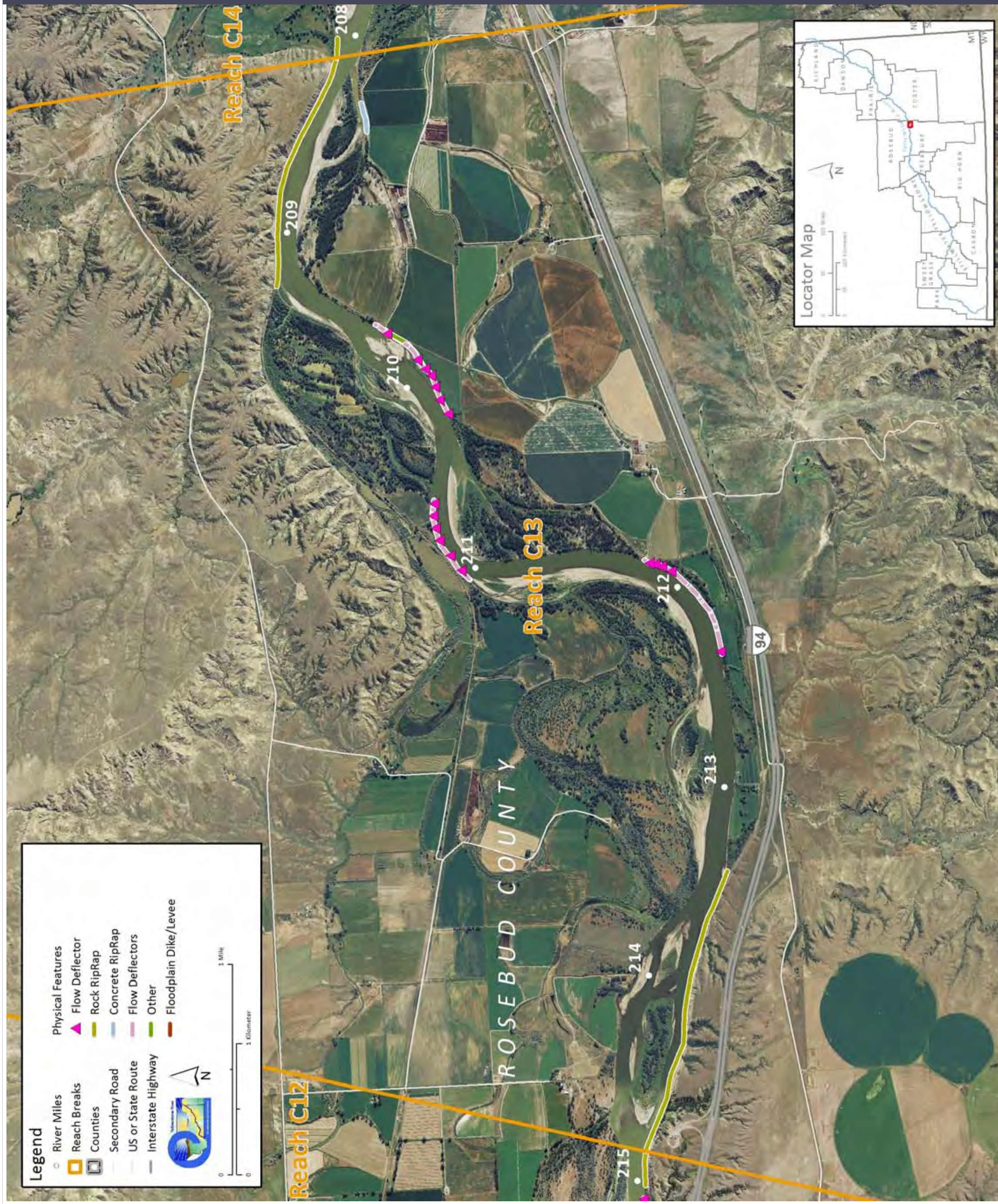
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	133.3	0.0	133.3	11.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	21.1	3.5	**209.6**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	134.3	22.5		
Scrub/Shrub	54.1	9.1		

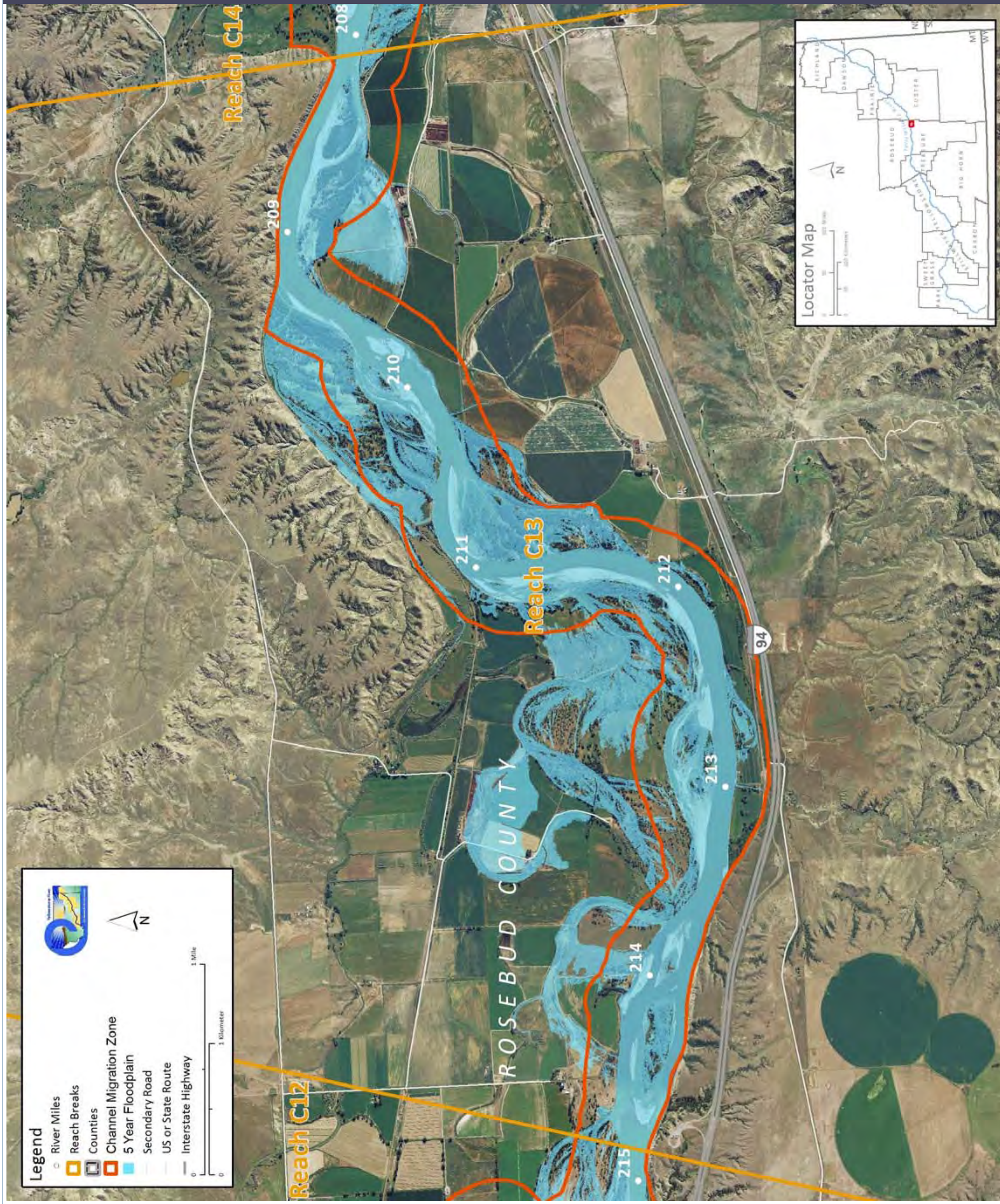
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	215.8	3.8%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	62.3	30.2	26.6	-35.7	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Rosebud	**Upstream River Mile**	208.1
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	195.9
General Location	Sheffield	**Length**	12.20 mi (19.63 km)

Narrative Summary

Reach C14 is 12.2 miles long and is located near Sheffield, which is about 15 miles upstream of Miles City. The reach straddles the Rosebud/Custer County Line. The reach is characterized by a dominant main thread that shows a distinct meandering pattern, with several islands persisting where meander bends have historically cut off. The river intermittently flows along the south valley wall. As a result it is classified as Partially Confined Meandering with Islands (PCM/I). In this section of river the valley bottom is consistently about 1.8 miles wide, and bound by Tertiary-age Fort Union Formation. The active meanderbelt of the Yellowstone River is about 3,000 feet wide.

The large meander features in Reach C14 have experienced significant migration since 1950 and also in recent years; one site at RM 204.5 migrated 977 feet southward between 1950 and 2001, and then over the next ten years continued to migrate another 400 feet so that it is now at the toe of the active rail line. At RM 200.5, the river has migrated 700 feet northward since 2001; eroding out irrigated lands and threatening structures.

As of 2011 there were about four miles of armor protecting 17% of the total bankline in Reach C14, including 15,087 feet of rock riprap and 6,300 feet of flow deflectors? Most of the rock riprap is protecting the rail line as it flows along the south bluff of Fort Union Formation, whereas flow deflectors are more commonly used to protect agricultural land. Between 2001 and 2011, about 3,000 feet of flow deflectors were evidently destroyed. Barbs can be seen in the river at RM 205.3R; the bank behind has since been partially armored with rock riprap. Another barb was flanked at RM 204.7L, and the river has migrated over 200 feet behind that structure towards the rail line. Another series of barbs were flanked at RM 203.6L and have since been replaced by rock riprap. Those flanked rock structures are visible on the 2011 air photos almost 200 feet out into the channel. At RM 200.8L, new riprap was built after older armor scoured out in 2011, which was followed by hundreds of feet of northward bank migration during the 2011 flood. Some of the new riprap appears to be trenched behind the bank. About 1,300 feet of rock riprap mapped in 2001 on the left bank at RM 196.9 has been flanked, and is now up to 70 feet out in the river.

Prior to 1950, about 3 miles of side channels were blocked in Reach C14. Chute channels formed through meander tabs have been blocked by small dikes such as at RM 198. Several historic anabranching channels appear to have been blocked prior to 1950 such as at RM 207.8. These areas provide excellent restoration/mitigation opportunities for side channel re-activation.

Similar to other reaches downstream of the Bighorn River confluence, the river channel has become smaller in Reach C14 since 1950. In 1950, the bankfull footprint was about 38 acres larger than it was in 2001, and riparian mapping shows about 208 acres of riparian encroachment into old channel areas. Floodplain turnover rates are also slightly lower; from 1950-1975 the average annual rate of floodplain turnover was 15.6 acres per year, and since 1975 it has been 12.5 acres per year.

Over two thousand acres of the 100-year floodplain has become isolated from the river due to flow alterations, agricultural development, and the abandoned railroad grade. In total, 40% of the entire historic 100-year floodplain has become isolated. Most of the isolation is associated with agricultural land development (29% of the historic floodplain), with another 10% of the isolation due to the abandoned rail grade. Isolation of the 5-year floodplain has been even more substantial; 2,321 acres or 59% of the 5-year floodplain has become isolated at that frequency event. Much of this isolated 5-year floodplain is on flood irrigated fields north of the river.

Bank armor on the north side of the river commonly narrows the natural meanderbelt of the river, which has resulted in large extents of the CMZ being restricted to migration. About 740 acres which represents 16% of the total CMZ has become restricted by physical features.

Four ice jams have been reported in the reach, including February of 1996, 1997, and 1998, and March of 2003. All of the ice jams in the 1990s were associated with lowland flooding

One dump site was mapped on the left bank at RM 196.3

Reach C14 has seen extensive riparian clearing since 1950s. Typically, riparian clearing for agriculture occurred prior to 1950 along the Yellowstone River. In this reach, however, 760 acres of riparian area were cleared since 1950, which represents 30% of the total 1950s riparian corridor. In several cases, this includes riparian clearing on large meander tabs. With this clearing, the reach has seen a substantial loss of forest area considered at low risk of cowbird parasitism. In 1950, the reach had 91.8 acres of such forest per valley mile and by 2001 that forest extent had dropped to 51.4 acres per valley mile.

Reach C14 has fairly extensive mapped wetland area; there are over 45 acres of mapped wetlands per valley mile, most of which is emergent marsh and wet meadow. A total of 22 acres of Russian olive were mapped in the reach, which reflects an abrupt reduction in Russian olive extent relative to upstream, where Reaches C10 through C13 have on the order of 200 acres of RO over similar valley distances.

Reach C14 was sampled as part of the fisheries study. A total of 36 species were sampled in the reach, including Sauger which has been identified as Species of Concern by the Montana Natural Heritage Program.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 18% and the 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted;

severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 3,070 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,330 cfs under unregulated conditions to 3,390cfs under regulated conditions, a reduction of 47%.

Fall and winter base flows have increased in Reach C14 by about 60%.

CEA-Related observations in Reach C14 include:
•Passive side channel abandonment due to flow alterations
•Flanking of barb structures on migrating meander bends
•Extensive floodplain isolation by agricultural dikes and abandoned railroad grade
•Pre-1950s blocking of side channels by agricultural dikes
•Armoring of bluff pool habitat against active railroad
•Floodplain isolation by the abandoned Milwaukee rail line on the north bank
•Post-1950s riparian clearing for irrigation development

Recommended Practices for Reach C14 include:
•Removal of flanked barb at RM 205.3
•Side channel reactivation at RM 208L
•CMZ Management due to extent of CMZ restriction (11%)
•Dump removal on left bank at RM 196.3L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	61,900	47,300	-23.6%
100 Year (cfs)	120,000	98,600	-17.8%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	1,355.6	1,388.0	1,289.0	1,318.2	-37.5

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	15,087	11.7%	1,773
Concrete Riprap	0	0.0%	0
Flow Deflectors	6,295	4.9%	-2,958
Total	**21,381**	**16.6%**	**-1,185**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	14,986	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	406.4	311.8
Acres/Year	15.6	12.5
Acres/Year/Valley Mile	1.6	1.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

207.7 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	-68.8	25.9	-32.3	-75.2

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	2,320.7	59%
100 Year	2,048.9	40%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	739.2	16%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	9,424.9	9,016.5
Ag. Infrastructure (Ac)	76.7	105.6
Exurban (Ac)	0.0	6.4
Urban (Ac)	0.0	0.0
Transportation (Ac)	130.9	171.4

	1950	2011
Flood (Ac)	2,516.5	3,398.1
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	660.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	755.3	4.8	760.1	30.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	48.6	5.0
Emergent	292.7	30.0
Scrub/Shrub	121.6	12.5

Total Wetland Acres **462.9**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

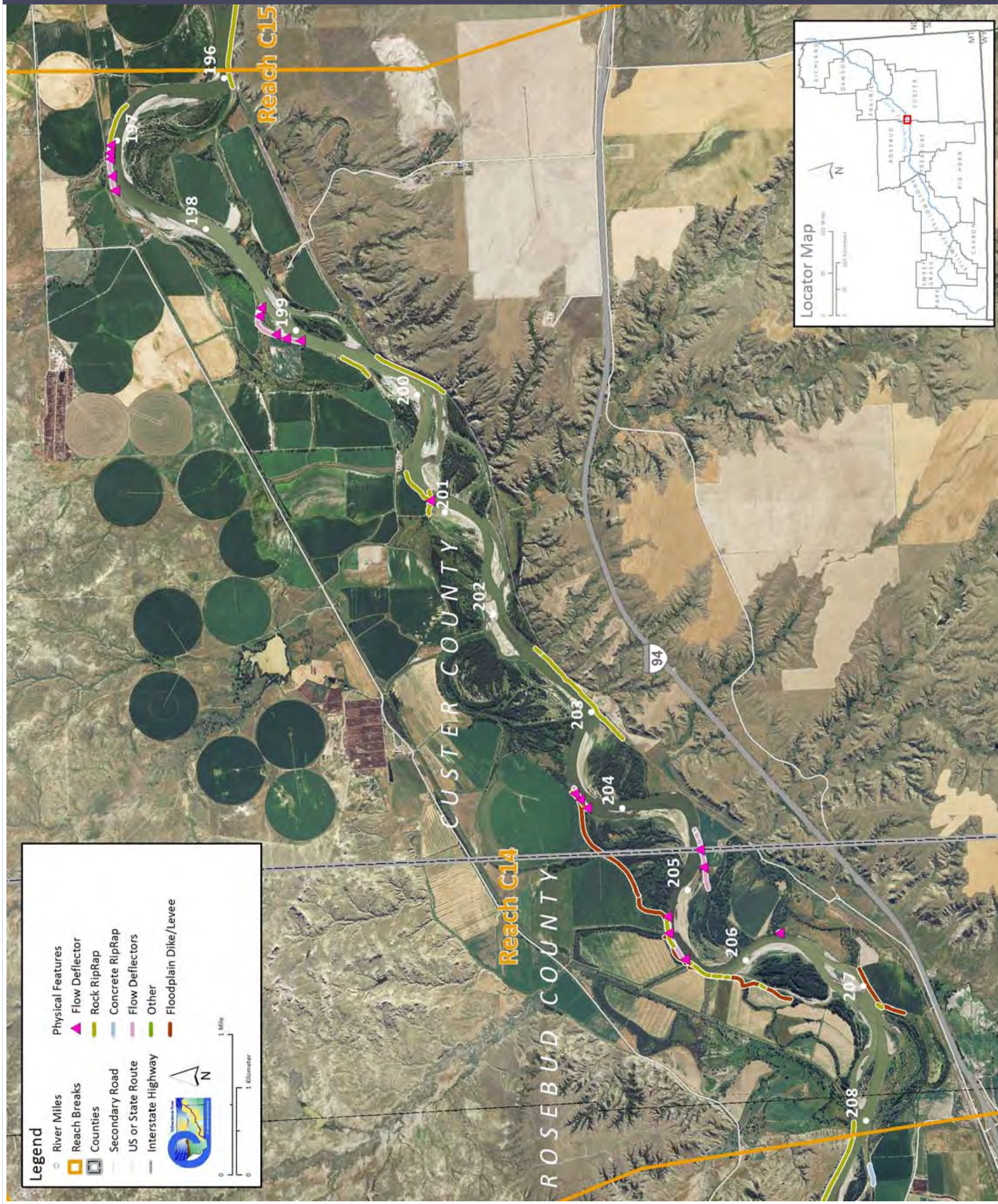
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	21.6	0.2%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

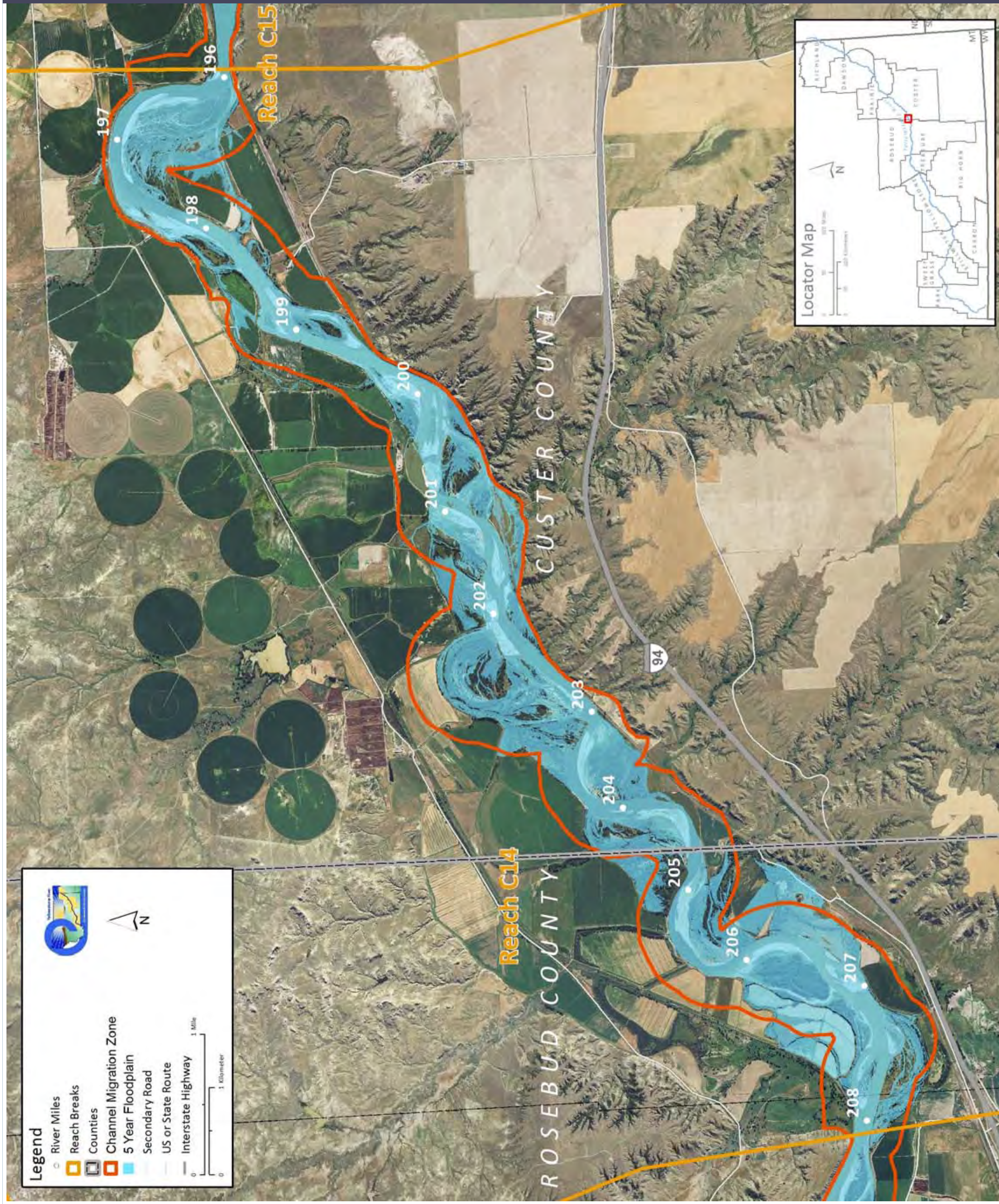
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	91.8	25.4	51.4	-40.4

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Custer	**Upstream River Mile**	195.9
Classification	PCS: Partially confined straight	**Downstream River Mile**	192.3
General Location	Horton Siding	**Length**	3.60 mi (5.79 km)

Narrative Summary

Reach C15 is located in Custer County at Horton Siding, about seven miles upstream of Miles City. It is 3.6 miles long and classified as a Partially Confined Straight (PCS) reach type, as the river has low sinuosity and flows along the south valley wall.

As of 2011 there were about 7,600 feet of armor protecting 19% of the total bankline in Reach C15, the vast majority of which is rock riprap protecting the rail line as it flows along the south bluff of Fort Union Formation. There are also minor amounts of flow deflectors (80 ft.) and car bodies (150 ft.) in the reach.

About 17% of the historic 100-year floodplain has become isolated. Isolation of the 5-year floodplain has been even more substantial; 298 acres or 61% of the 5-year floodplain has become isolated at that frequency event. Floodplain isolation appears to be mostly due to flow alterations, although there are35 acres if isolated 100-year floodplain behind the abandoned Milwaukee rail line embankment.

Reach C15 has lost approximately 3,000 feet of side channel length since 1950; although there is no indication that side channels were intentionally blocked.

There has been about 1,200 acres of pivot irrigation development in Reach C15 since 1950, and most of that expansion has occurred since 2001. Pivot irrigation is more extensive than flood irrigation in this area, which is somewhat unusual in the Yellowstone River valley. About 10% (115 acres) of the land under pivot irrigation is within the Channel Migration Zone (CMZ) of the river, making it especially prone to threats of river erosion.

Reach C15 has seen relatively extensive riparian clearing since 1950s. Typically, riparian clearing for agriculture occurred prior to 1950 along the Yellowstone River. In this reach, however, 48 acres of riparian area were cleared since 1950, which represents 20% of the total 1950s riparian corridor. With this clearing, the reach has seen a substantial loss of forest area considered at low risk of cowbird parasitism. In 1950, the reach had 51.3 acres of such forest per valley mile and by 2001 that forest extent had dropped to 37.2 acres per valley mile.

A total of 8 acres of Russian olive have been mapped in Reach C15.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 18% and the 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 3,070 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,340 cfs under unregulated conditions to 3,390cfs under regulated conditions, a reduction of 47%.

Fall and winter base flows have increased in Reach C15 by over 60%.

CEA-Related observations in Reach C15 include:
•Passive side channel abandonment due to flow alterations
•Extensive pivot irrigation development since 2001

Recommended Practices for Reach C15 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	62,000	47,300	-23.7%
100 Year (cfs)	120,000	98,600	-17.8%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	368.5	371.3	359.6	365.6	-2.8

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	7,578	19.2%	-235
Concrete Riprap	0	0.0%	0
Flow Deflectors	80	0.2%	80
Total	**7,658**	**19.4%**	**-155**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	43.6	23.1
Acres/Year	1.7	0.9
Acres/Year/Valley Mile	0.5	0.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

12.67 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	0	42.5	-7.5	35

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	298.3	61%
100 Year	168.3	17%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	15.5	2%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	3,770.6	3,729.5
Ag. Infrastructure (Ac)	6.4	53.7
Exurban (Ac)	0.0	0.0
Urban (Ac)	0.0	0.0
Transportation (Ac)	40.0	29.1

	1950	2011
Flood (Ac)	323.9	696.2
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	1,244.4

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	48.0	0.0	48.0	20.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	7.0	1.9
Emergent	25.5	7.1
Scrub/Shrub	14.4	4.0

Total Wetland Acres **46.9**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

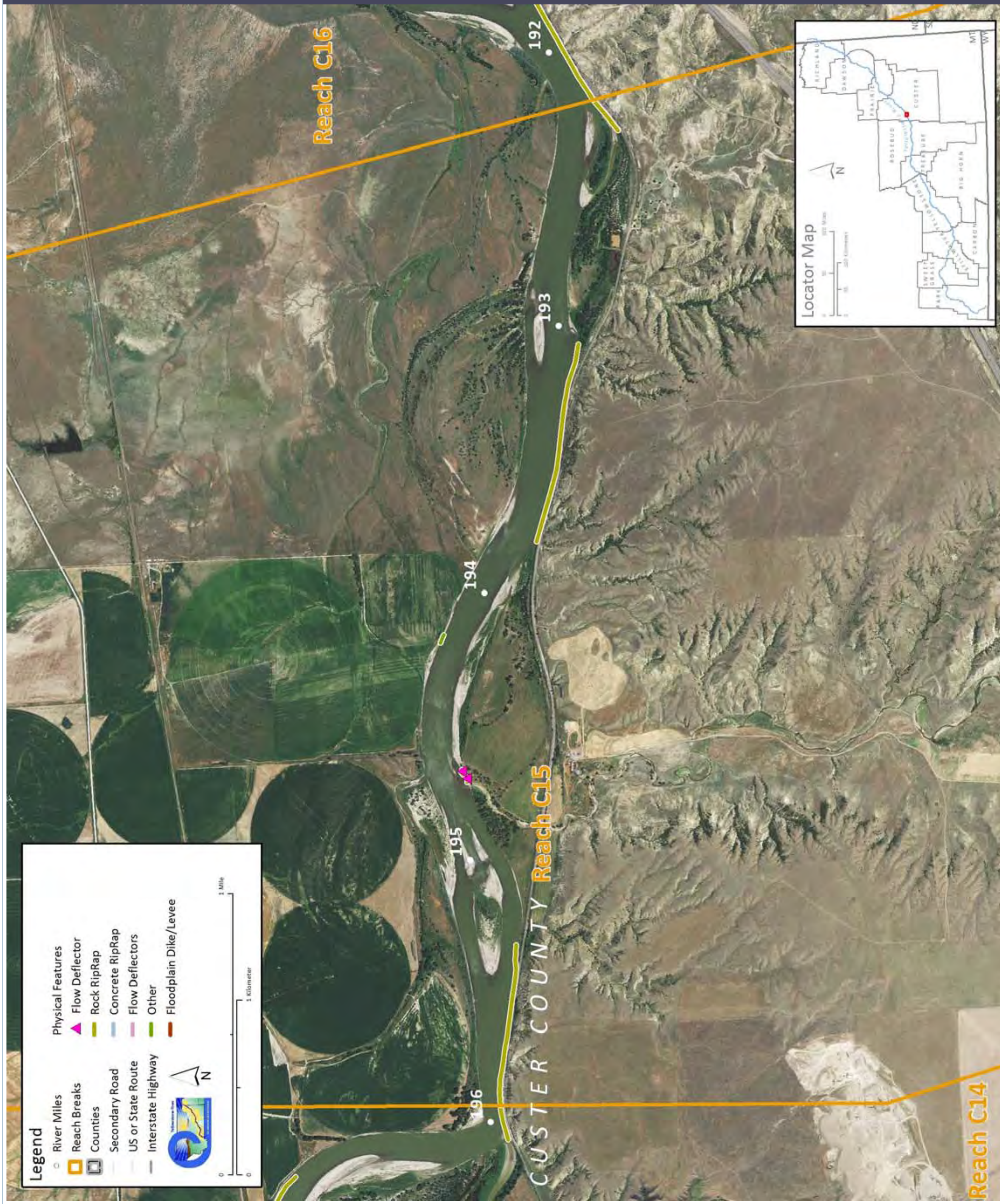
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	8.0	0.3%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

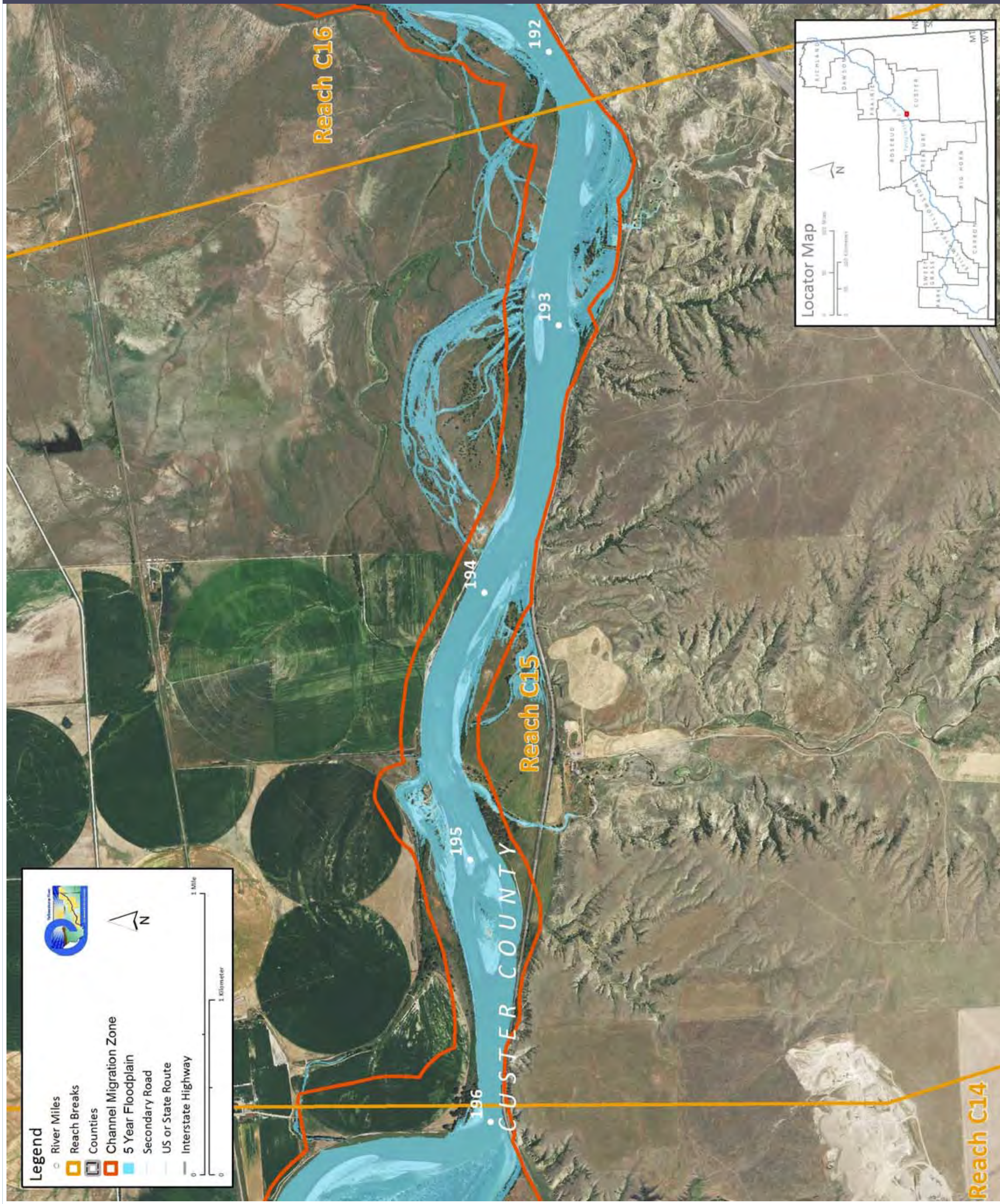
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	51.3	33.5	37.2	-14.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Custer	**Upstream River Mile**	192.3
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	185
General Location	to Miles City	**Length**	7.30 mi (11.75 km)

Narrative Summary

Reach C16 is 7.32 miles long and is located just upstream of Miles City. The downstream limit of the reach is the mouth of the Tongue River at RM 185. The reach is characterized by a dominant main thread that shows a distinct meandering pattern, with several islands persisting where meander bends have historically cut off. The river intermittently flows along the valley wall. As a result it is classified as Partially Confined Meandering with Islands (PCM/I).

As of 2011 there were about two miles of armor protecting 14% of the total bankline in Reach C16, including 7,000 feet of rock riprap, 2,200 feet of concrete riprap, and 1,550 feet of flow deflectors. All of the concrete armor is protecting urban areas around the water treatment plant in Miles City. The flow deflectors protect non-irrigated agricultural land, and the rock riprap is protecting agricultural land (irrigated and non-irrigated), roads, and the rail line. A ~550 ft long stretch of armor at RM 190.5R has been flanked since 2001, and erosion behind the armor now threatens a road; the river has locally eroded into the road embankment. There were also several miles of transportation encroachments and floodplain levees mapped in the reach.

About 13 % (308 acres) of the 100-year floodplain has become isolated from the river in Reach C16, meaning it is no longer inundated at what was historically a 100-year flood event. Isolation can be due to flow changes and/or physical features that block overflows from reaching floodplain areas. Most of the 100-year floodplain isolation (185 acres) is due to the active rail line. Isolation of the 5-year floodplain has been even more substantial, with 62% (721 acres) of the historic 5-year floodplain no longer inundated at what was historically a 5-year flood event.

Three ice jams have been reported in the reach, including February of 2011, and March of 2003 and 2012. No damages were reported in the ice jam database.

At RM 186.6 a steel trestle bridge built for the now abandoned Milwaukee Railroad crosses the river where it is about 1,000 feet wide. There are several very large barbs on the right bank of the river upstream of the bridge that extend about 100 feet off of the bank, and there is riprap directly under the structure.

About 210 acres which represents 9% of the total CMZ has become restricted by physical features. Areas that have become restricted to channel migration include the water treatment plant just upstream of the mouth of the Tongue River, behind the railroad grade at RM 191.5, and locally behind stretches of bank armor protecting irrigated and non-irrigated fields.

Mapped land uses in Reach C16 range from agricultural to urban to transportation infrastructure. The total acreage of flood irrigated land in the reach has dropped from 1,000 acres in 1950 to 830 acres in 2001; and during that time about 300 acres were developed for pivot. All of the pivot development occurred prior to 1976. Pivot irrigation has encroached into the active river corridor; approximately 27 acres of pivot-irrigated land is within the natural Channel Migration Zone (CMZ) of the river, making it especially susceptible to threats of river erosion. This pivot is at RM 190R, where a ~300 acre pivot field extends to within 150 feet of the river bank.

Reach C16 shows an increase in forest area considered to be at low risk of cowbird parasitism. In 1950, the reach had 54.5 acres of such forest per valley mile and by 2001 that forest extent had increased to 66.7 acres per valley mile.

A total of 170 acres of Russian olive were mapped in the reach, which is an abrupt increase relative to the two reaches upstream. The Russian olive is distributed throughout the riparian corridor but becomes more prolific in the downstream direction towards Miles City.

Reach C16 was sampled as part of the fisheries study. A total of 32 fish species were sampled in the reach, including Blue sucker, and Sauger which have been identified as Species of Concern by the Montana Natural Heritage Program.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 18% and the 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 3,070 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,340 cfs under unregulated conditions to 3,390cfs under regulated conditions, a reduction of 47%.

Fall and winter base flows have increased in Reach C16 by about 60%.

CEA-Related observations in Reach C16 include:
•Pivot irrigation encroachment into CMZ

Recommended Practices for Reach C16 include:
•Russian olive removal
•Removal of flanked rock riprap at RM 190.5R to prevent accelerated erosion behind

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	62,000	47,300	-23.7%
100 Year (cfs)	120,000	98,500	-17.9%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
848.9	841.5	827.6	839.3	-9.6

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	7,009	9.2%	221
Concrete Riprap	2,192	2.9%	0
Flow Deflectors	1,555	2.0%	-55
Total	**10,756**	**14.1%**	**166**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	120.7	119.2
Acres/Year	4.6	4.8
Acres/Year/Valley Mile	0.7	0.7

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

54.51 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	10.5	46.1	-3	53.6

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	721.5	62%
100 Year	308.2	13%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
210.4	9%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	6,183.9	6,007.7
Ag. Infrastructure (Ac)	91.9	159.1
Exurban (Ac)	74.5	3.7
Urban (Ac)	108.3	366.0
Transportation (Ac)	117.5	90.6

	1950	2011
Flood (Ac)	1,003.6	827.0
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	303.6

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
1.2	8.3	9.5	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	21.2	3.2
Emergent	94.7	14.3
Scrub/Shrub	23.1	3.5

Total Wetland Acres **139.1**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
170.2	3.7%

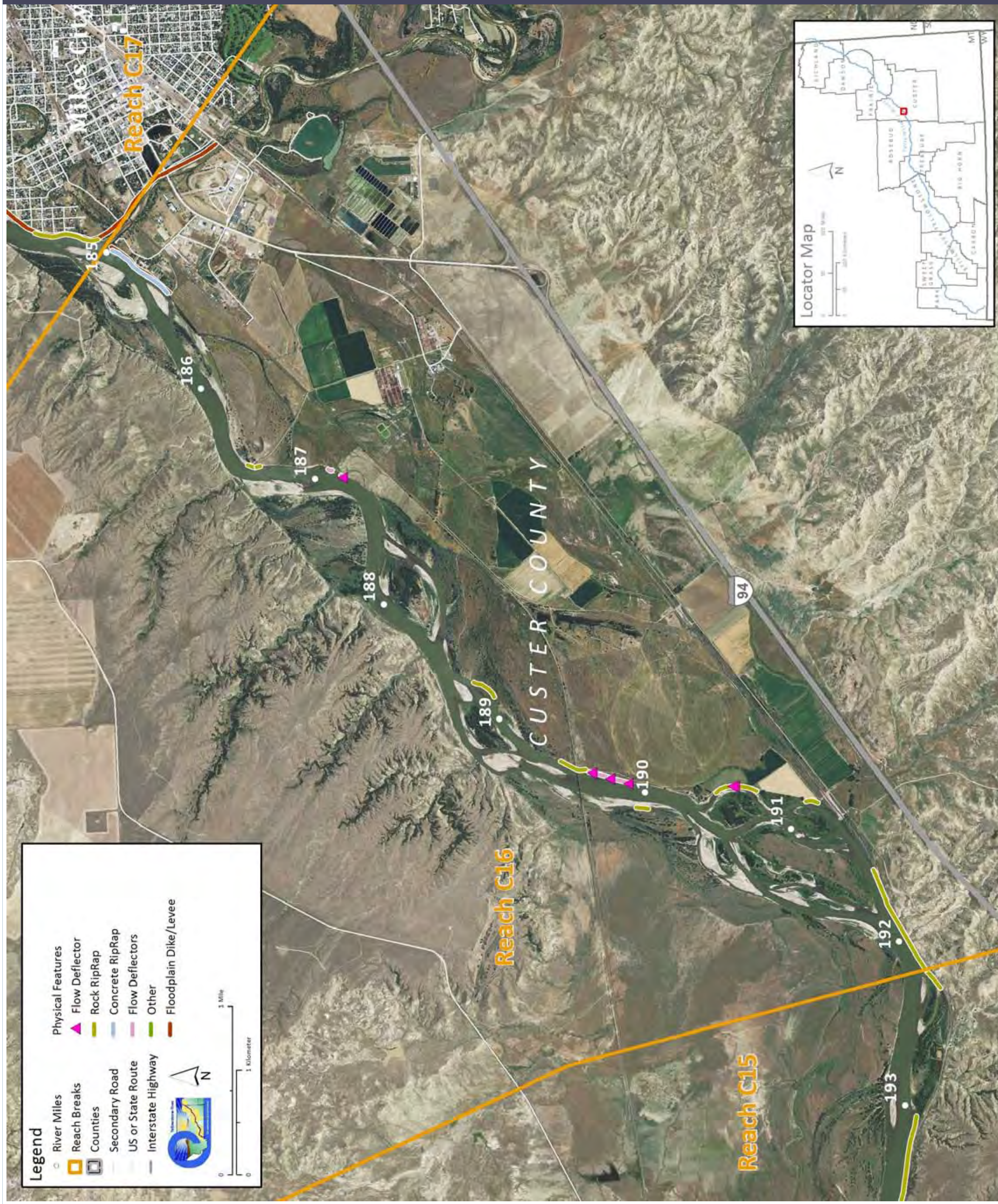
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

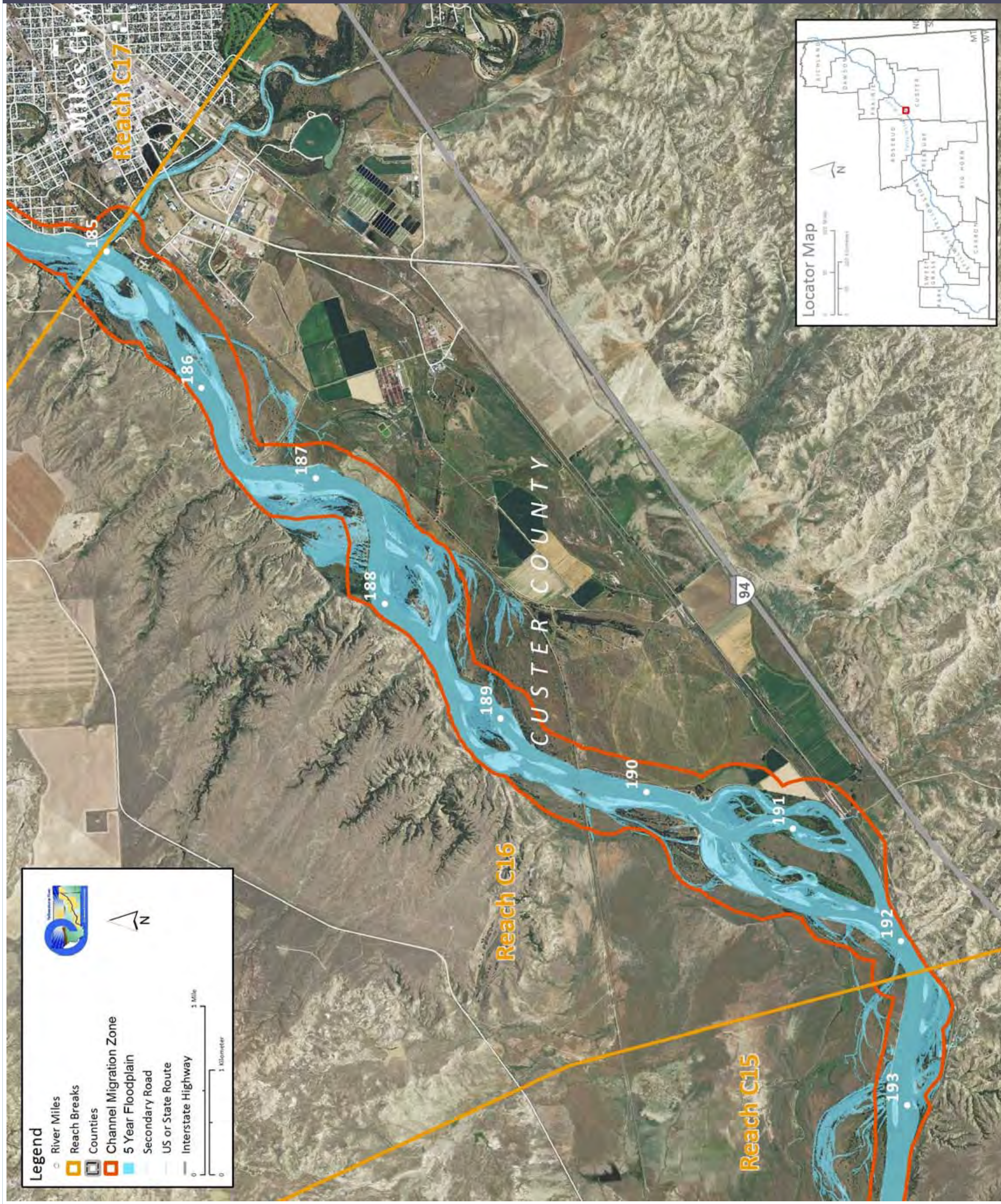
1950	1976	2001	Change 1950-2011
54.5	53.7	66.7	12.2

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Custer	**Upstream River Mile**	185
Classification	PCS: Partially confined straight	**Downstream River Mile**	180.5
General Location	Miles City; Tongue River confluence	**Length**	4.50 mi (7.24 km)

Narrative Summary

Reach C17 is 4.5 miles long and is in Miles City. Through town the Yellowstone River is a Partially Confined Reach type as the river flows on the north edge of town against high bluffs of the Fort Union Formation.

As of 2011 there was just under two miles of armor protecting 21% of the total bankline in Reach C17, including 7,300 feet of rock riprap, 2,400 feet of concrete riprap, and less than a hundred feet of flow deflectors. Over 2,700 feet of rock riprap has been constructed in the reach since 2001. Most of the armor is on the right bank through town. The rock riprap is protecting either urban areas (2,540 feet) the railroad (2,040 feet), or agricultural lands (2,400 ft). The concrete riprap is all protecting agricultural land. Reach C17 also has over three miles of mapped floodplain dikes and levees, much of which is the Miles City Levee that is on the right bank of the river through town.

Prior to 1950, about 1,500 feet of side channel was blocked in Reach C17. This channel was actually the lowermost part of the Tongue River, which was re-routed to the Yellowstone and abandoned through what is now Miles City.

Ice jams have been a major issue in Miles City. The ice jam database records 24 ice jams in Reach C17 between 1934 and 2011. Most of the jams occurred in March, with a few in February and one in April in 1950. Damages associated with the jams include damages to the Miles City dike, damaged water gages, flooding, and evacuations.

The levees in Miles City coupled with flow alterations have isolated 683 acres, or 74% of the 100-year floodplain in the reach. Isolation of the 5-year floodplain has been similar; 286 acres or 78% of the 5-year floodplain has become isolated at that frequency event. Most of the 5-year floodplain isolation is along the historic Tongue River channel that has been cut off from the river.

Bank armor and levees on the south side of the river has narrowed the natural Channel Migration Zone of the river. About 540 acres which represents 40% of the total CMZ has become restricted by physical features.

One dump site was mapped on the right bank just below the Highway 59 Bridge at RM 184.

As an urban reach, the riparian corridor had already been largely impacted by 1950. Since then, however, almost 100 acres of additional riparian area has been cleared, representing 23% of the entire 1950s riparian footprint. With this clearing, the reach has seen a substantial loss of forest area considered at low risk of cowbird parasitism. In 1950, the reach had 9.1 acres of such forest per valley mile and by 2001 that forest extent had dropped to 0 acres per valley mile.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 19% and the 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 5,100 cfs to 3,180 cfs with human development, a reduction of 37%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,730 cfs under unregulated conditions to 3,530 cfs under regulated cond8itions, a reduction of 48%.

Fall and winter base flows have increased in Reach C17 by about 60%.

CEA-Related observations in Reach C17 include:
•Side channel blockage with urbanization
•Extensive armoring with urbanization

Recommended Practices for Reach C17 include:
•CMZ Management due to extent of CMZ restriction (41%)
•Dump removal on right bank at RM 184R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	63,400	48,200	-24.0%
100 Year (cfs)	117,000	94,400	-19.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	485.6	470.6	452.1	455.9	-29.7

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	7,294	15.5%	2,714
Concrete Riprap	2,397	5.1%	-3
Flow Deflectors	92	0.2%	92
Total	**9,784**	**20.8%**	**2,803**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	1,466	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	32.5	34.8
Acres/Year	1.2	1.4
Acres/Year/Valley Mile	0.3	0.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat): 50.08 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	2.3	26.2	0	28.6

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	258.5	78%
100 Year	682.7	74%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	540.1	40%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	2,011.1	1,539.5
Ag. Infrastructure (Ac)	31.4	65.2
Exurban (Ac)	30.2	477.1
Urban (Ac)	1,177.2	1,212.0
Transportation (Ac)	86.6	61.2

	1950	2011
Flood (Ac)	824.7	609.4
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	21.6	75.5	97.1	23.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	18.5	4.6
Emergent	48.4	12.0
Scrub/Shrub	0.7	0.2

Total Wetland Acres: **67.6**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	66.5	2.6%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	9.1	2.6	0.0	-9.1

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)

CHANNEL MIGRATION ZONE MAP

County	Custer	**Upstream River Mile**	180.5
Classification	PCS: Partially confined straight	**Downstream River Mile**	177.3
General Location	Downstream of Miles City	**Length**	3.20 mi (5.15 km)

Narrative Summary

Reach C18 is 3.2 miles long and is located just downstream of Miles City. It is a Partially Confined Straight reach type, as the river flows over steep bedrock shelves that create a series of rapids between Miles City and a few miles above Kinsey Bridge. The river flows along the north bluff line through the whole reach, and has consistently maintained this course since at least 1950.

Reach C18 has no mapped bank armor which is indicative of the natural stability provided to this reach by erosion-resistant bedrock. The 2001 physical features inventory identified 1,742 feet of bedrock outcrop in the reach. A total of three discreet sets of rapids were mapped in the reach, all of which have been described as part of the Buffalo Shoals (RM 180, RM179.9, and RM 178.2).

Between 1950 and 2001 there was about 26 net acres of riparian encroachment into the channel, and the bankfull channel area decreased by ~30 acres, indicating a diminishing river size over the last half-century. This trend is common below the mouth of the Bighorn River, where flow alterations have reduced peak flows and cause the active river channel to shrink. Consumptive water uses, primarily associated with irrigation, have contributed to the reduced flows.

Prior to 1950, a side channel that was just over 1,000 feet long appears to have been blocked at RM179. There are currently several blockages across this old channel, including two roads that access a large gravel pit on the right bank of the river. This gravel pit at RM178.4 is partly within the Channel Migration Zone (CMZ) of the river. Although the channel showed clear expression in the 1950s imagery, it is not very visible in the 2011 imagery, suggesting that restoring this feature may be difficult.

About 20% of the total 100-year floodplain has become isolated due to human development, and most of the isolation appears to be due to flow alterations rather than floodplain dikes. The 5-year floodplain is even more affected; 59% of the historic 5-year floodplain is no longer inundated at that frequency.

Land use is dominated by flood irrigation with additional gravel pit development (mapped as exurban industrial) and transportation infrastructure. There is one Fishing Access Site at Kinsey Bridge. There are two animal handling facilities north of the river that are within several hundred feet of the streambank; both are downstream of Kinsey Bridge, at RM 166.2 and RM 167.8.

There are 65 acres of Russian olive in the reach, most of which is on the south side of the river away from the bluff line to the north.
Over half of the low-flow fish habitat in this reach is bluff pool, potentially making it important for fish with bluff pool habitat preferences.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 5,100 cfs to 3,180 cfs with human development, a reduction of 38%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,730 cfs under unregulated conditions to 3,530cfs under regulated conditions, a reduction of 48%.

CEA-Related observations in Reach C18 include:
•Natural channel stability provided by bedrock
•Minimal bank armoring

Recommended Practices for Reach C18 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	63,400	48,200	-24.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	117,000	94,400	-19.3%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	323.6	351.7	346.8	343.9	20.3	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	0	0.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**0**	**0.0%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	1,052	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	45.3	21.5	26 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	1.7	0.9		
Acres/Year/Valley Mile	0.6	0.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	13.9	40.9	-17.3	37.5	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	67.1	59%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	59.4	20%	

Restricted Migration Area	Acres	% of CMZ	
	1.5	0%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	2,390.9	2,289.9	Flood (Ac)	1,319.4	1,305.2	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	29.2	85.0	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	3.8	41.6	Pivot (Ac)	0.0	0.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	21.4	16.4				

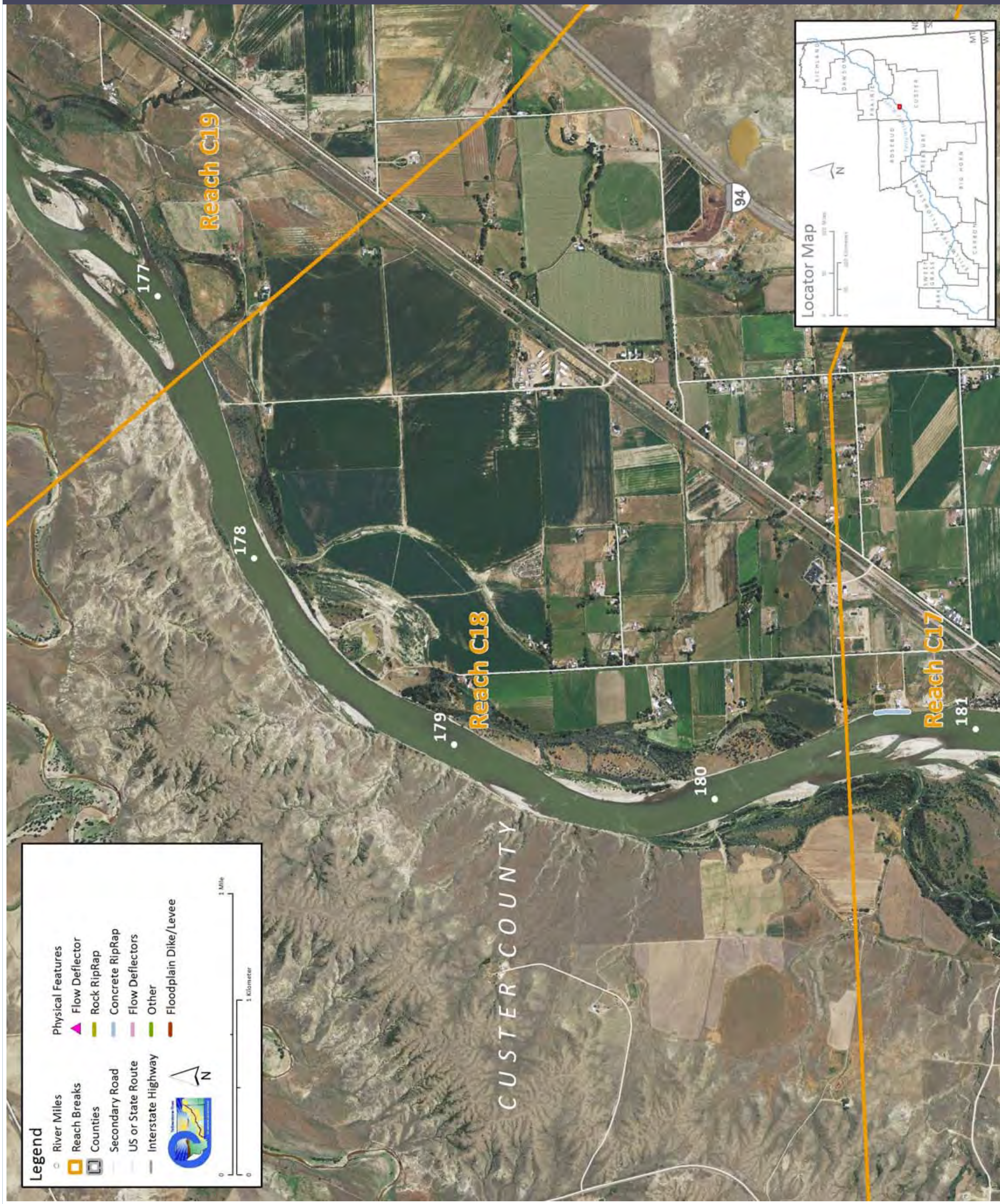
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	31.8	13.0	44.8	17.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	5.7	1.8	**27.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	21.8	7.0		
Scrub/Shrub	0.0	0.0		

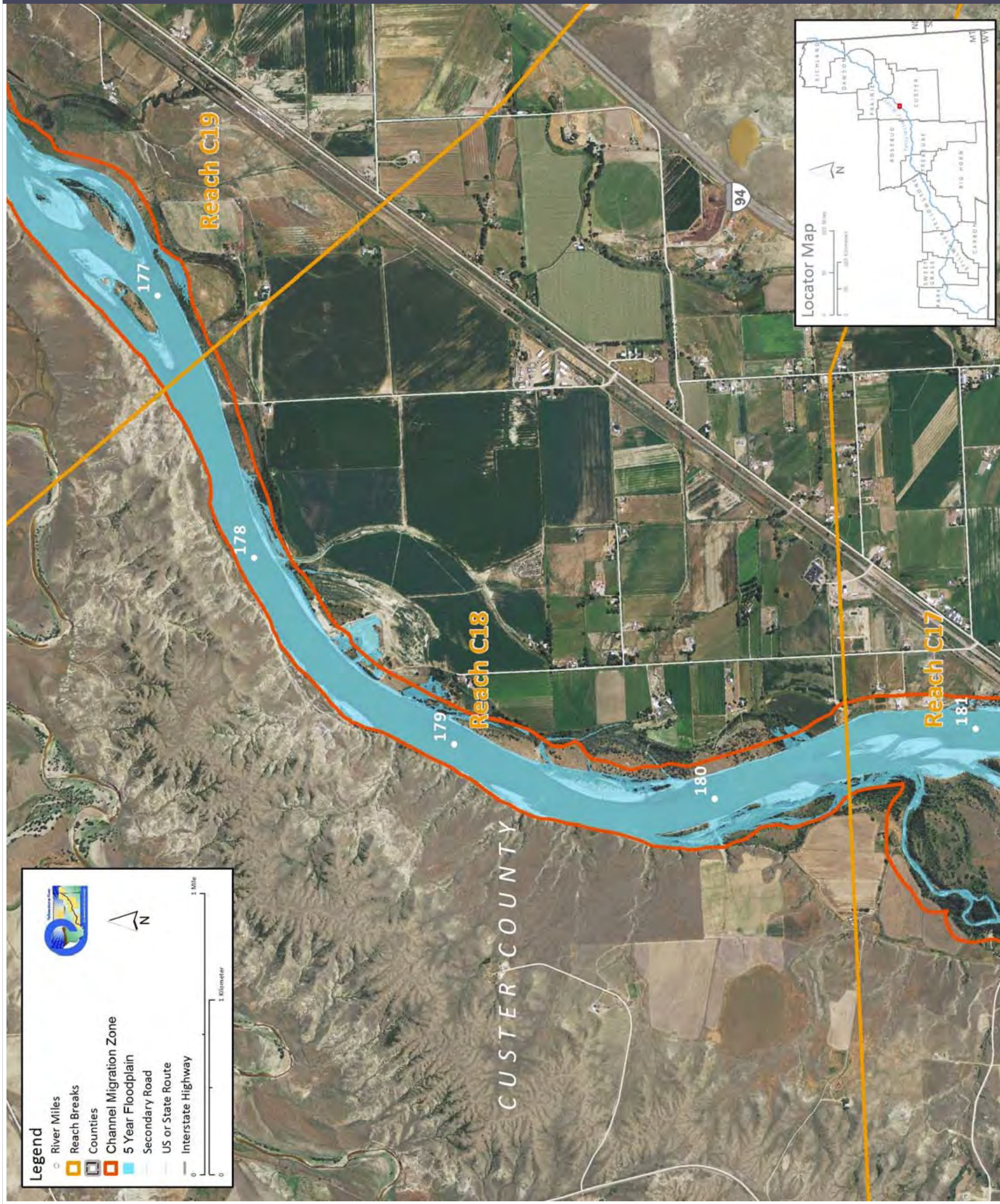
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	65.4	5.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	2.0	0.0	0.0	-2.0	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Custer	**Upstream River Mile**	177.3
Classification	CS: Confined straight	**Downstream River Mile**	166.2
General Location	Kinsey Bridge	**Length**	11.10 mi (17.86 km)

Narrative Summary

Reach C19 is 11.1 miles long and is located downstream of Miles City at Kinsey Bridge. It is a Confined Straight reach type, as the river flows over steep bedrock shelves that create a series of rapids between Miles City and a few miles below Kinsey Bridge.

There are approximately 4,000 feet of rock riprap in the reach, about one third of which was built since 2001. All of the armor is protecting the rail line on the south side of the river. By 1950 over three miles of side channels had been blocked off by small floodplain dikes in Reach C19. These old side channels are on both sides of the river just upstream of Kinsey Bridge. Bank migration rates are very low in the reach, and as a result the Channel Migration Zone (CMZ) is unusually narrow.

The Kinsey Main Canal diversion and pump station are located on the left bank at RM175. The site consists of a rock diversion that extends about 200 feet into the river at an upstream angle to deflect flows into an excavated approach channel and pumping station. Kinsey Bridge is located at RM 172.1 and consists of a Steel multi-beam structure that was built in 1907 for the Milwaukee Railroad, but now supports County Road 62. It is just over 1,000 feet long and has four spans.

The 2001 physical features inventory also identified 7,200 feet of bedrock outcrop in the reach. A total of five discreet sets of rapids were mapped in the reach, including Buffalo Shoals (RM 176 and RM 177, Matthew Rapids (RM174.5), and two unnamed rapids upstream and downstream of Kinsey Bridge at RM 172.5 and RM171, respectively.

On the downstream end of the reach, an 8-inch Cenex pipeline that carries petroleum products flows parallel to the river on the landward side of the active BNSF rail line. The pipeline is about 400 feet away from the active riverbank at RM 166.5, but the fact that the rail line sits between the pipeline and the river suggests that its risk of exposure is low.

Between 1950 and 2001 there was about 89 net acres of riparian encroachment into the channel, and the bankfull channel area decreased by ~100 acres, indicating a diminishing river size over the last half-century. This trend is common below the mouth of the Bighorn River, where flow alterations have reduced peak flows and cause the active river channel to shrink. Consumptive water uses, primarily associated with irrigation, have contributed to the reduced flows.

About 13% of the total 100-year floodplain has become isolated due to human development, and most of the isolation appears to be due to flow alterations rather than floodplain dikes. The 5-year floodplain is even more affected; 55% of the historic 5-year floodplain is no longer inundated at that frequency.

Two ice jams have been reported in Reach C19; one in March of 1994 at RM 168 and the other in February of 1997 at RM 174. No damages were reported.

Land use is dominated by agriculture (~4,700 acres), with 326 acres of pivot irrigation development since 1950. There is one Fishing Access Site at Kinsey Bridge. There are two animal handling facilities north of the river that are within several hundred feet of the streambank; both are downstream of Kinsey Bridge, at RM 166.2 and RM 167.8.

There are 254 acres of Russian olive in the reach, most of which is on the north side of the river away from the bluff line to the south. Russian olive comprises almost 30% of all of the mapped shrubs in the reach. There are notably high concentrations of Russian olive in one of the abandoned side channels that is located on the left bank just downstream from the Kinsey Main Canal diversion.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 5,080 cfs to 3,150 cfs with human development, a reduction of 38%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,740 cfs under unregulated conditions to 3,510cfs under regulated conditions, a reduction of 48%.

CEA-Related observations in Reach C19 include:
•Side channel blockages pre-1950
•Russian olive colonization, especially in blocked side channels
•Armoring needs by the railroad on the south bluff line
•Low natural rates of bank movement in reach with extensive bedrock exposure and rapids

Recommended Practices for Reach C19 include:
•Side channel reactivation at RM 175L and RM174R
•Russian olive removal
•Nutrient management at animal handling facilities at RM 166.2L and RM 167.8L

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change		"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
2 Year (cfs)	63,700	48,500	-23.9%		
100 Year (cfs)	119,000	96,100	-19.2%		

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.
	1,259.4	1,190.3	1,150.4	1,157.3	-102.1	

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Rock RipRap	4,043	3.4%	1,474	
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**4,043**	**3.4%**	**1,474**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.
	17,355	0	

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Total Acres	84.9	60.8	88.9 acres	
Acres/Year	3.3	2.4		
Acres/Year/Valley Mile	0.3	0.2		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.
Change in Area '50 - '01 (Ac)	-4.4	100.2	17.5	113.2	

Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
5 Year	116.2	55%	
100 Year	85.9	13%	

Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.
	2.6	0%	

Land Use	1950	2011		1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Agricultural Land (Ac)	9,752.6	9,591.9	Flood (Ac)	4,385.3	4,125.1	
Ag. Infrastructure (Ac)	178.6	363.1	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	11.8	Pivot (Ac)	0.0	325.8	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	213.2	251.8				

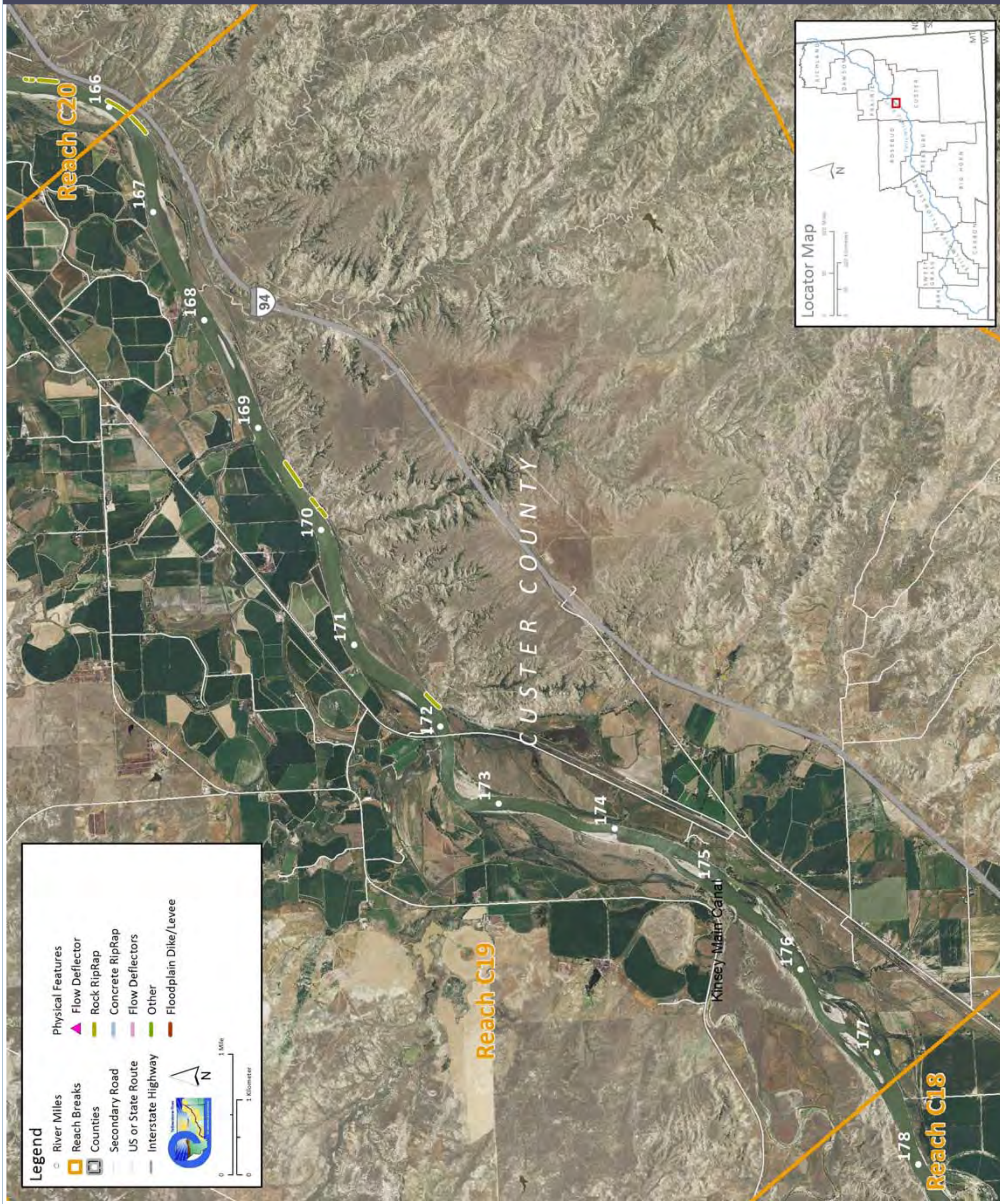
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.
	10.4	8.3	18.8	3.0%	

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Riverine	16.1	1.5	**193.5**	
Emergent	165.2	15.4		
Scrub/Shrub	12.2	1.1		

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.
	254.1	5.0%	

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.
	10.1	1.0	0.1	-10.0	

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

Yellowstone River Reach Narratives

Reach C20

County	Custer	**Upstream River Mile**	166.2
Classification	CS: Confined straight	**Downstream River Mile**	158.7
General Location	Shirley	**Length**	7.50 mi (12.07 km)

Narrative Summary

Reach C20 is 7.5 miles long and is located downstream in lowermost Custer County at Shirley. The Bonfield Fishing Access Site is located at RM 161 on the left bank. It is a Confined Straight reach type, as the river flows through the confining geology of the Fort Union Formation sandstones. Small tributaries that enter Reach C20 include Hay Creek (RM 165), Harris Creek (RM 164), Cabin and Cottonwood Creeks (RM 162) and Saugus Creek (RM 160.2). Bank migration rates are very low in the reach, and as a result the Channel Migration Zone (CMZ) is unusually narrow.

There is just over a mile of bank armor in the reach that covers about 8% of the total bankline. As of 2011 there was 6,059 feet of rock riprap in reach C20, and 1,650 feet of that armor was built between 2001 and 2011. Most of the rock riprap is protecting the abandoned Milwaukee Rail line on the north side of the river where it runs in the edge of the bluff line. The new armor is protecting the Shirley Pump Station at RM 165.3R. There are also 131 feet of flow deflectors across the river from the Bonfield Fishing Access Site.

Between 1950 and 2001 there was about 50 net acres of riparian encroachment into the channel, and the bankfull channel area decreased by ~58 acres, indicating a diminishing river size over the last half-century. This trend is common below the mouth of the Bighorn River, where flow alterations have reduced peak flows and cause the active river channel to shrink. Consumptive water uses, primarily associated with irrigation, have contributed to the reduced flows.

About 13% of the total 100-year floodplain has become isolated due to human development, and most of the isolation appears to be due to flow alterations rather than floodplain dikes. The 5-year floodplain is even more affected; 55% of the historic 5-year floodplain is no longer inundated at that frequency.

Land use is dominated by agriculture (~6,200 acres), with 327 acres of pivot irrigation development since 1950. Irrigated fields extend to the active streambank through much of the reach.

There are 84 acres of Russian olive in the reach. The Russian olive is concentrated on tributaries and in riparian areas colonizing old river swales, mostly in the upstream portion of the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of 100-year flood has dropped by 19% due to flow alterations associated with human development. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 5,080 cfs to 3,150 cfs with human development, a reduction of 38%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,750 cfs under unregulated conditions to 3,510cfs under regulated conditions, a reduction of 48%.

CEA-Related observations in Reach C20 include:
•Irrigated land encroachment in reach stabilized by bedrock
•Bank armor on abandoned rail line on northern bluff

Recommended Practices for Reach C20 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	63,800	48,600	-23.8%
100 Year (cfs)	119,000	96,400	-19.0%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
798.7	764.1	746.8	740.8	-57.8

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	6,059	7.6%	1,649
Concrete Riprap	0	0.0%	0
Flow Deflectors	131	0.2%	131
Total	**6,190**	**7.8%**	**1,781**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	53.7	41.2
Acres/Year	2.1	1.6
Acres/Year/Valley Mile	0.3	0.2

1950-2001 In-channel riparian encroachment (negative number indicates retreat): 50.32 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	30.1	52.3	-4.3	78.1

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	95.3	55%
100 Year	48.3	13%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
1.7	0%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	6,116.5	5,996.3
Ag. Infrastructure (Ac)	42.5	158.1
Exurban (Ac)	0.0	1.9
Urban (Ac)	0.0	0.0
Transportation (Ac)	113.3	184.3

	1950	2011
Flood (Ac)	2,725.1	2,714.2
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	327.3

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
5.4	1.5	7.0	3.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	5.7	0.8
Emergent	49.2	6.7
Scrub/Shrub	1.6	0.2

Total Wetland Acres: **56.5**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
83.7	2.0%

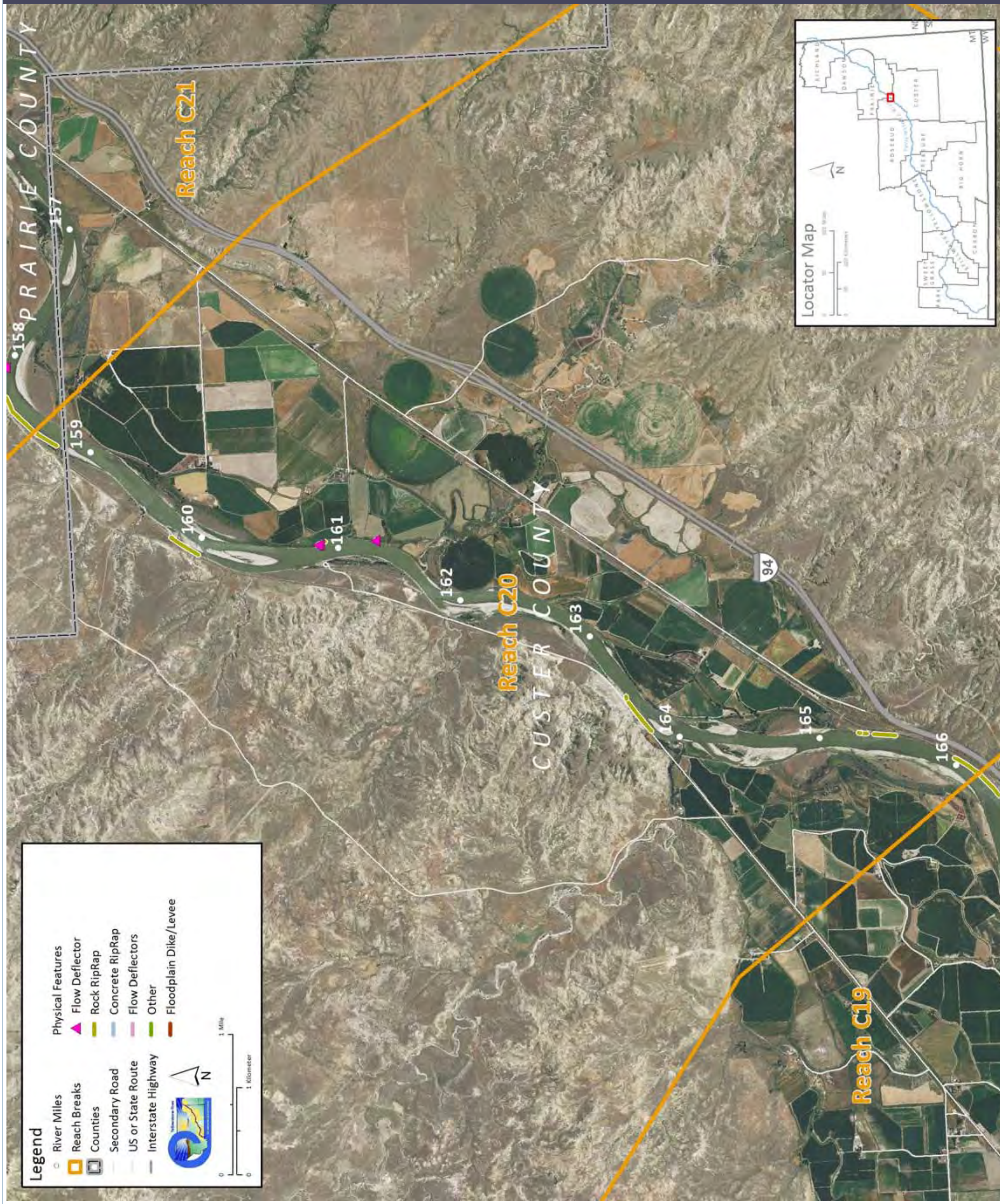
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

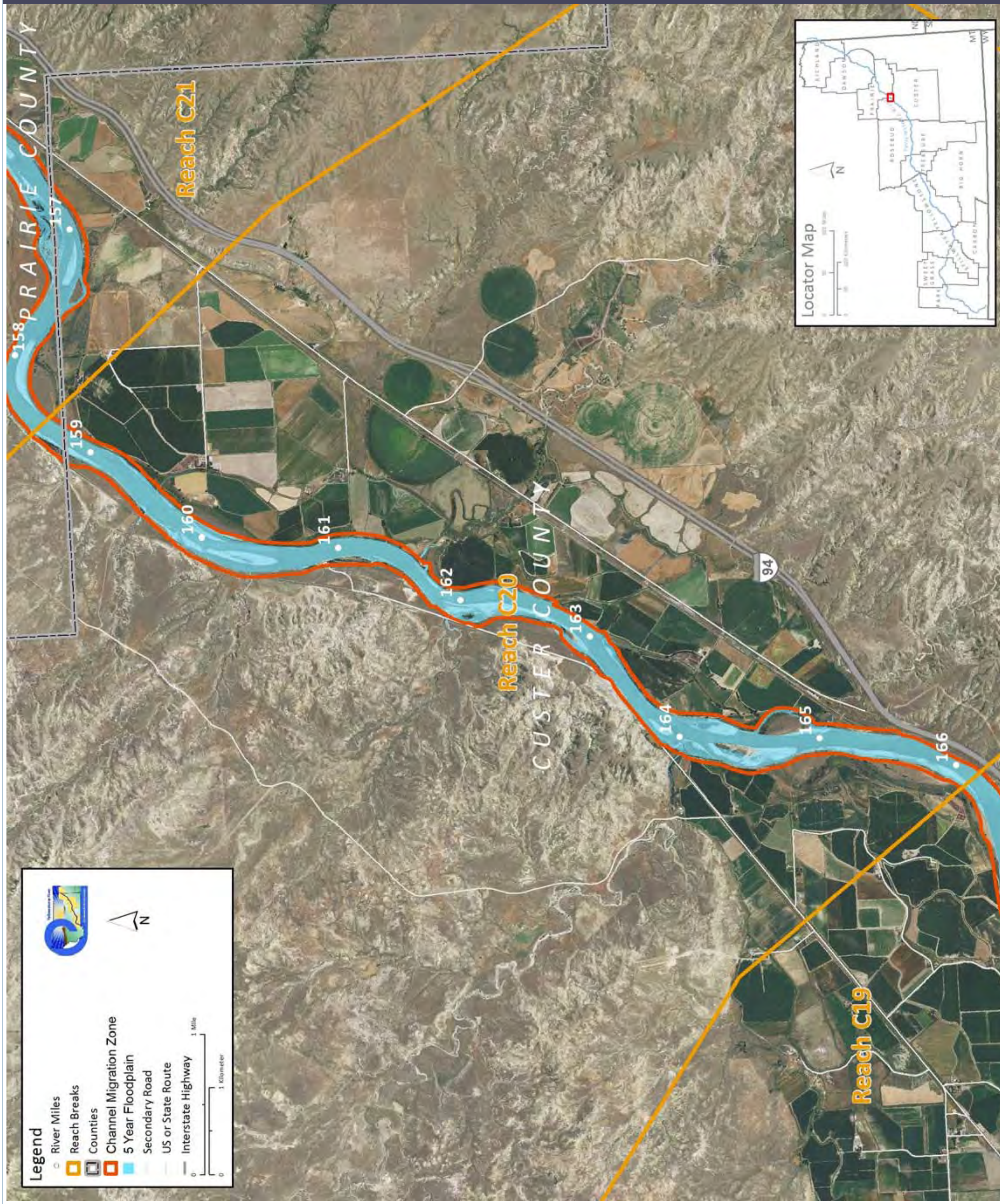
1950	1976	2001	Change 1950-2011
2.5	1.9	4.1	1.6

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Custer	**Upstream River Mile**	158.7
Classification	CM: Confined meandering	**Downstream River Mile**	149.2
General Location	To Powder River confluence	**Length**	9.50 mi (15.29 km)

Narrative Summary

Reach C21 is 9.5 miles long and extends from River Mile (RM) 158.7 downstream to the mouth of the Powder River at RM 149.2. It is a Confined Meandering (CM) reach type, as the river flows down a sinuous course that is highly confined by Fort Union Formation sandstones and younger erosion –resistant terraces.

Reach C21 has just over 4,000 feet of rock riprap and 71 feet of mapped flow deflectors, which collectively armor 4.1% of the total stream bank. About one half of the armor is protecting road embankments, and the other half is protecting the railroad.

Bear Rapids forms two distinct shoals as bedrock shelves in the river between RM 153 and RM 154 near the mouth of Camp Creek.

Between 1950 and 2001 there was about 53 net acres of riparian encroachment into the channel, and the bankfull channel area decreased by ~58 acres, indicating a diminishing river size over the last half-century. This trend is common below the mouth of the Bighorn River, where flow alterations have reduced peak flows and cause the active river channel to shrink. Consumptive water uses, primarily associated with irrigation, have contributed to the reduced flows.

Land use is dominated by agriculture with 164 acres of the ~7,000 acre mapping footprint occupied by transportation-related land uses. There is one ~0.6 acre series of corrals near the mouth of Mack Creek at RM 157.2R that are within 200 feet of the river. There are also several acres of corrals within 300 feet of the river on the left bank at RM 154.9L. At RM 153.3R there is another much larger series of corrals that are within 500 feet of Camp Creek.

There are 49 acres of Russian olive in the reach, which appears to dominate riparian areas.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 19%. The 2-year flood, which strongly influences overall channel form, has dropped by 24%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 5,080 cfs to 3,140 cfs with human development, a reduction of 38%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,730 cfs under unregulated conditions to 3,510cfs under regulated conditions, a reduction of 48%.

CEA-Related observations in Reach C21 include:
- Natural channel stability provided by bedrock
- Minimal bank armoring

Recommended Practices for Reach C21 include:
- Russian olive removal
- Nutrient management at corrals at RM 157.2R and RM 153.2R, and 154.9L

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	63,900	48,600	-23.9%
100 Year (cfs)	119,000	96,800	-18.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	973.2	929.6	936.0	914.8	-58.4

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	4,024	4.0%	-41
Concrete Riprap	0	0.0%	0
Flow Deflectors	71	0.1%	71
Total	**4,096**	**4.1%**	**30**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	64.9	62.0
Acres/Year	2.5	2.5
Acres/Year/Valley Mile	0.3	0.3

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

53.32 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	29.2	76.2	-1.1	104.4

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	95.2	35%
100 Year	12.7	3%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	2.4	0%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	6,629.3	6,527.2
Ag. Infrastructure (Ac)	35.4	99.7
Exurban (Ac)	0.0	11.1
Urban (Ac)	0.0	0.0
Transportation (Ac)	100.5	163.8

	1950	2011
Flood (Ac)	1,799.1	1,915.9
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	0.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	0.0	1.2	1.2	1.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	7.7	0.9
Emergent	61.4	7.2
Scrub/Shrub	10.5	1.2

Total Wetland Acres **79.6**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

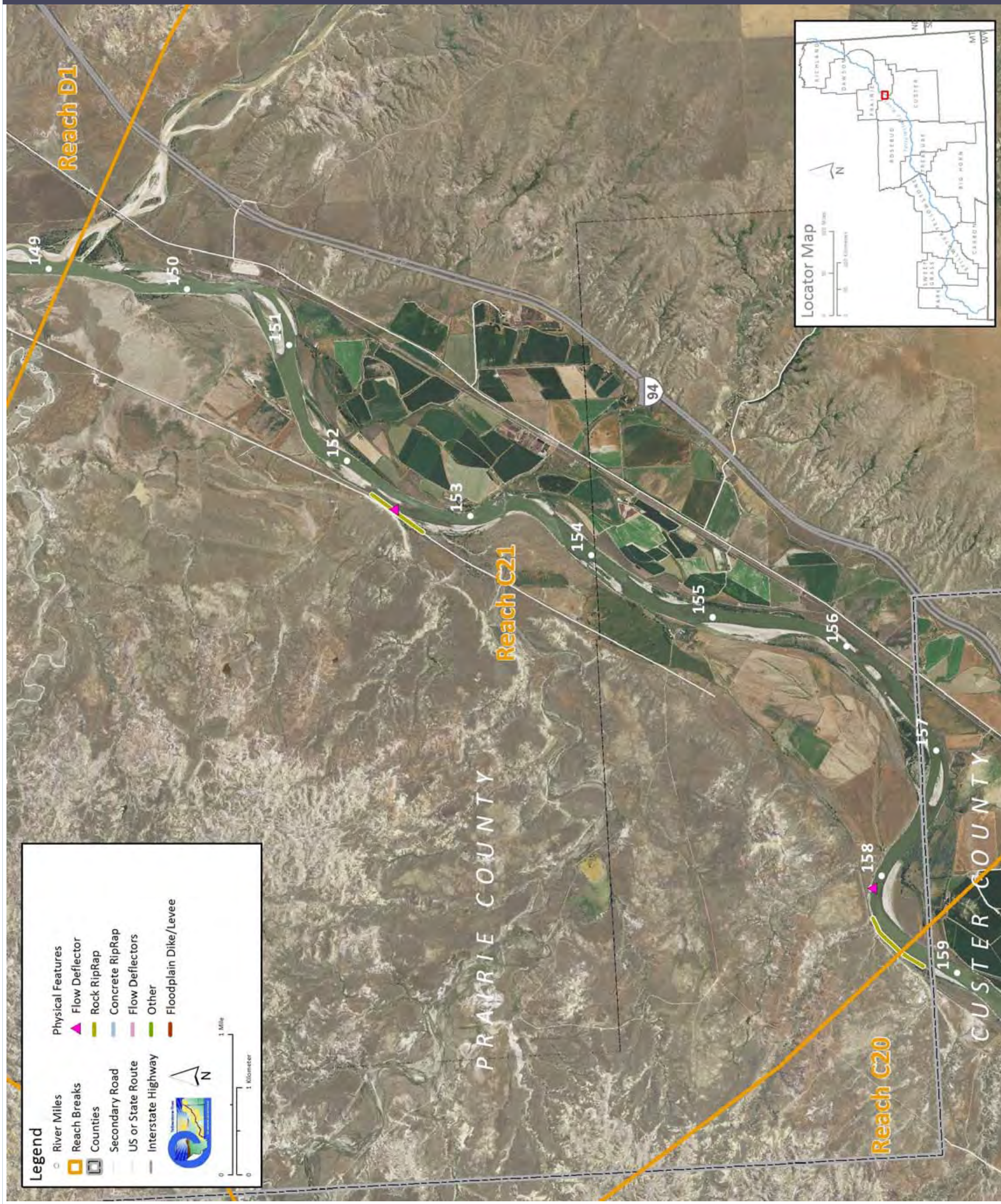
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	48.6	0.8%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	8.9	3.3	7.5	-1.4

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

County	Prairie	**Upstream River Mile**	149.2
Classification	CM: Confined meandering	**Downstream River Mile**	137
General Location	To Terry Bridge	**Length**	12.20 mi (19.63 km)

Narrative Summary

Reach D1 is located in Prairie County, and extends from just below the mouth of the Powder River to Terry. The reach is a 12.2 mile long Confined Meandering (CM) reach type, indicating that the river flows along a meandering course that is confined by older geologic units. Sandstones of the Fort Union Formation and younger erosion-resistant terraces confine the channel through the reach. Because of the geologic confinement, channel migration rates are low and the riparian corridor is notably thin or absent. There is one Fishing Access Site at the upper end of the reach at the Powder River confluence (Powder River Depot).

There are less than 1000 feet of bank armor in the reach; including about 550 feet of rock riprap and 140 feet of flow deflectors. The flow deflectors were all built between 2001 and 2011. During that timeframe there was a loss of 650 feet or rock riprap where it was protecting an old railroad bridge at RM 144.5. The bridge was built in 1907 for the railroad and now serves County Road 42.

Wolf Rapids is located on the apex of a large meander at RM 146. These rapids are formed from an exposed bedrock shelf that extends across the entire river.

Reach D1 has lost almost a mile of side channel length, but none of this loss has been associated with intentional blockages. There has been 126 acres of riparian recruitment into abandoned 1950s channels.

Land use is predominantly agricultural, and there has been 310 acres of land developed under pivot irrigation. There are two animal handling facilities just north of Terry that are adjacent to old swales. One dump site was mapped on the right bank of the river at RM137.5R, about ¾ miles upstream from the Terry Bridge.

About 51% of the historic 5-year floodplain has become isolated, primarily due to flow alterations. The abandoned Milwaukee rail line embankment has been breached by river erosion in several locations on the south side of the river.

A total of four ice jams have been reported in the reach. One of these events was in February (1996), and three occurred in March (1993, 2009, and 2011). No damages were reported.

There are about 20 acres of mapped Russian olive in the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850cfs to 2,810 cfs with human development, a reduction of 42%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270cfs under regulated conditions, a reduction of 53%.

CEA-Related observations in Reach D1 include:
•Breaching of abandoned Milwaukee Railroad line

Recommended Practices for Reach D1 include:
•Dump site BMP at RM 137.5R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	68,200	53,000	-22.3%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	140,000	119,000	-15.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,265.9	1,213.5	1,213.1	1,230.9	-34.9	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	545	0.4%	-651	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	243	0.2%	243	
Total	**787**	**0.6%**	**-409**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	88.0	68.1	7.17 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	3.4	2.7		
Acres/Year/Valley Mile	0.4	0.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-50.3	92.6	12.9	55.2	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	95.5	51%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	14.9	3%	

Restricted Migration Area	Acres	% of CMZ	
	11.8	1%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	6,528.5	6,539.6	Flood (Ac)	682.4	846.1	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	7.0	56.6	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	16.2	Pivot (Ac)	0.0	310.5	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	103.5	58.7				

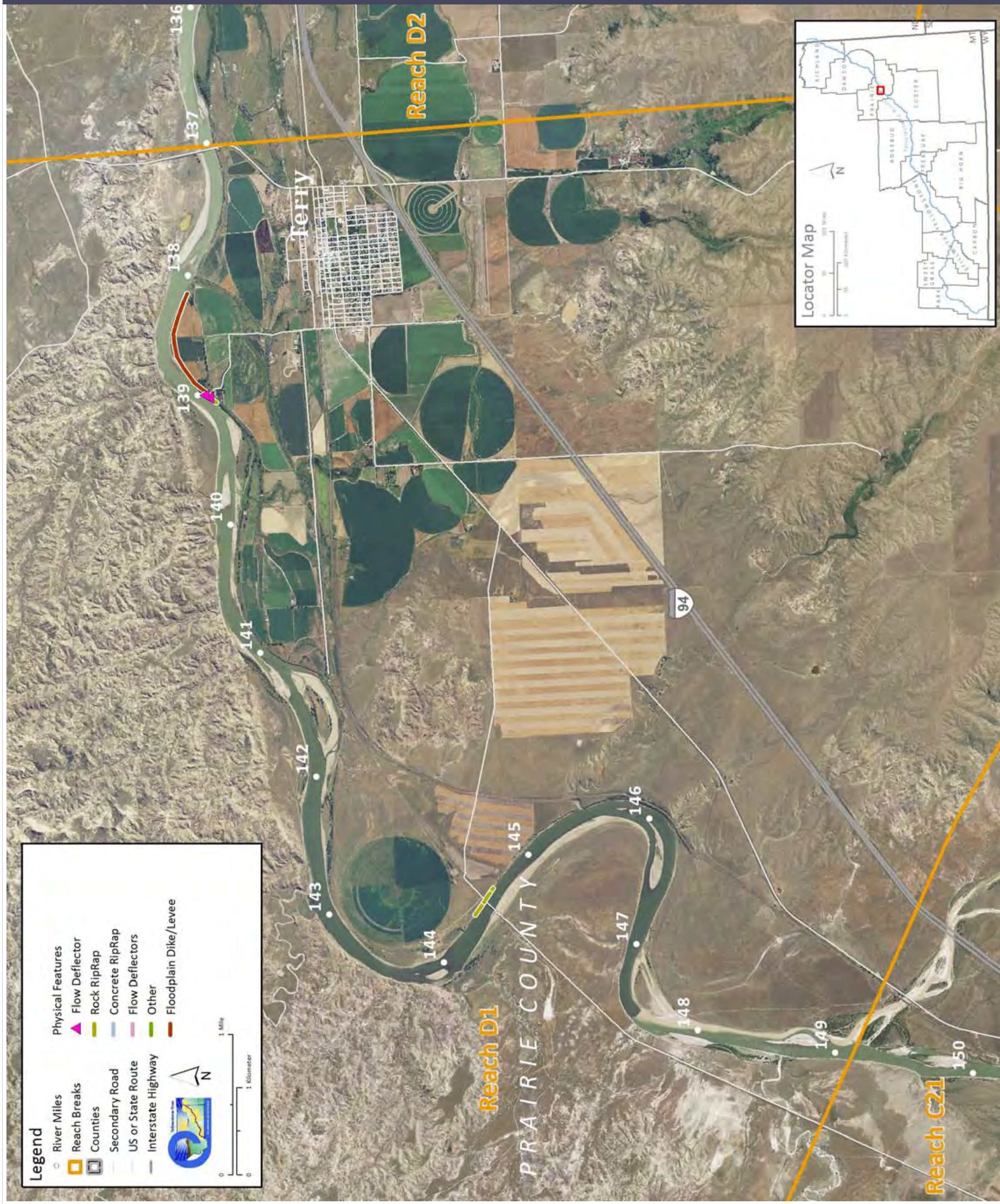
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	1.2	0.2	1.4	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	27.0	3.0	**45.0**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	18.0	2.0		
Scrub/Shrub	0.0	0.0		

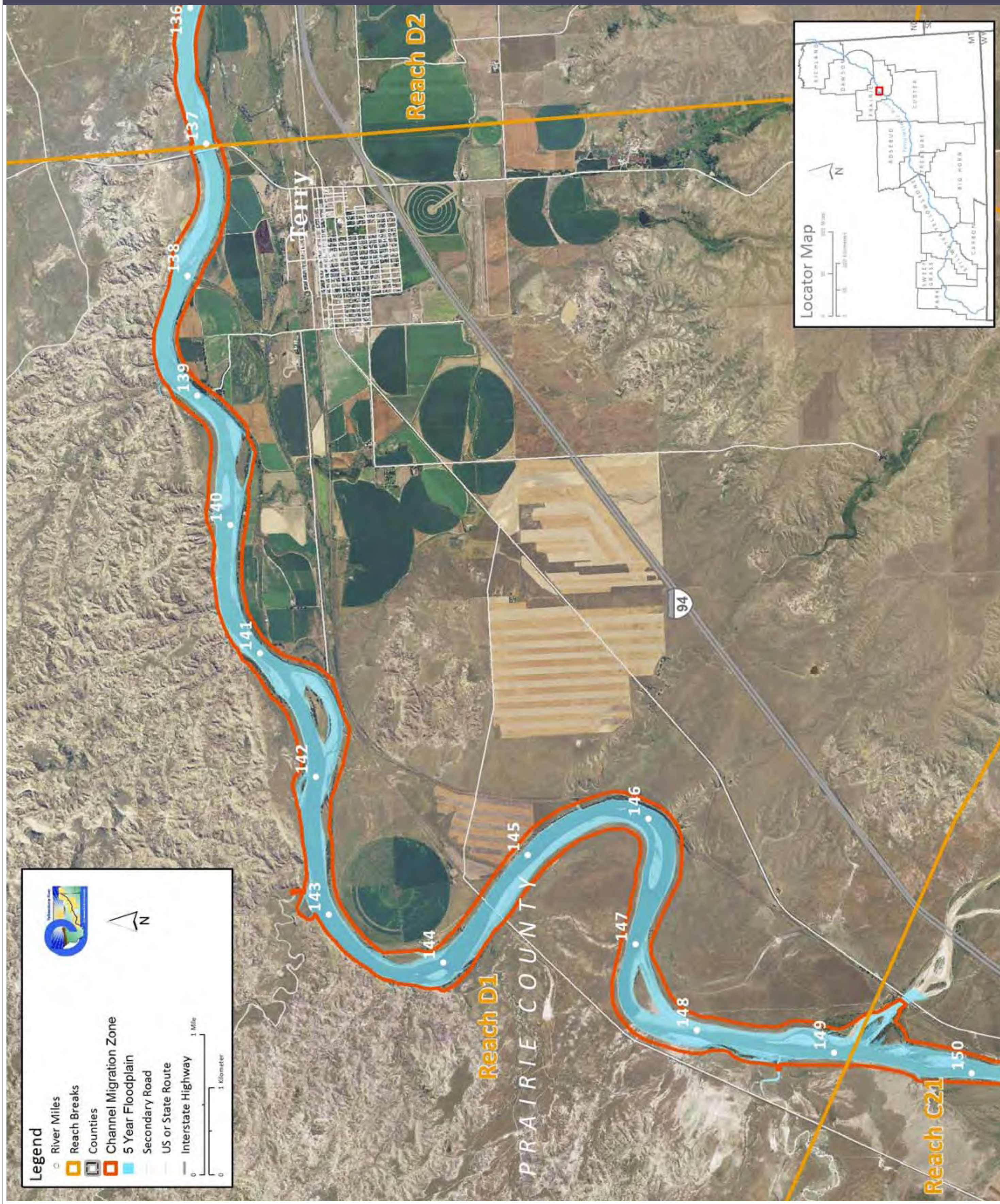
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	19.9	1.4%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	5.8	2.9	3.4	-2.4	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives — Reach D2

County	Prairie	**Upstream River Mile**	137
Classification	CM: Confined meandering	**Downstream River Mile**	126.5
General Location	To Fallon, I-90 Bridge	**Length**	10.50 mi (16.90 km)

Narrative Summary

Reach D2 is located in Prairie County, and extends from Terry to Fallon and the I-90 Bridge. The reach is a 10.5 mile long Confined Meandering (CM) reach type, indicating that the river flows along a meandering course that is confined by older geologic units. Sandstones of the Fort Union Formation and younger erosion-resistant terraces confine the channel through the reach. Because of the geologic confinement, channel migration rates are low and the riparian corridor is notably thin or absent. The Channel Migration Zone (CMZ) is extremely narrow because there has been essentially no bank migration in this reach since 1950.

There is just over, 1000 feet of bank armor in the reach; all of which is rock riprap that is protecting the Fallon Bridge.

Land use is predominantly agricultural with more acreage irrigated under pivot than under flood; as of 2011 there were 712 acres in flood and 1,070 acres in pivot in the reach. All of the pivots are on the north side of the river, and several of them extend to the river bank.

One dump site was mapped on the right bank at RM 135.1. There is also an animal handling facility on lower O'Fallon Creek near RM 130.

About 57% of the historic 5-year floodplain has become isolated, primarily due to flow alterations. There has been almost 50 acres of riparian encroachment in the reach, likely due to reduced 2-year flows.

Two ice jams have been reported in the reach. In early April of 1943, the breakup of ice jams at Fallon resulted in a 13 ft rise in the river stage at Intake. According to records, many of the farmers "remained in their homes, taking refuge in the attics and second floors of their homes, and some in the haylofts of their barns". More recently in February 1996, lowland flooding resulted from another ice jam breakup.

There are about 20 acres of mapped Russian olive in the reach.

Bluff pools and terrace pools make up 57% of the low flow fish habitat mapped in the reach, indicating that this reach may provide important areas for fish species that prefer this habitat type.

O'Fallon Creek enters the Yellowstone River at RM 129. The lowermost 3,100 feet of this creek has been diked off, and the channel now bypasses that remnant and flows directly into the Yellowstone. This abandoned channel supports some emergent wetland and could potentially provide excellent restoration opportunities for wetlands and slackwater areas connected to the Yellowstone River in this highly confined reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850cfs to 2,810 cfs with human development, a reduction of 43%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270cfs under regulated conditions, a reduction of 53%.

CEA-Related observations in Reach D2 include:
•Breaching of abandoned Milwaukee Railroad line
•Diking of lower O'Fallon Creek and isolation of ~3,000 feet of historic tributary channel

Recommended Practices for Reach D2 include:
•Dump site BMP at RM 137.5R
•Nutrient management at animal handling facility on lower O'Fallon Creek RM 130
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	68,300	53,100	-22.3%
100 Year (cfs)	141,000	120,000	-14.9%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
1,007.7	979.9	984.9	993.8	-13.9

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	1,055	0.9%	166
Concrete Riprap	0	0.0%	0
Flow Deflectors	0	0.0%	0
Total	**1,055**	**0.9%**	**166**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	48.8	32.3
Acres/Year	1.9	1.3
Acres/Year/Valley Mile	0.2	0.1

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

48.3 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	-117	51.9	3.4	-61.7

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	100.7	57%
100 Year	39.7	7%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
5.6	0%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	7,045.8	6,783.1
Ag. Infrastructure (Ac)	9.7	60.7
Exurban (Ac)	0.0	3.2
Urban (Ac)	0.0	0.0
Transportation (Ac)	142.2	348.3

	1950	2011
Flood (Ac)	630.5	711.7
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	1,070.2

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
2.4	2.8	5.2	2.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	11.0	1.1
Emergent	22.9	2.3
Scrub/Shrub	4.5	0.5

Total Wetland Acres **38.4**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
10.8	1.0%

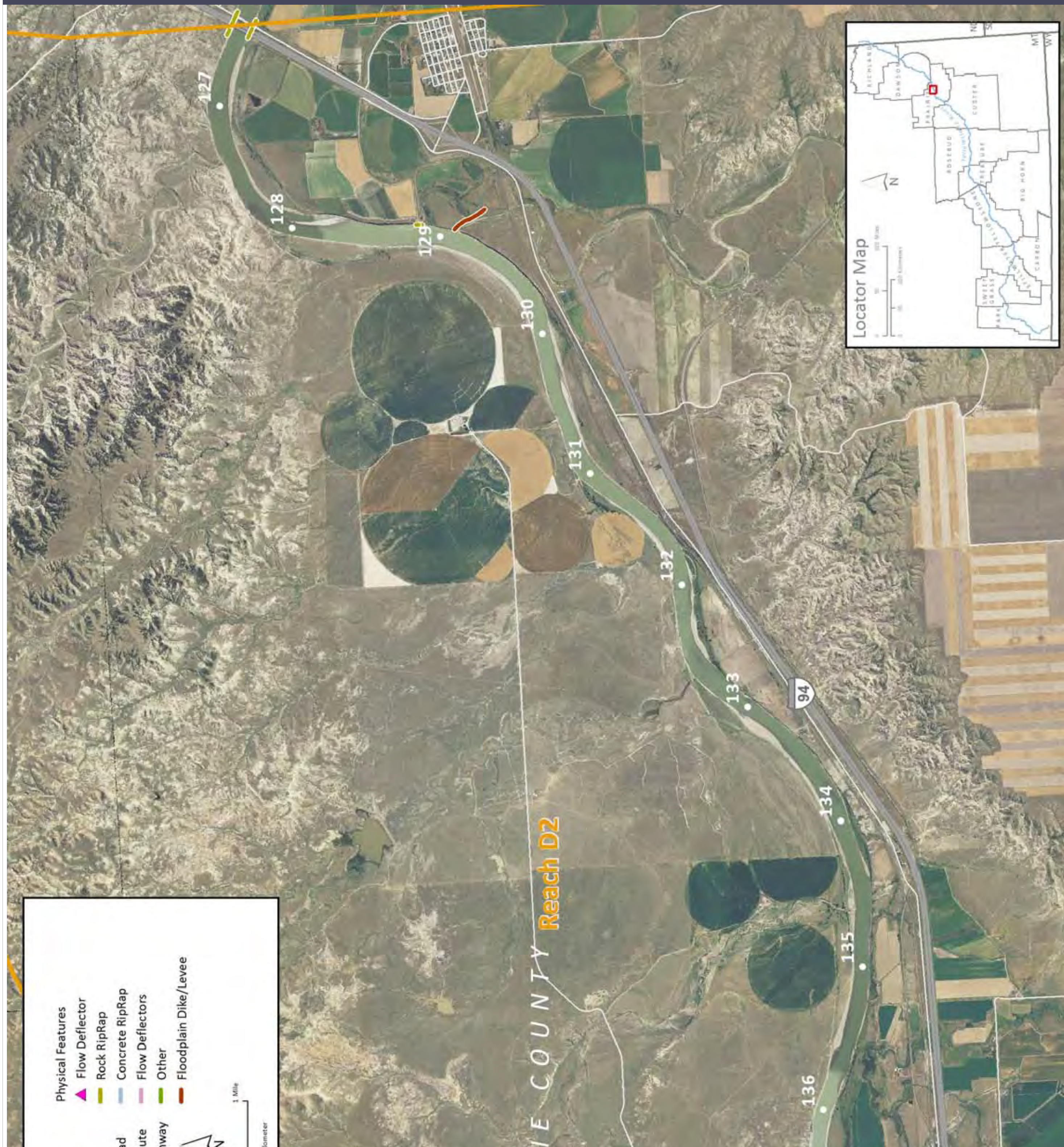
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

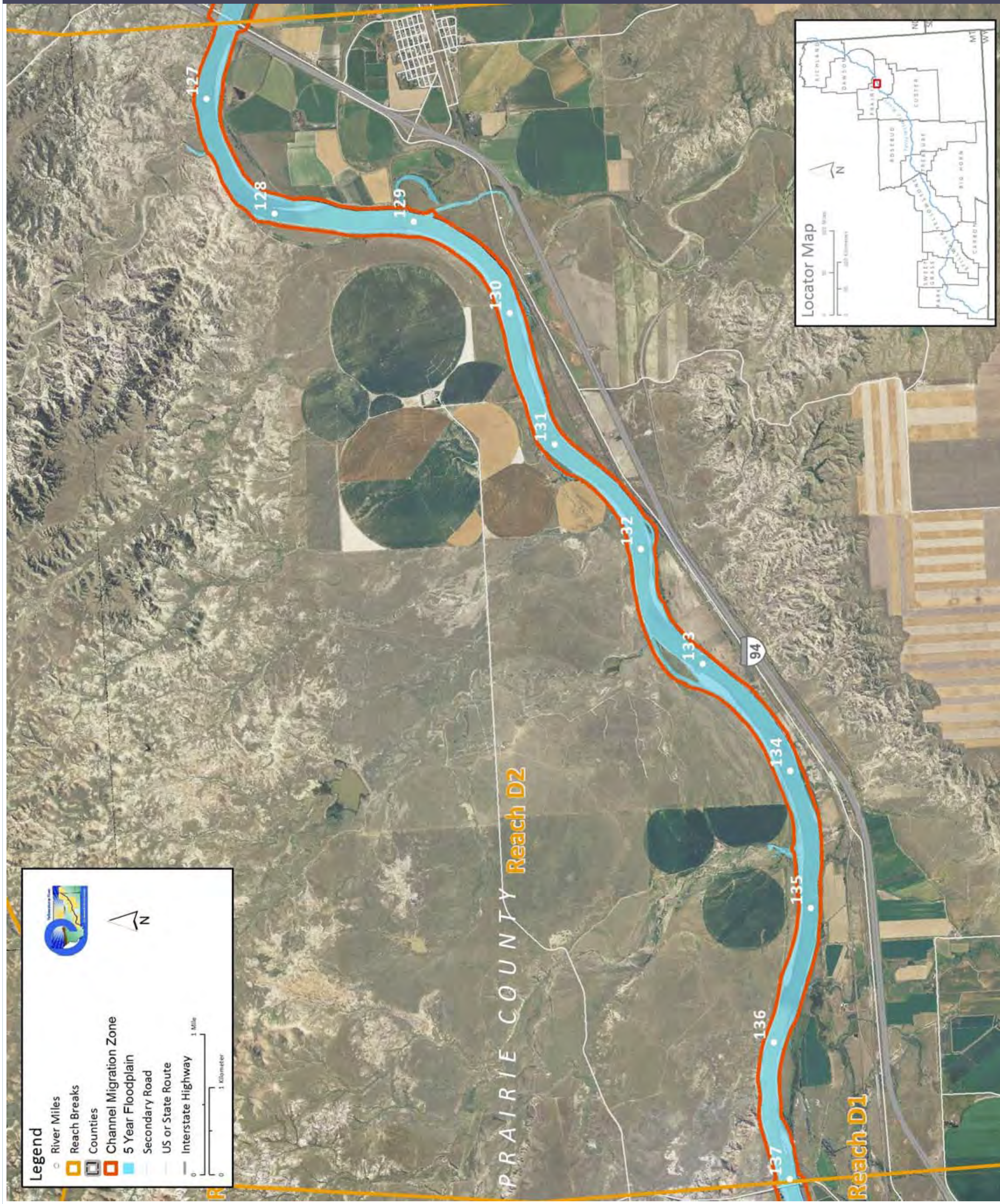
1950	1976	2001	Change 1950-2011
7.2	1.6	7.4	0.2

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives Reach D3

County	Prairie	**Upstream River Mile**	126.5
Classification	PCS: Partially confined straight	**Downstream River Mile**	118.1
General Location	Downstream of Fallon Bridge	**Length**	8.40 mi (13.52 km)

Narrative Summary

Reach D3 straddles the Prairie/Dawson County line, extending from the Fallon Bridge to about two miles into Dawson County. The reach is 8.4 miles long and has been classified as a Partially Confined Straight (PCS) reach type, indicating minimal meandering and some influence of the valley wall on river form and process. Sandstones of the Fort Union Formation typically form the south bank, and younger erosion-resistant terraces confine the channel to the north. Because of the geologic confinement, channel migration rates are low and the riparian corridor is notably thin or absent. The Channel Migration Zone (CMZ) is extremely narrow because there has been only minor bank migration in this reach since 1950. All of the migration measured in the reach was at RM 123, where the river abruptly hits the south valley wall and apparently backwaters as it has developed a series of islands that drive local bank movement. From 1950 to 2011, the right bank migrated almost 900 feet at this single location. These islands provide areas for riparian colonization and habitat for bird species such as least terns.

Approximately 1,500 feet of bank armor has been mapped in the reach; about 2/3 of that armor protects the Interstate Bridge, with the remainder (600 ft) protecting irrigated land. Two pipelines cross the river about 1,000 feet downstream from the Interstate Bridge. One is an 8-inch petroleum product line that has been abandoned and purged, and the other is a product line that was directionally drilled in 1999. About 4,000 feet downstream from the Fallon Bridge, three large bridge piers from an old trestle remain in the middle of the river.

The Glendive Pump Station #1 is located about two miles downstream of the Fallon Bridge at RM 124.5L and is part of the Glendive Unit of the Buffalo Rapids Project. Construction of the unit began November 12, 1937, with ground breaking for excavation of the main canal. The following April 1938, excavation began on the lateral system. The first operation of the pumping station occurred on September 26, 1939, before the Unit was completed; diverted water was allowed to flow about ten miles down the main canal. Ice damage in 2012 required in extensive repairs to the pumping station. The unit serves 16,500 acres of irrigated land.

Land use in Reach D3 is predominantly agricultural, with about 600 acres of pivot irrigation development since 1950. All of the pivots are on the north side of the river, and several of them extend to the river bank and into the CMZ. In total, 57 acres of land under pivot irrigation are within the CMZ, making them especially prone to the threat of bank erosion. Although there has been extensive pivot development, most irrigated land had remained in flood irrigation in 2011 (1,500 acres).

Dump sites were mapped on the banks or in adjacent riparian areas at RM 125.6R, RM 124.2L, and RM 122L.

The most recently available map of the proposed Keystone Pipeline route shows that the line would cross the Yellowstone River at the lower end of Reach D3, at approximately RM 118.2 (www.keystone.steamingmules.com). The river is at Milepost 198 on the proposed pipeline route.

About 108 acres or 49% of the historic 5-year floodplain has become isolated in Reach D3, primarily due to flow alterations.

There are 11 acres of mapped Russian olive in the reach.

Bluff pools and terrace pools make up 22% of the low flow fish habitat mapped in the reach, indicating that this reach may provide important areas for fish species that prefer this habitat type.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 20,000 cfs or 14% lower than it was pre-development. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,820cfs to 2,750 cfs with human development, a reduction of 43%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,970 cfs under unregulated conditions to 3,240cfs under regulated conditions, a reduction of 55%.

Seasonal low flows have increased by 62% in the winter and 75% in the fall.

CEA-Related observations in Reach D3 include:
•Isolation of historic 5-year floodplain area due to flow alterations

Recommended Practices for Reach D3 include:
•Solid waste (dump site) removal at RM 125.6R, RM 124.2L, and RM 122L
•Pipeline crossing Practices at RM 126.2
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	68,900	53,700	-22.1%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	143,000	123,000	-14.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	859.0	873.8	874.4	875.1	16.1	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	1,492	1.7%	210	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**1,492**	**1.7%**	**210**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	85.7	56.1	13.81 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	3.3	2.2		
Acres/Year/Valley Mile	0.4	0.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-86.9	37	13.8	-36.1	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	107.6	49%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	100.7	13%	

Restricted Migration Area	Acres	% of CMZ	
	17.7	1%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	5,808.1	5,698.2	Flood (Ac)	1,421.0	1,504.2	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	21.5	69.3	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	597.7	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	65.1	78.0				

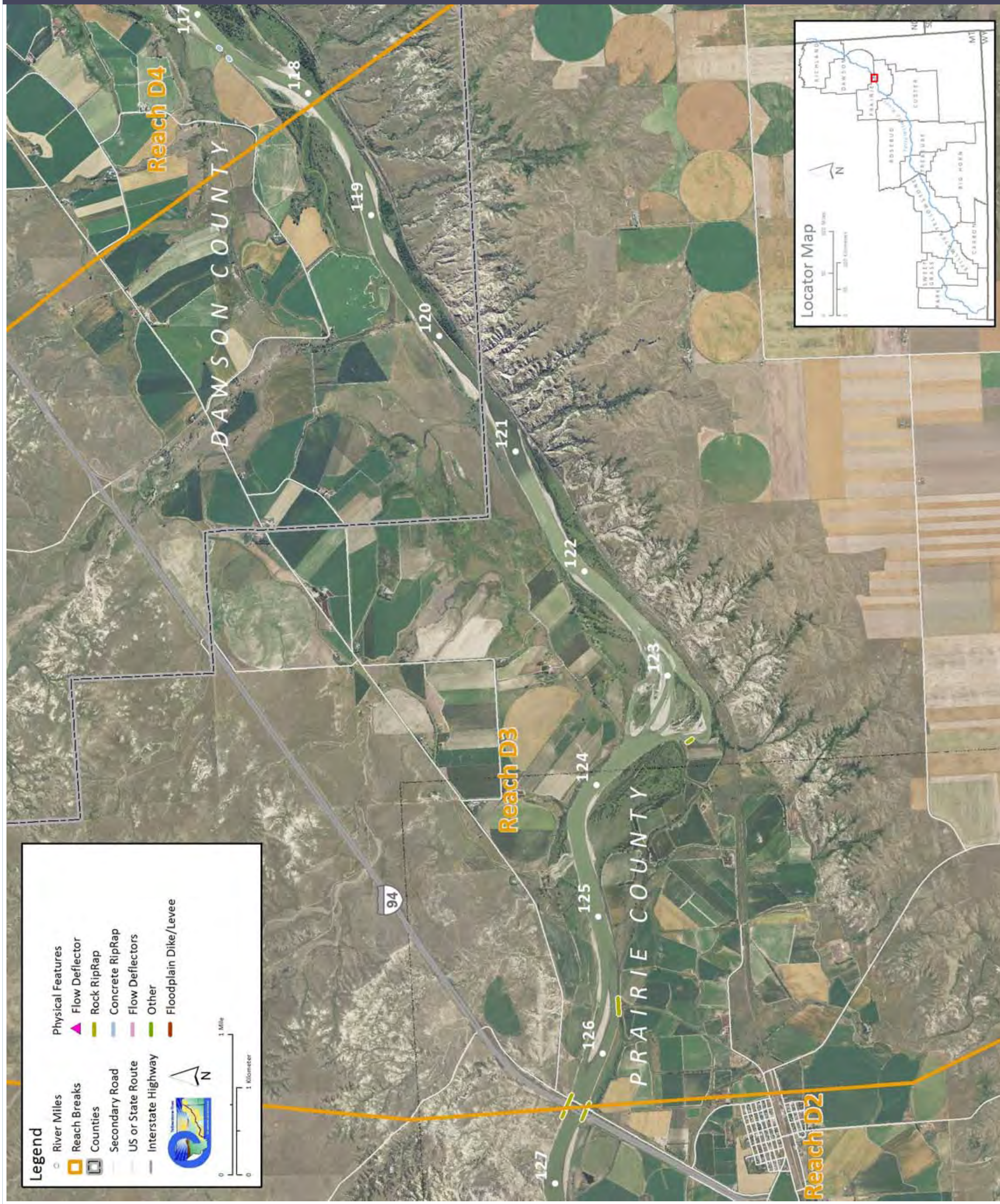
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	5.3	0.0	5.3	1.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	12.1	1.5	**99.3**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	80.1	10.2		
Scrub/Shrub	7.1	0.9		

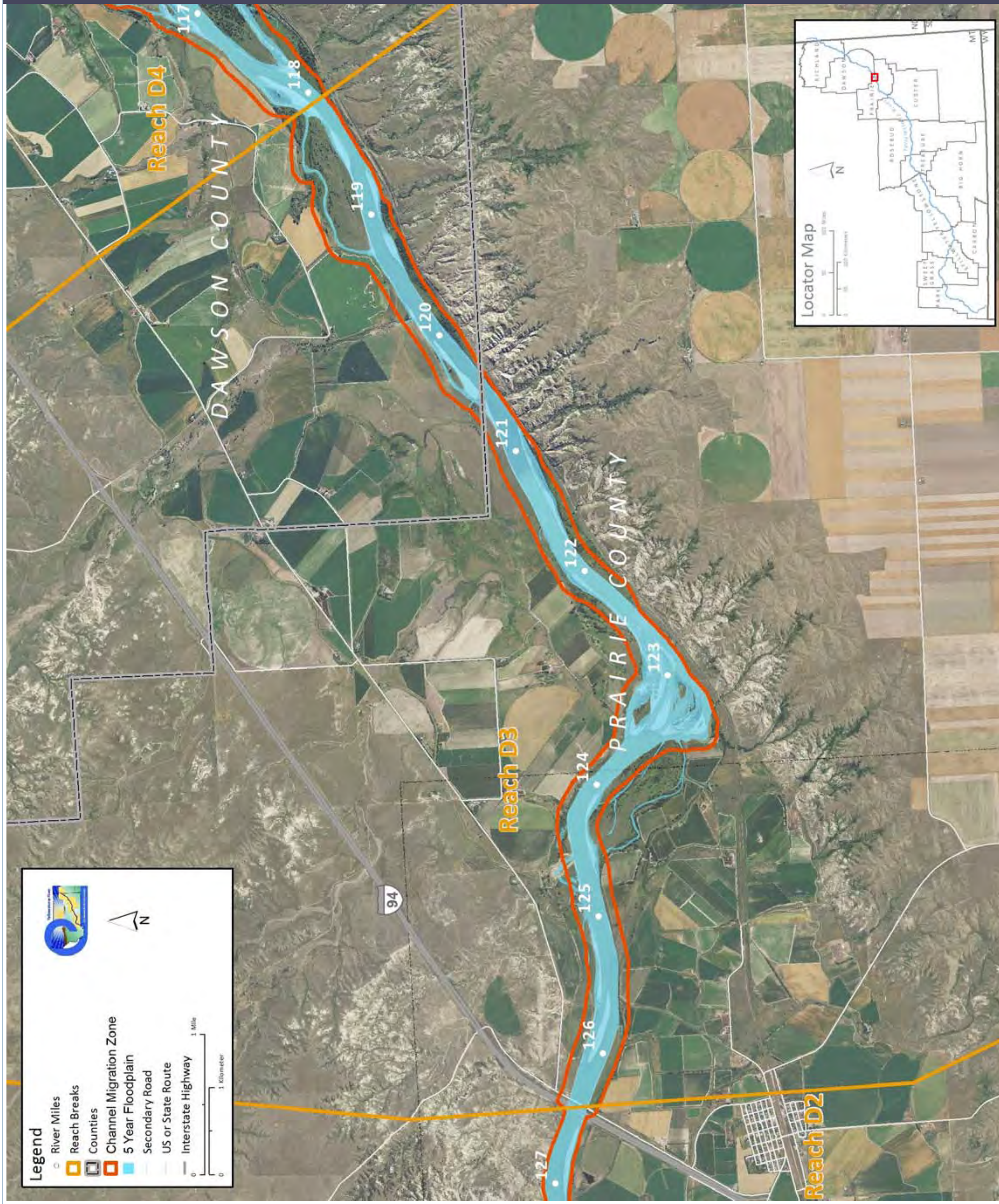
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	10.7	0.9%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	30.6	7.8	5.5	-25.1	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Dawson	**Upstream River Mile**	118.1
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	107.1
General Location	Hoyt	**Length**	11.00 mi (17.70 km)

Narrative Summary

Reach D4 is located in western Dawson County. The reach is 11 miles long and has a meandering planform with forested islands that formed where meanders have cut off.

Approximately 1,500 feet of bank armor has been mapped in the reach; including 920 feet of rock riprap and 590 feet of concrete riprap. This armor collectively covers about 1.3% of the bankline.

Prior to 1950, a side channel on the south floodplain at RM 110.8R was blocked by a small dike. This channel remnant is about a mile and a half long and currently has blockages at its middle and lower end.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D4 has gotten smaller since 1950. The channel contracted by about 115 acres in this reach since 1950, and about 84 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development. Although there has been net encroachment of riparian vegetation, most of this cover is either shrub or open timber. The extent of closed timber dropped from 371 acres in 1950 to 191 acres in 2001.

Land use is predominantly agricultural, with about 180 acres of pivot irrigation development since 1950. About 20 acres of land in pivot irrigation has encroached into the Channel Migration Zone (CMZ), making it especially susceptible to damage by river erosion. Although there has been extensive pivot development, most irrigated land had remained in flood irrigation in 2011 (2,300 acres). Approximately 125 acres of flood irrigated land is within the CMZ.

One solid waste dump site was mapped on the right bank at RM 117.8L. Animal handling facilities (corral complexes) were mapped within a few thousand feet of the river at RM 112.2R, RM 114L, and RM 116L.

About 195 acres or 46% of the historic 5-year floodplain has become isolated, primarily due to flow alterations.

There are 16 acres of mapped Russian olive in the reach. Most of the Russian olive is in tributary drainages that flow into the Yellowstone River from the north.

Due to a reduction in the extent of closed timber with time, the extent of riparian forest considered at low risk of cowbird parasitism in Reach D4 has been reduced since 1950. At that time, there were 36.5 acres per mile of forest considered less prone to cowbirds, but by 2001 that had dropped to 14.7 acres per mile of such forest.

One ice jam was recorded in Reach D4. On March 4, 1994, a breakup jam forced local evacuations due to flooding.

Bluff pools and terrace pools make up 22% of the low flow fish habitat mapped in the reach, indicating that this reach may provide important areas for fish species that prefer this habitat type.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 121,000 cfs, or 14% lower than it was pre-development. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,800cfs to 2,730 cfs with human development, a reduction of 43%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,980 cfs under unregulated conditions to 3,220cfs under regulated conditions, a reduction of 54%.

Seasonal low flows have increased by 63% in the winter and 76% in the fall.

CEA-Related observations in Reach D4 include:
•Increased risk of cowbird parasitism with loss of closed timber

Recommended Practices for Reach D4 include:
•Side channel reactivation at RM 110.3R
•Solid waste (dump site) removal at RM 117.8L
•Russian olive removal
•Nutrient management at corral complexes at RM 112.2R, RM 114L, and RM 116L

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,100	53,900	-22.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	145,000	124,000	-14.5%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,349.9	1,279.9	1,230.5	1,234.4	-115.5	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	921	0.8%	921	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	587	0.5%	587	
Flow Deflectors	0	0.0%	0	
Total	**1,509**	**1.3%**	**1,509**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	8,549	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	143.9	90.3	84.53 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	5.5	3.6		
Acres/Year/Valley Mile	0.5	0.4		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-1.2	70.4	-36.2	33.1	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	194.6	46%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	97.9	8%	

Restricted Migration Area	Acres	% of CMZ	
	55.2	2%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011	
Agricultural Land (Ac)	7,623.1	7,894.5	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	75.0	142.8	
Exurban (Ac)	0.0	0.0	
Urban (Ac)	0.0	0.0	
Transportation (Ac)	87.6	86.8	

	1950	2011
Flood (Ac)	1,601.4	2,320.7
Sprinkler (Ac)	0.0	44.1
Pivot (Ac)	0.0	180.0

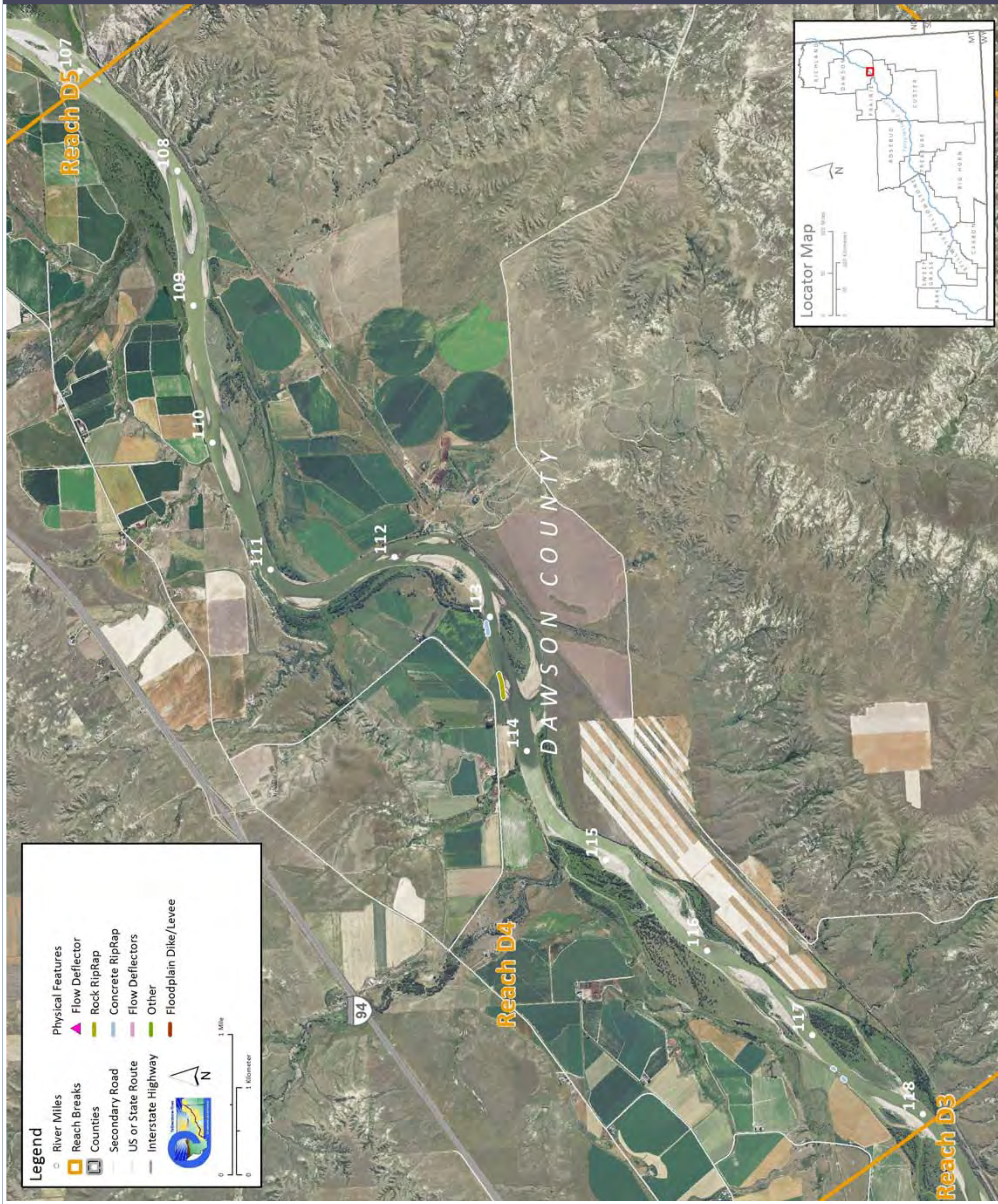
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	3.1	0.2	3.3	0.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	8.0	0.8	**135.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	103.2	10.1		
Scrub/Shrub	24.3	2.4		

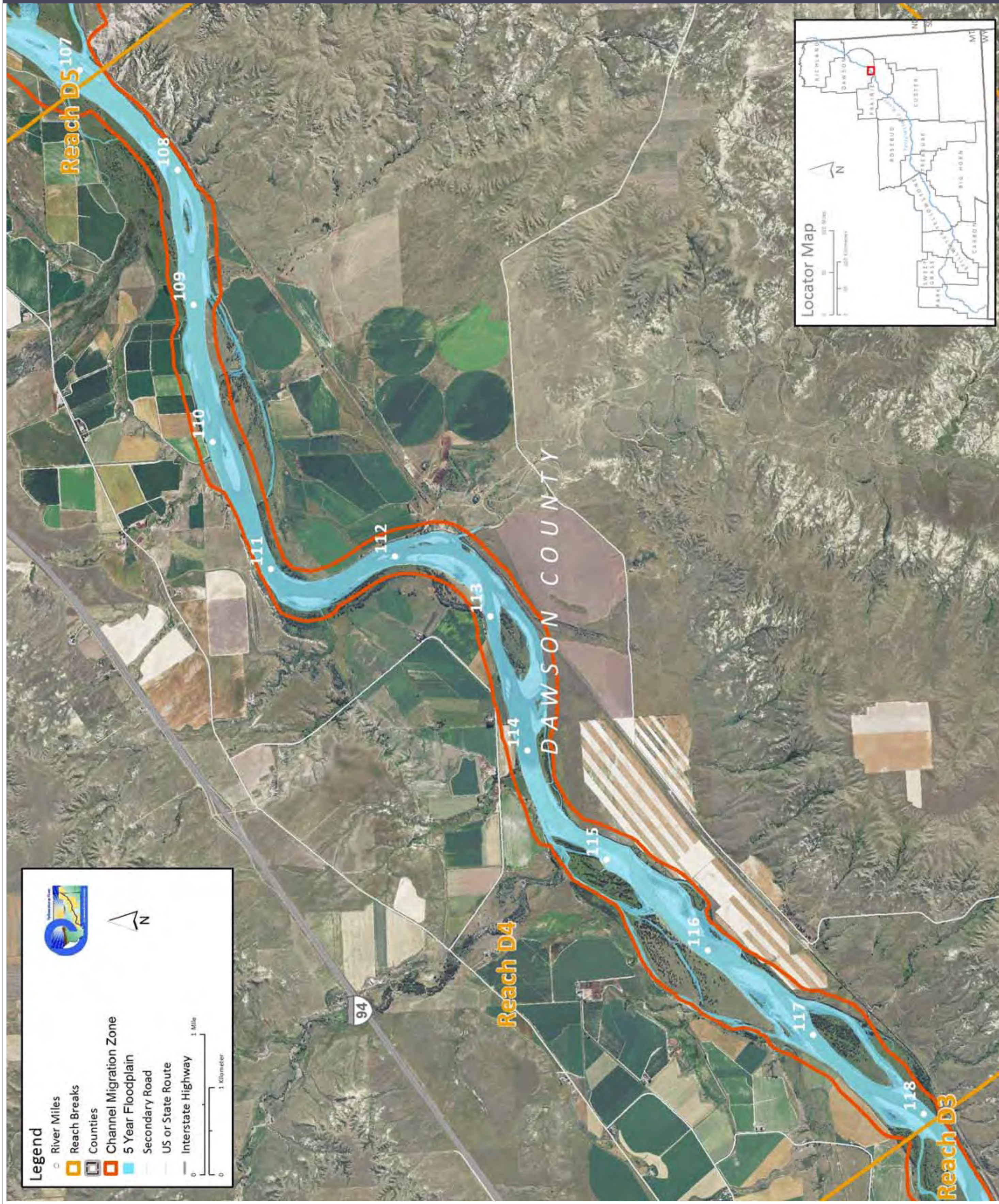
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	16.3	1.6%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	36.5	23.4	14.7	-21.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Dawson	**Upstream River Mile**	107.1
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	94.6
General Location	To Glendive	**Length**	12.50 mi (20.12 km)

Narrative Summary

Reach D5 is located just south of Glendive. The reach is a 12.5 mile long Partially Confined Anabranching reach type, indicating the presence of forested islands with some valley wall influence on the river. The downstream end of the reach is at Black Bridge. Within Reach D5, the river flows across the Cedar Creek Anticline, which is a~115 mile long structure that extends from Glendive to Buffalo South Dakota. Oil was discovered on the anticline in 1951, and since then over a half a billion barrels of oil have been produced from 2700 wells. As the river flows right through the anticline, the Pierre Shale becomes exposed in the right bluff line and the channel becomes more dynamic than upstream reaches. Active drill pads are located on both sides of the river; several of them are within the 100-year floodplain, and two are mapped within the CMZ.

Reach D5 has just over a mile of bank armor, and most of that armor is rock riprap. There are also 1,050 feet of concrete armor and a few flow deflectors. About 640 feet of riprap was built between 2001 and 2011. The majority of the bank armor is protecting either streambank just upstream of Black Bridge. Black Bridge forms a major constriction in the river corridor and bank migration upstream of the bridge has been extensive. The bridge is oriented about 45 degrees off of the axis of the river corridor which further disrupts channel processes upstream. Just upstream of the bridge the river migrated over 1,700 feet eastward between 1950 and 2001, which is over 30 feet per year on average.

Since 1950, a side channel that is over 9,000 feet of side channel has been blocked by a dike at RM 105R. The dike crossing the head of this old channel is about 720 feet long. There are still several side channels in the reach that are perennial (flow year-round) and over a mile long.

Floodplain turnover rates have dropped in Reach D5 since 1976; prior to that time, floodplain turnover rates were about 18.5 acres per year, and since then rates have averaged 14.2 acres per year. The reduction in rates has been coupled by an increase in the extent of woody riparian vegetation of almost 300 acres.

Land use is dominated by agriculture, with 219 acres of pivot irrigation development since 1950. Some of the irrigation development took place in historic riparian areas; a total of 161 acres of riparian lands were converted for agricultural and other land uses since 1950. Development near Glendive has created about 310 acres of urban/exurban land uses in the reach. About 190 acres or 3% of the total CMZ has become restricted by physical features. Residential development near Glendive has encroached into the CMZ; in 2011, there were over 75 acres of urban/exurban land uses mapped within the CMZ.

Six dump sites were mapped in the reach in 2001. These sites are at RM104L, RM104.2L, RM101L, RM98L, RM97.5L, and RM97.1L.

One ice jam has been recorded in Reach D5. A breakup event was recorded on March 17, 2011, but no damages were recorded.

There is one pipeline crossing in the reach at RM100. This crossing is the Poplar Pipeline owned by Bridger Pipeline, a 10 inch crude oil pipeline that ruptured in 2015. The pipeline crossing is located at the downstream end of a large forested island. Bank migration at the site has been relatively slow.

About 8% of the total 100-year floodplain has become isolated due to human development and most of that isolated floodplain area is behind floodplain dikes near Black Bridge. The 5-year floodplain is even more affected; 31% of the historic 5-year floodplain is no longer inundated at that frequency. There has been over 1,260 acres of woody riparian vegetation recruitment in the reach since 1950, indicating generation of new forest, some of which reflects encroachment due to lower flows and a shrinking river channel. The bankfull area of the channel has dropped by 255 acres since 1950. Some of that riparian expansion has been due to Russian olive colonization; there are just under 50 acres of mapped Russian olive in the Reach D5 floodplain.

Reach D5 was sampled as part of the fisheries study. A total of 33 fish species were sampled in the reach including four identified by the Montana Natural Heritage Program as a Species of Concern (SOC): the Blue sucker, Pallid sturgeon, Sauger, and Sturgeon chub.

Reach D5 was sampled as part of the avian study. A total of 33 bird species were identified in the reach. One bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) was found, the Plumbeous vireo. The Red-headed woodpecker was also observed, which has been identified as a Species of Concern (SOC). Reach D5 has seen a decrease in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 86 acres per valley mile of such forest, and that number increased to 38 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,800 cfs to 2,720 cfs with human development, a reduction of 436%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,980 cfs under unregulated conditions to 3,220cfs, a reduction of 54%.

CEA-Related observations in Reach D5 include:
•Channel migration issues upstream of major constriction that is poorly aligned to corridor (Black Bridge)

Recommended Practices for Reach D5 include:

- Side channel reactivation at RM 104.5
- Russian olive removal
- Pipeline Crossing Practices at RM100
- Dump site removal at RM104L, RM104.2L, RM101L, RM98L, RM97.5L, and RM97.1L

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,200	54,000	-22.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	145,000	124,000	-14.5%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	2,086.3	1,995.7	1,964.9	1,830.9	-255.4	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	4,408	3.3%	638	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	1,049	0.8%	0	
Flow Deflectors	58	0.0%	58	
Total	**5,515**	**4.1%**	**696**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
		9,066	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	479.8	355.3	294.44 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	18.5	14.2		
Acres/Year/Valley Mile	1.7	1.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-7.9	28.3	21.8	42.2	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	536.1	31%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	248.3	8%	

Restricted Migration Area	Acres	% of CMZ	
	189.6	3%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	7,069.1	6,378.8	Flood (Ac)	864.7	1,691.1	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	25.2	114.2	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	23.7	Pivot (Ac)	0.0	218.5	
Urban (Ac)	0.0	391.2				
Transportation (Ac)	105.6	102.2				

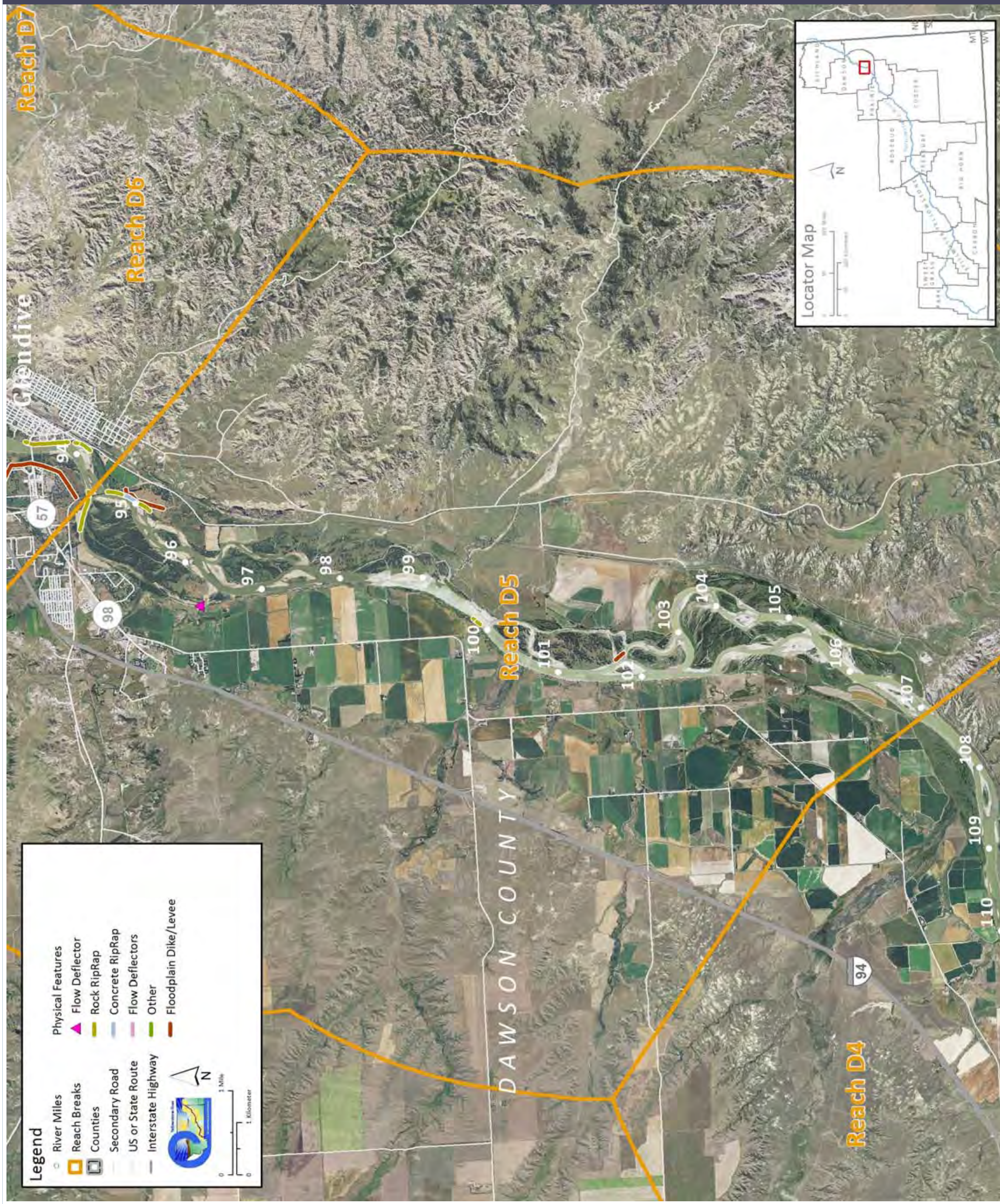
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	114.0	46.8	160.8	6.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	23.7	2.2	**278.7**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	152.8	14.3		
Scrub/Shrub	102.2	9.5		

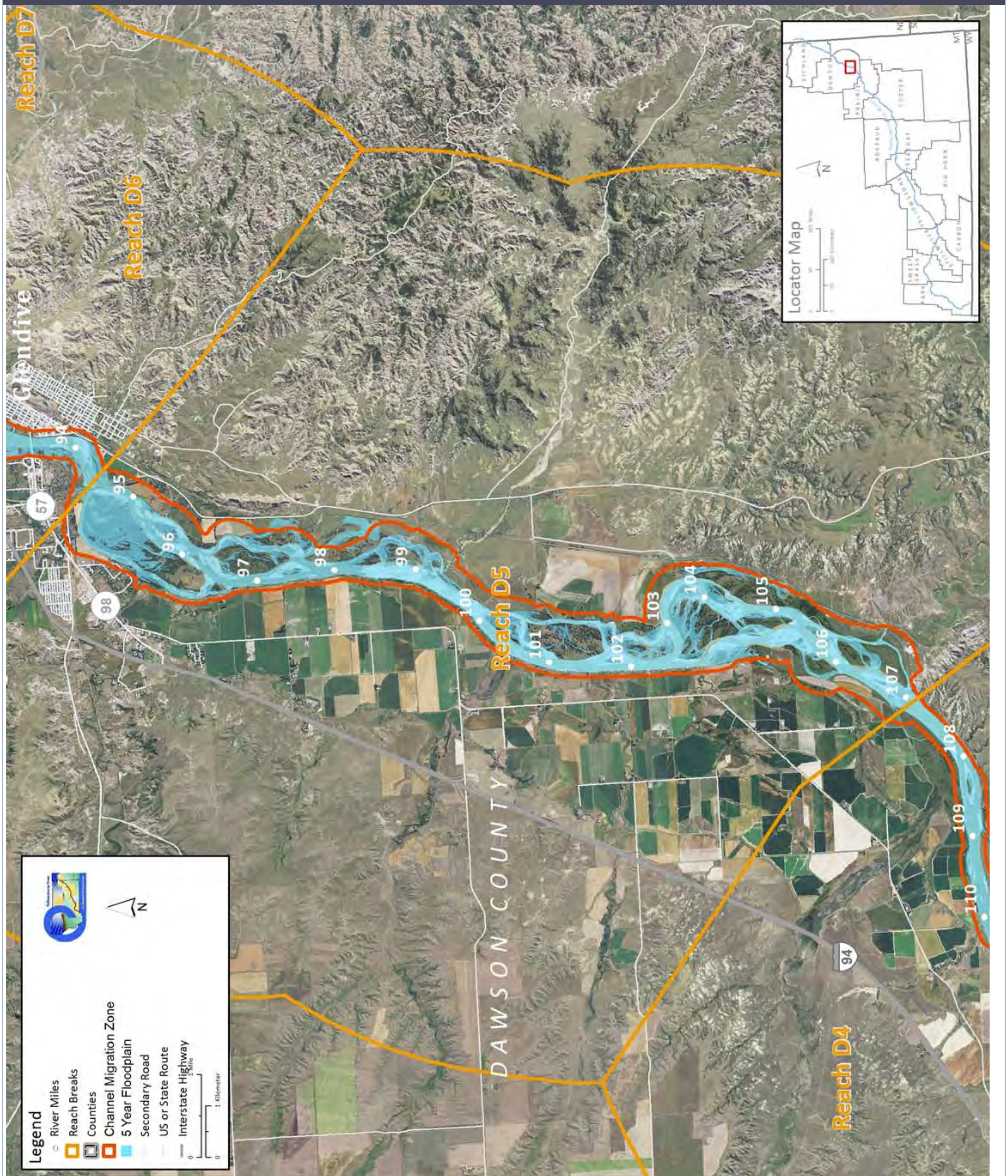
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	49.0	2.6%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	86.2	57.1	38.3	-47.9	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Dawson	**Upstream River Mile**	94.6
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	89
General Location	Glendive	**Length**	5.60 mi (9.01 km)

Narrative Summary

Reach D6 is located in Dawson County at Glendive. The reach is a 5.6 mile long Partly Confined Meandering reach type, extending from Black Bridge at RM 89.0 to downstream of Glendive at RM 94.6. The partial confinement is imposed by terraces and Hell Creek Formation bluff line. The reach is fairly straight, with minor bendways and several densely vegetated islands. Within Reach D6, the Yellowstone River has been directly affected by both urban/exurban development and the I-94 transportation corridor.

Reach D6 has almost a mile of bank armor including 2,930 feet of rock riprap, 1,200 feet of concrete riprap, and 760 feet of flow deflectors as mapped in 2011. About 8.3% of the total bankline is armored. Between 2001 and 2011, about 1,300 feet of rock riprap and 200 feet of flow deflectors were built, whereas 354 feet of concrete riprap were destroyed.

Prior to the 1950s, about three miles of side channel were blocked in the reach by physical features. Since then another three miles have been blocked such that a total of six miles of side channel have been blocked in this urbanized section of the Yellowstone River. The side channel losses occurred under the interstate and near the mouth of Glendive Creek. In 1950, the side channel under the interstate was almost three miles long before being blocked off.

Floodplain dikes have isolated historic floodplain area. There are 14,700 feet of floodplain dikes mapped in the reach, most of which was built between 1950 and 1976. There are also 23,736 feet of transportation encroachments. The encroachments associated with the railroad have been in place since 1950; however the length of bridge approaches increased substantially from 1950 to 1976, which is when I-94 was constructed. The large West Glendive Dike (RM 93.5) was constructed in 1957 by the US Army Corps of Engineers to protect the west Glendive area from Yellowstone River flooding.

There are five bridge crossings in Reach D6. The uppermost crossing is referred to as the BNSF “Black Bridge”, which is a 1325 ft long steel truss bridge at RM 94.5. There is a natural gas pipeline crossing at the bridge. Just downstream at RM 93.6, the “Old Bell Street Bridge’ is a 1,290 foot long bridge that was originally built in 1894, then destroyed by ice in 1899, and rebuilt in 1924. It is currently preserved as a pedestrian bridge. Approximately 0.1 mile downstream, the Towne Street Bridge is a 1,318 ft long steel girder/floor beam structure that was built in 1958. About 1.3 miles downstream from that structure, I-94 consists of two bridges built in 1968. These bridges are 2,013 and 1,973 feet long, and both are steel girder/floor beam structures. The I-94 bridges restrict about 200 acres of the CMZ.

Some of the most severe ice jamming in Montana occurs in Glendive. A total of 30 ice jam floods have occurred in the Glendive area since 1890 (COE, 2009). Descriptions of these and even older ice jams include loss of life (1894, 1899), bridge failure (1899) and major flooding (1899, 1936, 1969, 1986 and 1994). In 1980, FEMA concluded that the West Glendive Levee did not provide adequate protection from ice jam flooding (COE, 2009). According to the COE (2009), the majority of ice jams form downstream of the I-94 Bridge and its embankment, which acts as a flow obstruction on the left floodplain of the Yellowstone River. This embankment cuts off a side channel of the Yellowstone, "which may have historically provided a relief for floodwaters to flow around the ice jams" (COE, 2009).

Similar to many reaches on the Lower Yellowstone, the river has gotten smaller since 1950. At that time, the bankfull channel area in Reach D6 was 810 acres, and by 2001 it was 640 acres, which is a reduction of 21%. This has been accompanied by the encroachment of 134 acres of riparian vegetation into old channel areas. On the floodplain, however, riparian clearing has been notable; since 1950 over 400 acres of riparian vegetation was converted to another land use, which was 32% of the entire 1950s riparian footprint.

Floodplain turnover rates in Reach D6 have dropped from 4 acres per year prior to 1976 to 2 acres per year since then. This is also a common trend on the lower river, as the influences of bank armor and reduced flow energy have collectively slowed rates of channel change.

Land use is dominated by agriculture and urban/exurban development; although there is over 1,300 acres of urban, exurban, and transportation-related land uses, there are still over 3,100 acres of agricultural land. Most is non-irrigated, but 502 acres are in flood irrigation and 280 are in pivot. Between 1950 and 2011 approximately two square miles of land was converted to Urban and Exurban uses in the Glendive area. Much of this growth occurred in the now-leveed area on the west side of the river.

About 18% of the total 100-year floodplain has become isolated due to human development and most of that isolated floodplain area is behind floodplain dikes. The 5-year floodplain is even more affected; 51% of the historic 5-year floodplain is no longer inundated at that frequency.

Reach D6 was sampled as part of the fisheries study. A total of 27 fish species were sampled in the reach including three identified by the Montana Natural Heritage Program as a Species of Concern (SOC): the Blue sucker, Sauger, and Sturgeon chub.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped from 146,000cfs pre-development to 125,000 cfs currently, which is a 14% reduction. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Summer base flows have dropped by 54% with human development, from 6,990 cfs to 3,210 cfs, a 54% reduction. In contrast, fall and winter base flows have both increased between 60% (winter) and 75% (fall). Fall and wither base flows are currently 2,030 and 2,110 cfs, respectively.

CEA-Related observations in Reach D6 include:
•Loss of side channels due to physical features
•Shrinking of channel due to flow consolidation and reduced high flows.
•Extensive transportation encroachment
•Dike construction post-1950 to facilitate urban/exurban development in West Glendive

Recommended Practices for Reach D6 include:
•Bank armor removal at RM 92.8L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	69,400	54,200	-21.9%
100 Year (cfs)	146,000	125,000	-14.4%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	810.6	695.8	659.4	640.3	-170.4

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	2,933	5.0%	1,278
Concrete Riprap	1,188	2.0%	-345
Flow Deflectors	762	1.3%	173
Total	**4,882**	**8.3%**	**1,106**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	16,884	16,597

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	103.6	49.8
Acres/Year	4.0	2.0
Acres/Year/Valley Mile	0.8	0.4

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

134.35 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	37.4	9.5	7.4	54.3

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	528.6	52%
100 Year	354.0	18%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	326.0	18%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	3,201.5	3,067.3
Ag. Infrastructure (Ac)	27.4	70.7
Exurban (Ac)	0.0	231.2
Urban (Ac)	563.1	987.6
Transportation (Ac)	110.3	169.6

	1950	2011
Flood (Ac)	304.1	502.4
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	279.4

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	274.9	134.3	409.2	32.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	47.0	9.1
Emergent	88.9	17.1
Scrub/Shrub	18.6	3.6

Total Wetland Acres **154.5**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

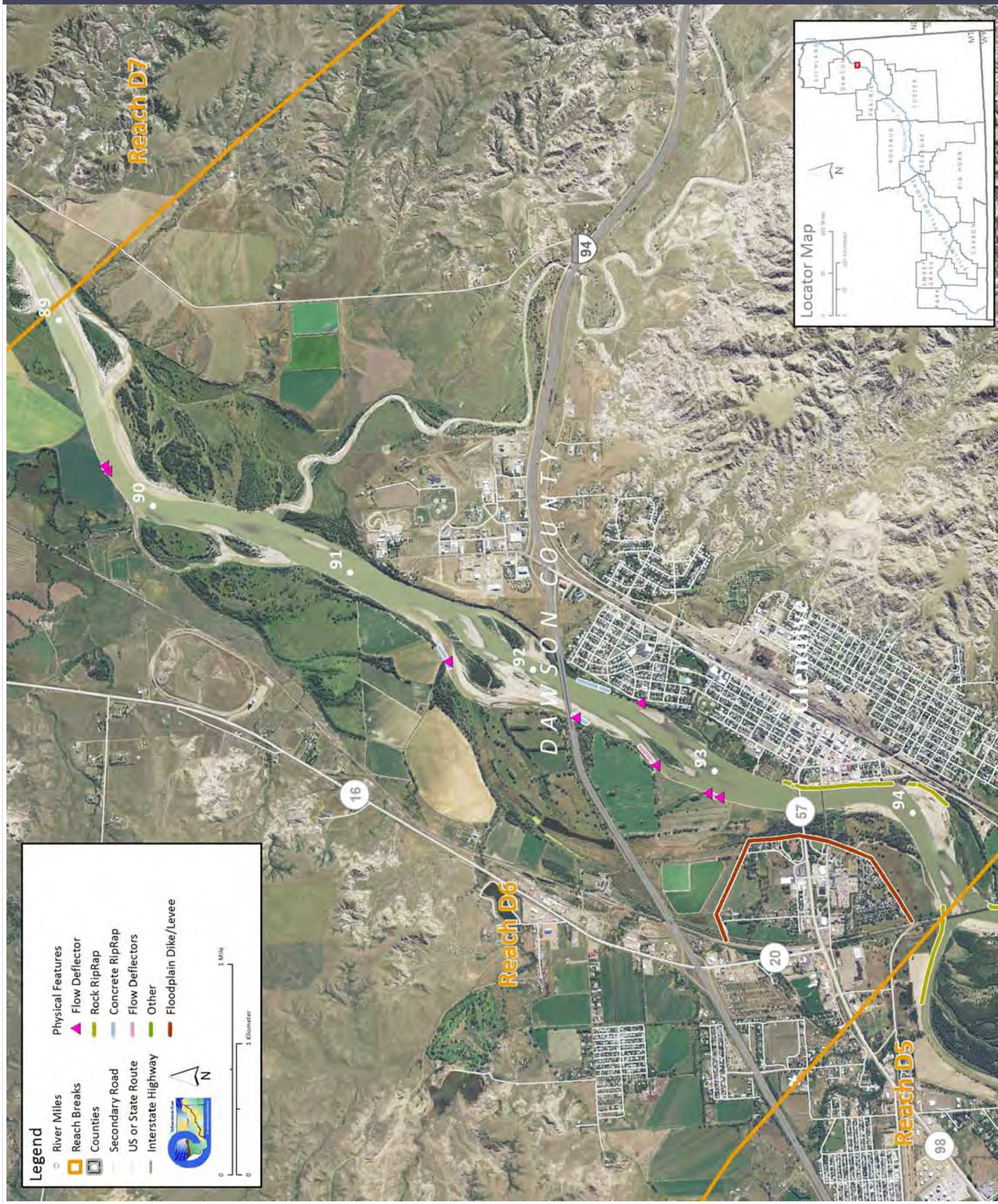
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	7.1	0.5%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

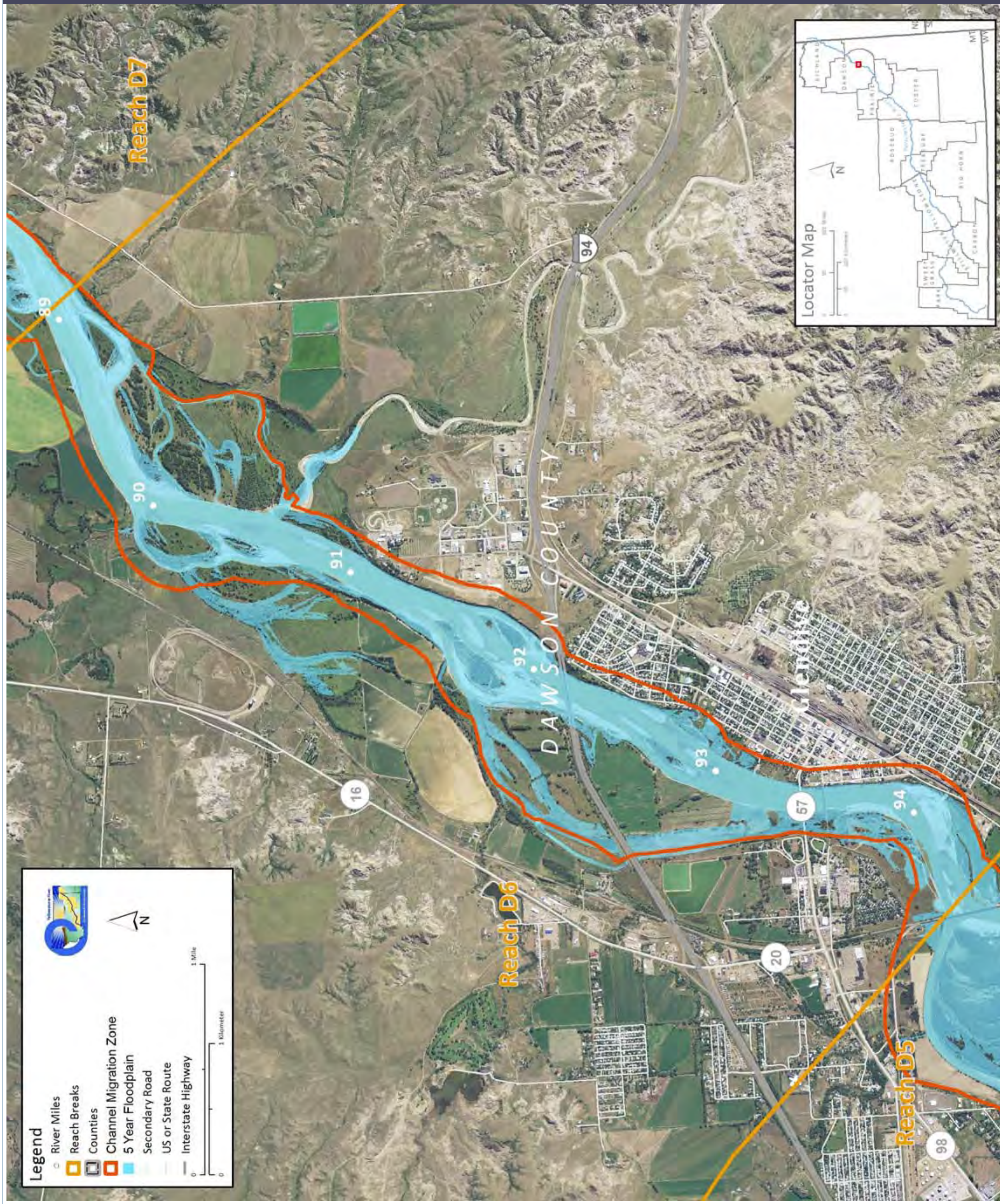
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	21.8	4.3	24.8	3.0

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Dawson	**Upstream River Mile**	89
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	81.4
General Location	Downstream of Glendive	**Length**	7.60 mi (12.23 km)

Narrative Summary

Reach D7 is located just downstream of Glendive. It is 7.6 miles long and is a Partially Confined Anabranching (PCA) reach type, including some valley wall influence as well as numerous forested islands. These reach types tend to be relatively dynamic with high rates of channel change through time. The Stipek Fishing Access Site is located in the middle portion of the reach.

No bank armor has been mapped in Reach D7, and no side channels have been blocked by dikes. About two miles of transportation encroachment by the railroad was mapped in Reach D7, all of which was in place by 1950.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D7 has gotten smaller since 1950. The channel contracted by about 121 acres in this reach since 1950, and about 150 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development. Floodplain turnover rates have dropped from 8.9 acres per year pre-1976 to5.4 acres per year post-1976.

Even though no side channels have been intentionally blocked, Reach D7 has lost about 3,800 feet of side channel length since 1950. This is likely due to passive loss caused by a reduction in high flows. Lower flows have also resulted in the isolation of 48% of the historic 5-year floodplain.

Land use is predominantly agricultural, with about 258 acres of pivot irrigation development since 1950. There are 27 acres of pivot irrigation and 21 acres of exurban land uses in the Channel Migration Zone. Two dump sites have been mapped on the right bank at RM 84R and RM85.9R.

There are 7.4 acres of mapped Russian olive in the reach.

Reach D7 was part of the avian study. A total of 43 species were identified in the reach, including the Ovenbird, which has been identified by the Montana Natural Heritage Program as a Potential Special Concern. The Black-billed Cuckoo and Red-headed Woodpecker were also identified, both of which are Species of Concern.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 127,000 cfs, which 12% lower than it was pre-development (145,000cfs). The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,700cfs to 2,600 cfs with human development, a reduction of 45%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,890 cfs under unregulated conditions to 3,110cfs under regulated conditions, a reduction of 55%.

Seasonal low flows have increased by 78% in the winter and 62% in the fall. Both fall and winter base flows are currently about 3,500 cfs.

CEA-Related observations in Reach D7 include:
•Passive loss of side channels with flow alterations

Recommended Practices for Reach D7 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,500	54,200	-22.0%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	145,000	127,000	-12.4%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,223.9	1,230.6	1,141.1	1,102.9	-121.1	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	0	0.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**0**	**0.0%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	230.7	133.9	149.38 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	8.9	5.4		
Acres/Year/Valley Mile	1.3	0.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-52.3	40.4	-2.8	-14.6	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	395.2	48%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	43.6	2%	

Restricted Migration Area	Acres	% of CMZ	
	6.0	0%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011	
Agricultural Land (Ac)	4,756.4	4,620.5	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	29.3	83.7	
Exurban (Ac)	0.0	48.9	
Urban (Ac)	0.0	0.0	
Transportation (Ac)	88.2	90.2	

Irrigated (sub-set of Agricultural Land)	1950	2011
Flood (Ac)	0.0	708.1
Sprinkler (Ac)	0.0	25.5
Pivot (Ac)	0.0	258.3

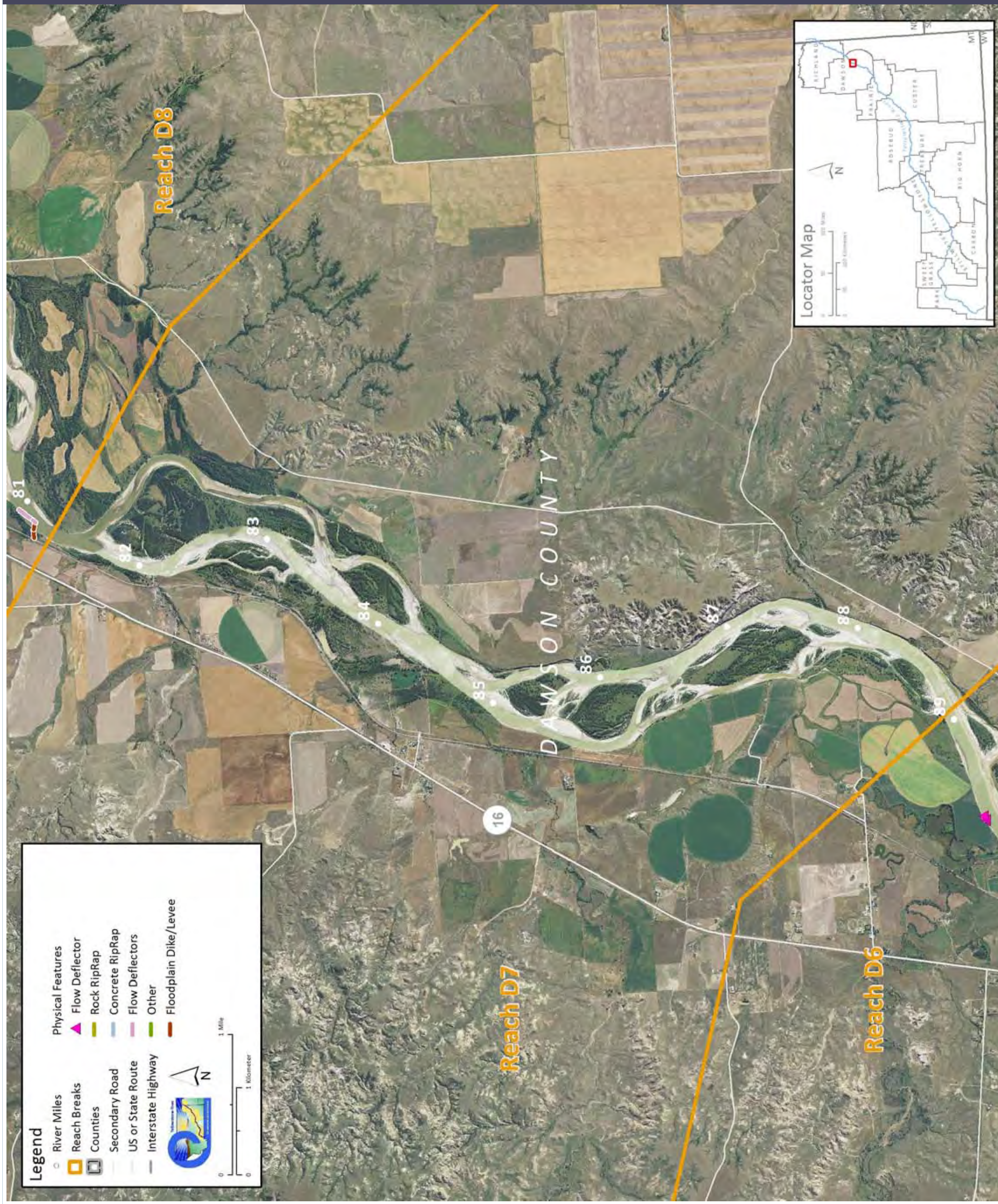
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	57.6	19.8	77.4	5.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	28.9	4.2	**148.2**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	72.3	10.6		
Scrub/Shrub	47.1	6.9		

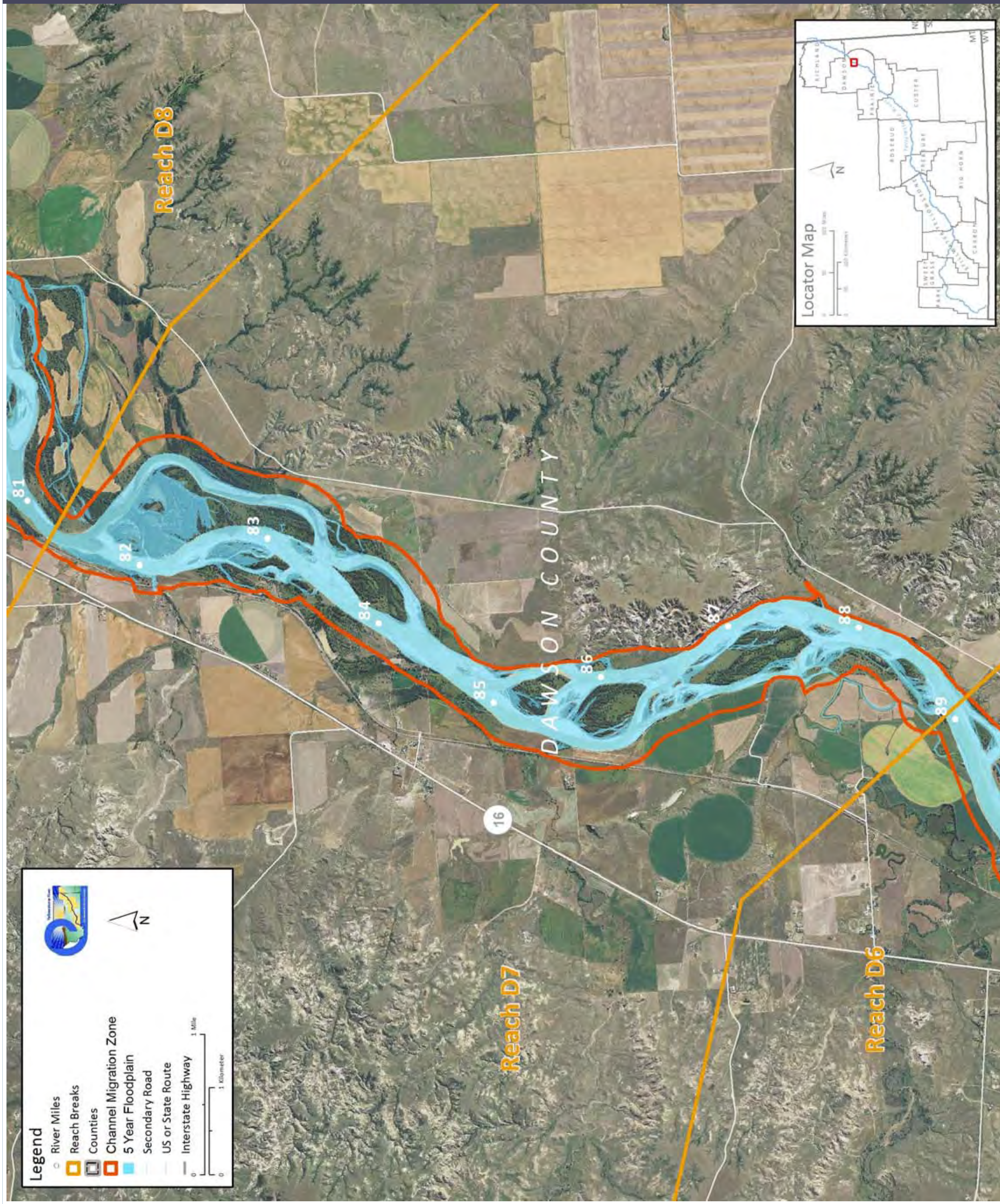
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	7.4	0.2%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	116.2	85.5	108.4	-7.9	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Dawson	**Upstream River Mile**	81.4
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	71.1
General Location	Intake	**Length**	10.30 mi (16.58 km)

Narrative Summary

Reach D8 is located in Dawson County, and includes Intake Diversion Dam. The reach is a Partly Confined Anabranching reach type, indicating distinct side channels around forested islands, and some valley wall influence on the active channel. Intake Diversion Dam is located on the lower end of the reach at RM 73.

The primary form of bank stabilization in Reach D8 is rock riprap, with 4,576 feet or 1.9% of the total bankline mapped as armored in 2011. All of the bank armor in Reach D8 is protecting either Intake Diversion or the railroad grade; the majority (3,178 ft) is against the rail line. In the uppermost part of the reach at RM 81L, over 1,500 feet of flow deflectors were flanked between 2001 and 2011. At RM 77L, the river has flanked two sections of rock riprap protecting the rail line, forming two large scallops in the bank that currently threaten to undermine the toe of the railroad embankment.

The largest diversion dam on the Yellowstone River is Intake Diversion Dam at RM73. Construction of the dam began in 1905, in response to authorization under the Reclamation Act of 1902 (http://www.fws.gov/yellowstonerivercoordinator/Intake.html). Intake Dam was completed in 1911 and is used to irrigate 50,000 acres of land in eastern Montana and western North Dakota. The original dam crest was 12 feet above the river bed; and the structure stretches 700 feet across the river. With a diversion capacity of 1,200 cfs, it feeds Intake Canal and a ~225 mile network of lateral canals that distribute water to approximately 500 farms. Fish passage issues at this structure are currently being addressed by the Bureau Reclamation, US Army Corps of Engineers, MT Fish Wildlife and Parks, US Fish and Wildlife Service, and Lower Yellowstone Irrigation District.

Reach D8 has lost almost three miles of side channel length since 1950, and none of this loss is attributable to floodplain dikes. Similar to other reaches in the lower Yellowstone River valley, side channel loss has occurred to both intentional blockages, as well as lost connectivity due to flow alterations. Flow alterations have also resulted in lost connectivity to the 5-year floodplain; development in the basin has resulted in the isolation of 58% of the historic 5-year floodplain.

There are 110 acres of sprinkler irrigation and 19 acres of exurban land in the Channel Migration Zone in Reach D8, making these areas especially susceptible to threats of river erosion.

There has been a net increase of woody riparian vegetation in Reach D8 of approximately 210 acres since 1950, indicating riparian colonization of open gravel bars and channel margins.

There are about 10 acres of mapped Russian olive in the reach.

Reach D8 was sampled as part of the avian study. A total of 21 species were identified in the reach, including the Red-headed Woodpecker, which is a Species of Concern.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 128,000 cfs, which 12% lower than it was pre-development (145,000cfs). The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,630cfs to 2,520 cfs with human development, a reduction of 46%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,810 cfs under unregulated conditions to 3,030cfs under regulated conditions, a reduction of 55%.

Seasonal low flows have increased by 78% in the winter and 62% in the fall. Both fall and winter base flows are currently about 3,500 cfs.

CEA-Related observations in Reach D8 include:
- Passive loss of side channels with flow alterations
- Low avian species richness
- Passive loss of 5-year floodplain area

Recommended Practices for Reach D8 include:
- Flanked bank armor removal at RM 77L and RM 81L
- Fish Passage Practices at Intake Diversion Dam (RM 73)
- Watercraft Passage BMP at Intake Diversion Dam (RM 73)
- Irrigation Structure Management at Intake Diversion Dam (RM 73)
- Russian olive removal

Yellowstone River Reach Narratives

Reach D8

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	69,500	54,200	-22.0%
100 Year (cfs)	145,000	128,000	-11.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	1,463.9	1,387.3	1,312.1	1,280.0	-183.9

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	4,576	4.3%	435
Concrete Riprap	0	0.0%	0
Flow Deflectors	0	0.0%	-763
Total	**4,576**	**4.3%**	**-328**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	177.2	104.2
Acres/Year	6.8	4.2
Acres/Year/Valley Mile	1.0	0.6

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

207.5 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	-121.4	56.3	17.9	-47.1

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	612.7	58%
100 Year	99.2	3%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	28.2	1%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	5,328.8	5,253.4
Ag. Infrastructure (Ac)	39.9	117.3
Exurban (Ac)	17.3	56.5
Urban (Ac)	0.0	0.0
Transportation (Ac)	139.9	115.5

	1950	2011
Flood (Ac)	44.2	270.7
Sprinkler (Ac)	7.0	164.3
Pivot (Ac)	0.0	180.0

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	151.6	23.2	174.8	6.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	13.7	2.0
Emergent	46.2	6.6
Scrub/Shrub	24.3	3.5

Total Wetland Acres **84.2**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

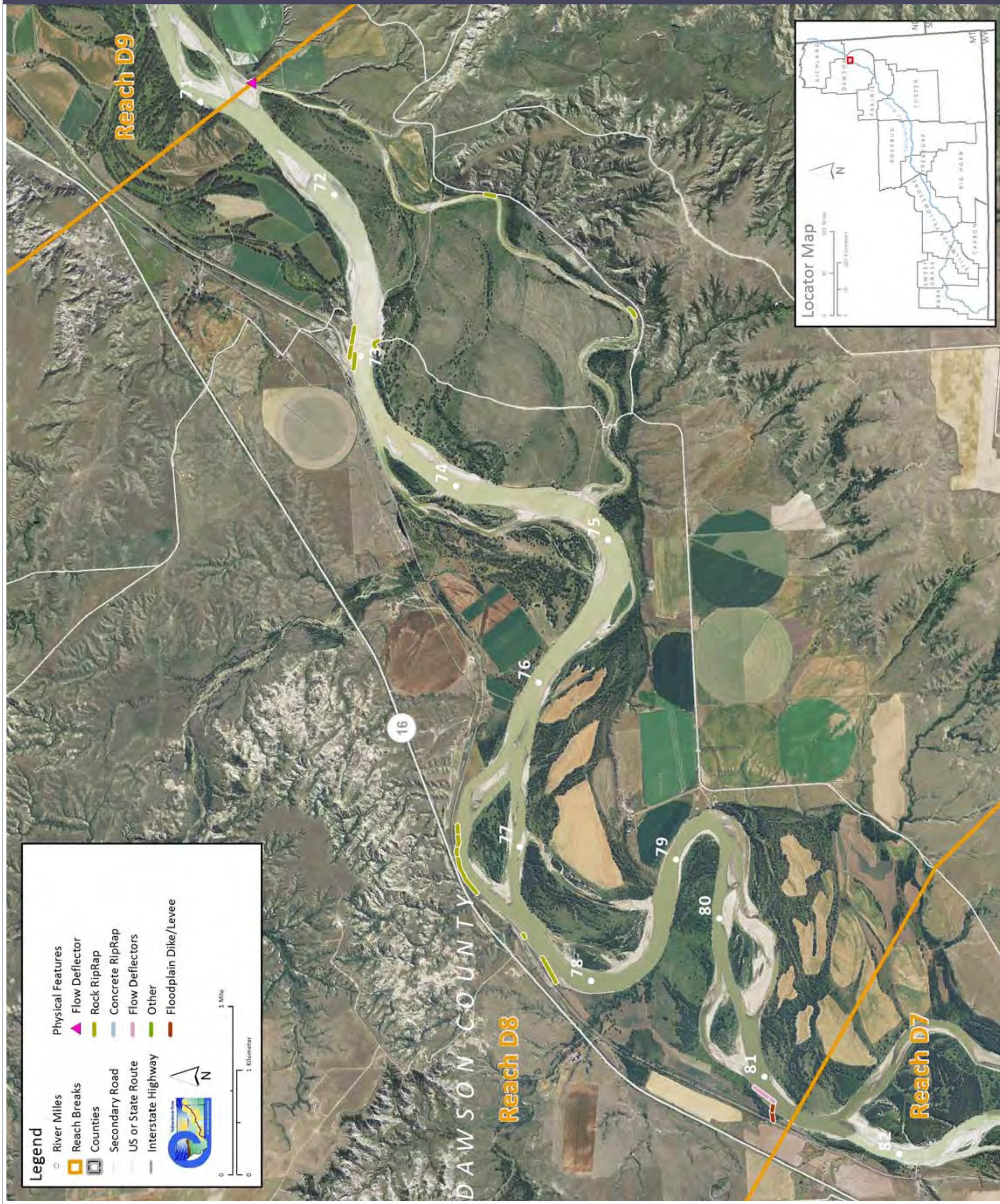
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	9.7	0.2%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

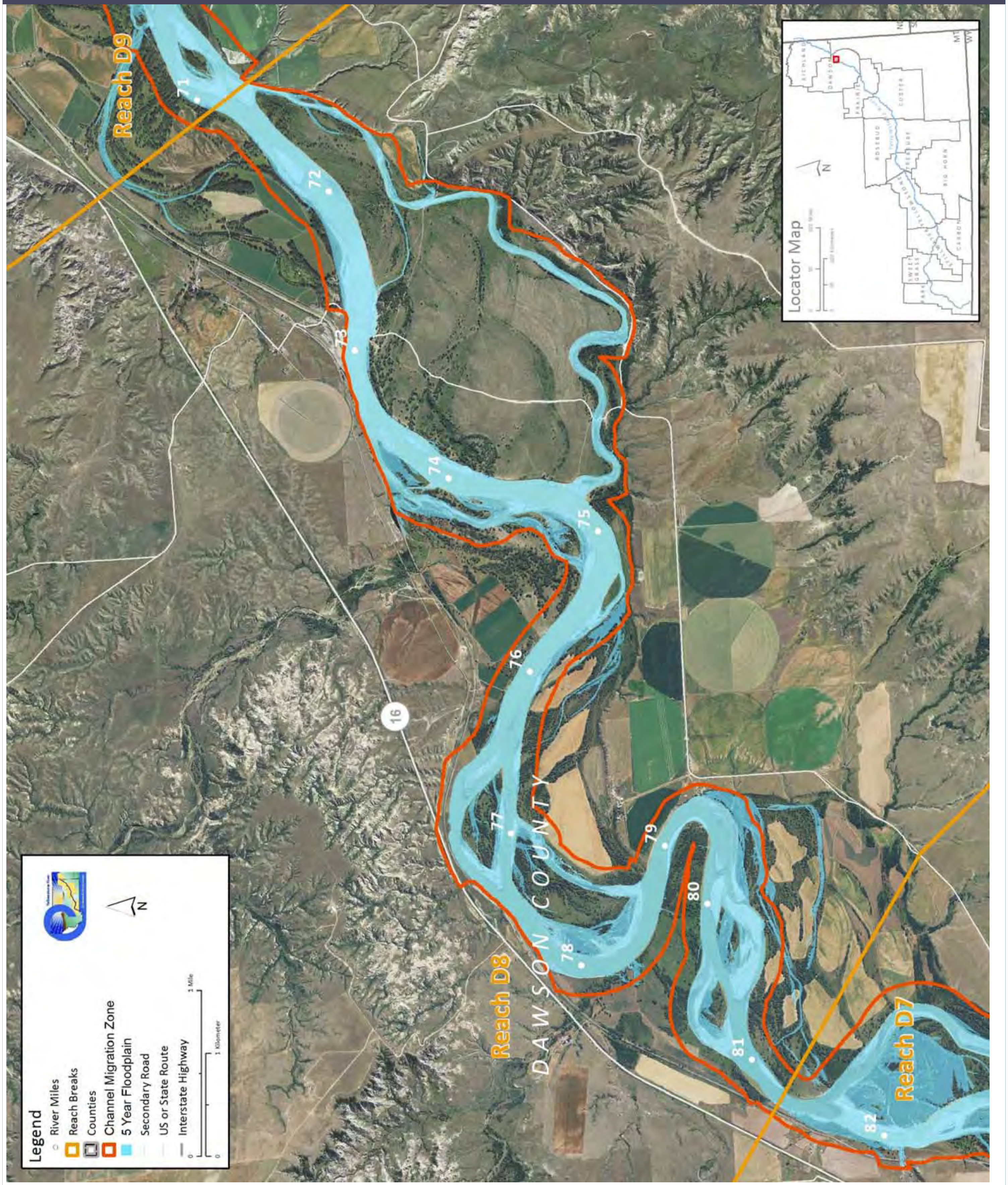
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	106.2	97.2	85.0	-21.1

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



Yellowstone River Reach Narratives

Reach D9

County	Dawson	**Upstream River Mile**	71.1
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	67.8
General Location	Downstream of Intake	**Length**	3.30 mi (5.31 km)

Narrative Summary

Reach D9 is located in Dawson County and starts 1 mile below the Intake Diversion Dam. The reach is a 3.3 mile long Partly Confined Meandering with Islands (PCM/I) reach type, indicating a single-threaded channel with vegetated islands and some valley wall influence on the active channel. This reach is currently the most upstream reach that fully supports pallid sturgeon and paddlefish in the watershed.

This reach has almost no bank armor. There are almost three miles of floodplain dikes associated with irrigation, and two miles of transportation encroachment associated with the railroad grade.

By 1950 almost three miles of side channel had been blocked in Reach D9, with another mile blocked since then. At RM 68.8L, discreet dikes block a side channel that remains within the riparian area, suggesting some potential for restoration.

There is one small rapid in the reach at RM 69.8 where it appears that a bedrock shelf is exposed in the riverbed.

Isolation of the 100 year floodplain has resulted from both physical features on the floodplain as well as reduced flows with human development. In Reach D9, 170 acres of the floodplain, which is 15 percent of the historic floodplain area, is no longer inundated at that frequency. Most of this area isolated is out in flood irrigated fields on the west floodplain. The 5-year floodplain, which has become smaller primarily due to flow alterations, has lost 161 acres or 50% of its original footprint.

Land use is predominantly agricultural, with about 183 acres of pivot irrigation development since 1950. There are a total of 19 acres of pivot-irrigated ground within the Channel Migration Zone (CMZ), making these fields especially prone to river erosion.

Reach D9 has seen an increase in the amount of forest area considered at low risk of cowbird parasitism. In 1950, there were 42.3 acres per valley mile of such forest, and by 2001, that number had increased to 79.7 acres per valley mile.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 128,000 cfs, which is 12% lower than it was pre-development (145,000cfs). The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,630cfs to 2,460 cfs with human development, a reduction of 47%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,760 cfs under unregulated conditions to 2,980cfs under regulated conditions, a reduction of 56%.

In the fall and winter, low flows are typically around 3,500cfs, which is 60-75% higher than historic flow conditions.

CEA-Related observations in Reach D9 include:
•Floodplain isolation due to flow alterations and agricultural dikes
•Side channel blockages

Recommended Practices for Reach D9 include:
•Side channel reactivation at RM 68.8L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,600	54,200	-22.1%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	145,000	128,000	-11.7%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	434.7	456.9	410.8	418.7	-16.0	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	0	0.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	45	0.1%	45	
Total	**45**	**0.1%**	**45**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	14,796	6,635	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	95.2	61.2	35.3 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	3.7	2.4		
Acres/Year/Valley Mile	1.2	0.8		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	47.2	15	-22.5	39.7	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	161.4	50%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	170.4	15%	

Restricted Migration Area	Acres	% of CMZ	
			Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,008.1	3,102.1	Flood (Ac)	760.3	708.0	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	81.3	78.3	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	183.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	35.2	35.2				

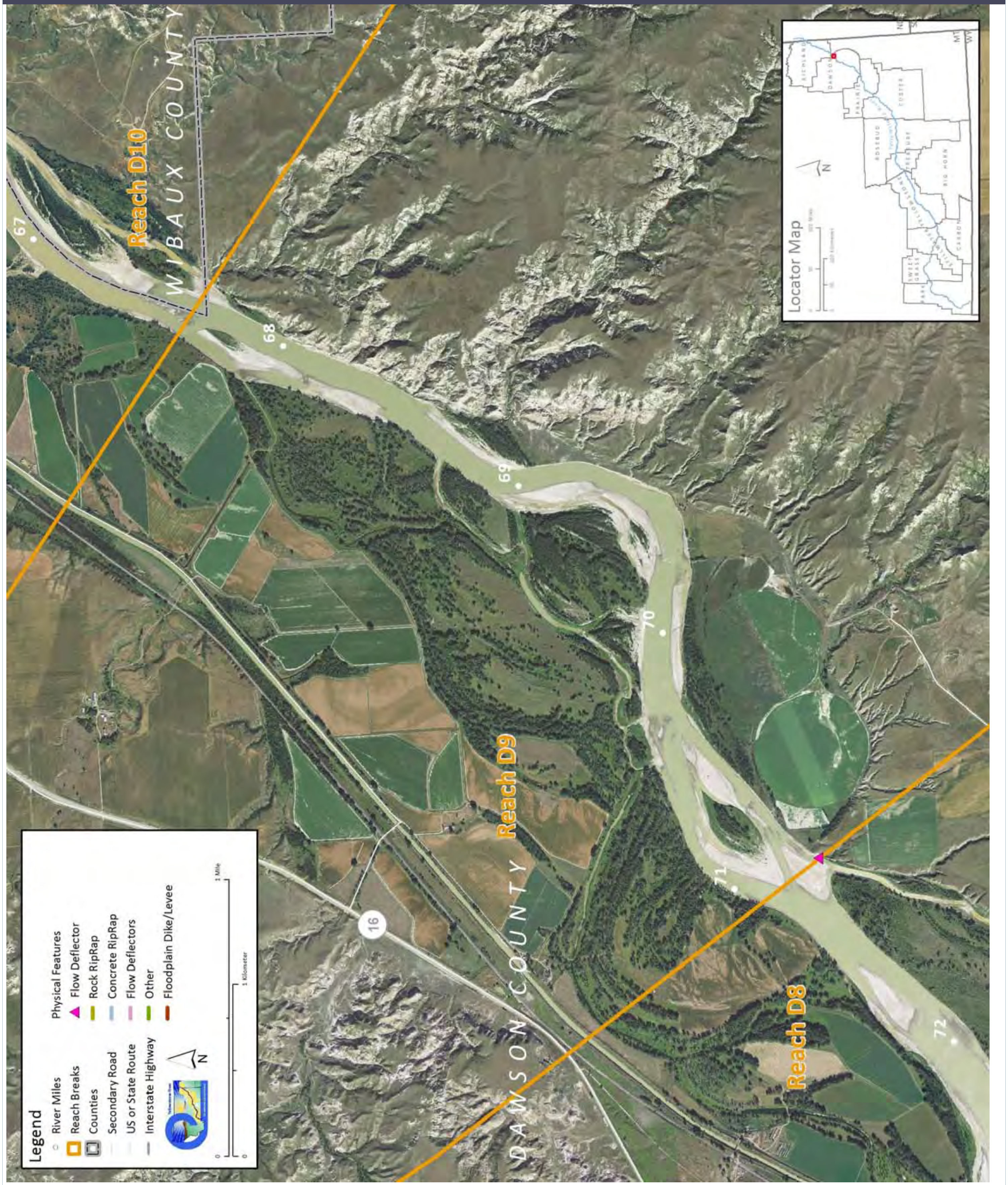
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	73.2	0.0	73.2	8.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	1.9	0.6	**41.9**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	21.8	7.2		
Scrub/Shrub	18.1	6.0		

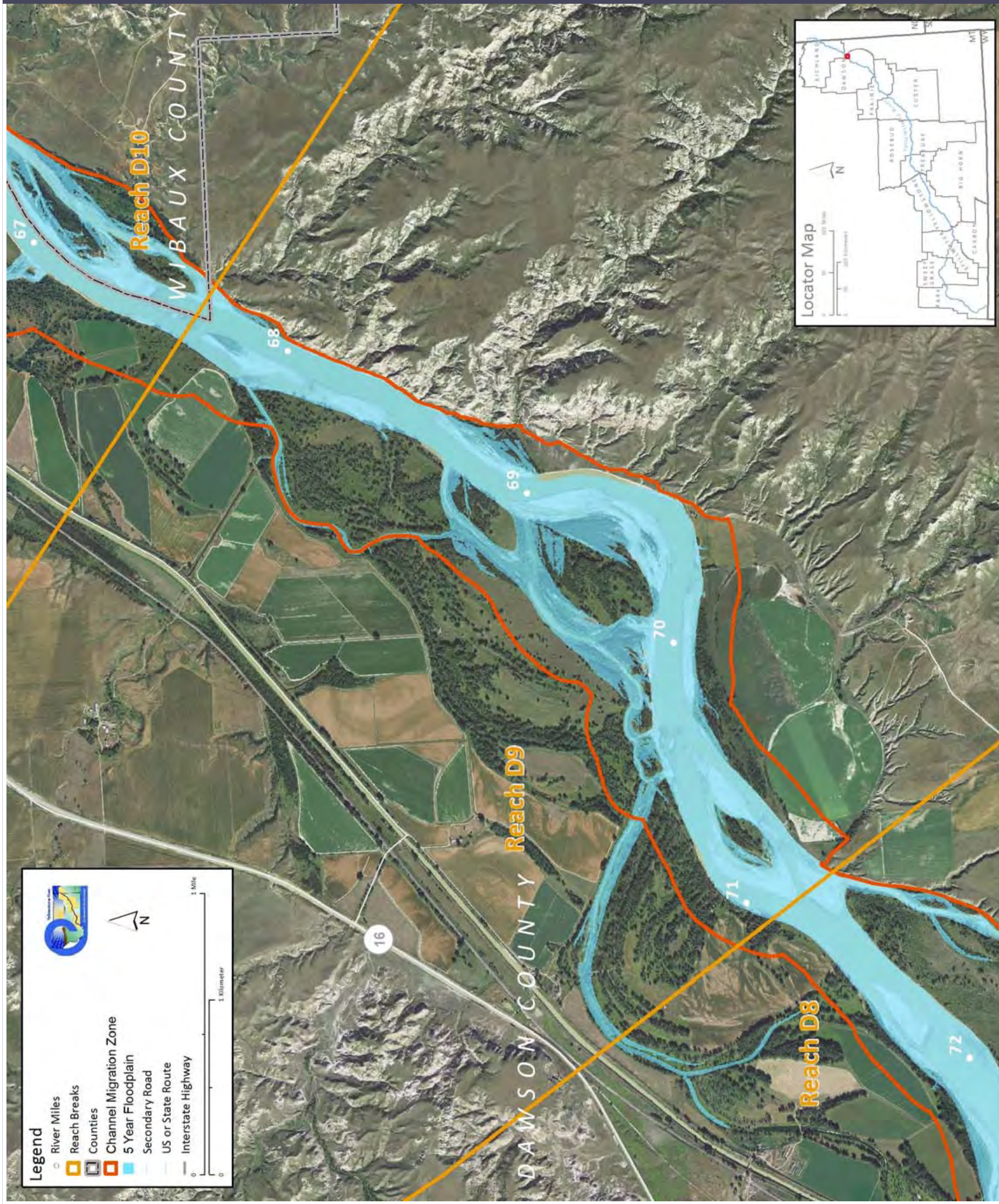
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	1.0	0.0%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	42.3	53.1	79.7	37.4	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Dawson	**Upstream River Mile**	67.8
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	56.3
General Location	Lowermost Dawson County, Richland County	**Length**	11.50 mi (18.51 km)

Narrative Summary

Reach D10 is located in lowermost Dawson County and extends into upper Richland County. The reach is an 11.5 mile long Partially Confined Anabranching (PCA) reach type, indicating some valley wall influence and numerous forested islands.

In 2011 there was just about 730 feet of rock riprap in the reach armoring 0.6% of the total stream bank. Prior to that some armor had been lost; between 2001 and 2011, almost 500 feet of rock riprap and 1,050 feet of concrete riprap were destroyed. Some of the greatest damage was at RM 64.2L, where several hundred feet of flow deflectors were flanked, and now are in the river over 100 feet off of the bank. The remaining bank protection in this area continues to flank. Another is at RM 60, where the flanking of concrete riprap has been followed by over 200 feet of erosion behind the original armor.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D10 has gotten smaller since 1950. The channel contracted by about 404 acres in this reach since 1950, and about 406 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development. The encroachment was at the expense of open gravel bars; between 1950 and 2001, the reach lost 151 acres of mid-channel bar habitat. Floodplain turnover rates have dropped as well; prior to 1976 measured floodplain turnover rates in this reach were 13.9 acres per year, and post-1976 rages were 7.0 acres per year.

Reach D10 has a relatively high concentration of mapped wetlands; the NWI mapping shows a total of 278 acres of mapped wetland, much of which is emergent marsh and wet meadow.

Land use is dominated by agriculture, with 230 acres of pivot irrigation development since 1950. Some of the irrigation development took place in historic riparian areas; a total of 457 acres of riparian lands were converted for agricultural and other land uses since 1950. This equates to 15% of the entire 1950 riparian footprint. There are 97 acres of land under pivot irrigation within the Channel Migration Zone (CMZ) of the river, making these areas especially prone to river erosion.

About 38% of the historic 5-year floodplain has become isolated, primarily due to flow alterations.

Reach D10 was sampled as part of the avian study. A total of 57 species were identified in the reach, indicating relatively high bird species richness on the Yellowstone River. Four species identified are considered Potential Species of Concern (PSOC) by the Montana Natural Heritage Center: The Black and white Warbler, Dickcissell, Ovenbird, and Plumbeous Vires. The Red-headed Woodpecker was also identified which is a species of concern. Similar to Reach D9 upstream, Reach D10 has seen an increase in the amount of forest area considered at low risk of cowbird parasitism. In 1950, there were 92 acres per valley mile of such forest, and by 2001, that number had increased to 112 acres per valley mile.

There are about 12 acres of mapped Russian olive in the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850cfs to 2,810 cfs with human development, a reduction of 43%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270cfs under regulated conditions, a reduction of 53%.

CEA-Related observations in Reach D10 include:
•Armor flanking and accelerated erosion behind

Recommended Practices for Reach D10 include:
•Removal of flanked armor at RM 60 and RM 64.2L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change
2 Year (cfs)	69,700	54,200	-22.2%
100 Year (cfs)	144,000	130,000	-9.7%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001
	1,843.3	1,737.0	1,544.0	1,439.2	-404.1

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	728	0.6%	-447
Concrete Riprap	0	0.0%	-1,051
Flow Deflectors	0	0.0%	0
Total	**728**	**0.6%**	**-1,498**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s
	0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001
Total Acres	361.0	174.9
Acres/Year	13.9	7.0
Acres/Year/Valley Mile	1.5	0.8

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

405.87 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	36.4	1.8	-150.8	-112.6

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP
5 Year	818.1	38%
100 Year	650.9	13%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area	Acres	% of CMZ
	52.1	1%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011
Agricultural Land (Ac)	4,586.0	5,330.0
Ag. Infrastructure (Ac)	44.1	52.6
Exurban (Ac)	0.0	5.7
Urban (Ac)	0.0	0.0
Transportation (Ac)	25.7	25.7

	1950	2011
Flood (Ac)	722.6	1,275.4
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	229.5

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
	455.3	2.2	457.5	15.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi
Riverine	21.6	2.3
Emergent	136.8	14.7
Scrub/Shrub	120.4	12.9

Total Wetland Acres **278.7**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

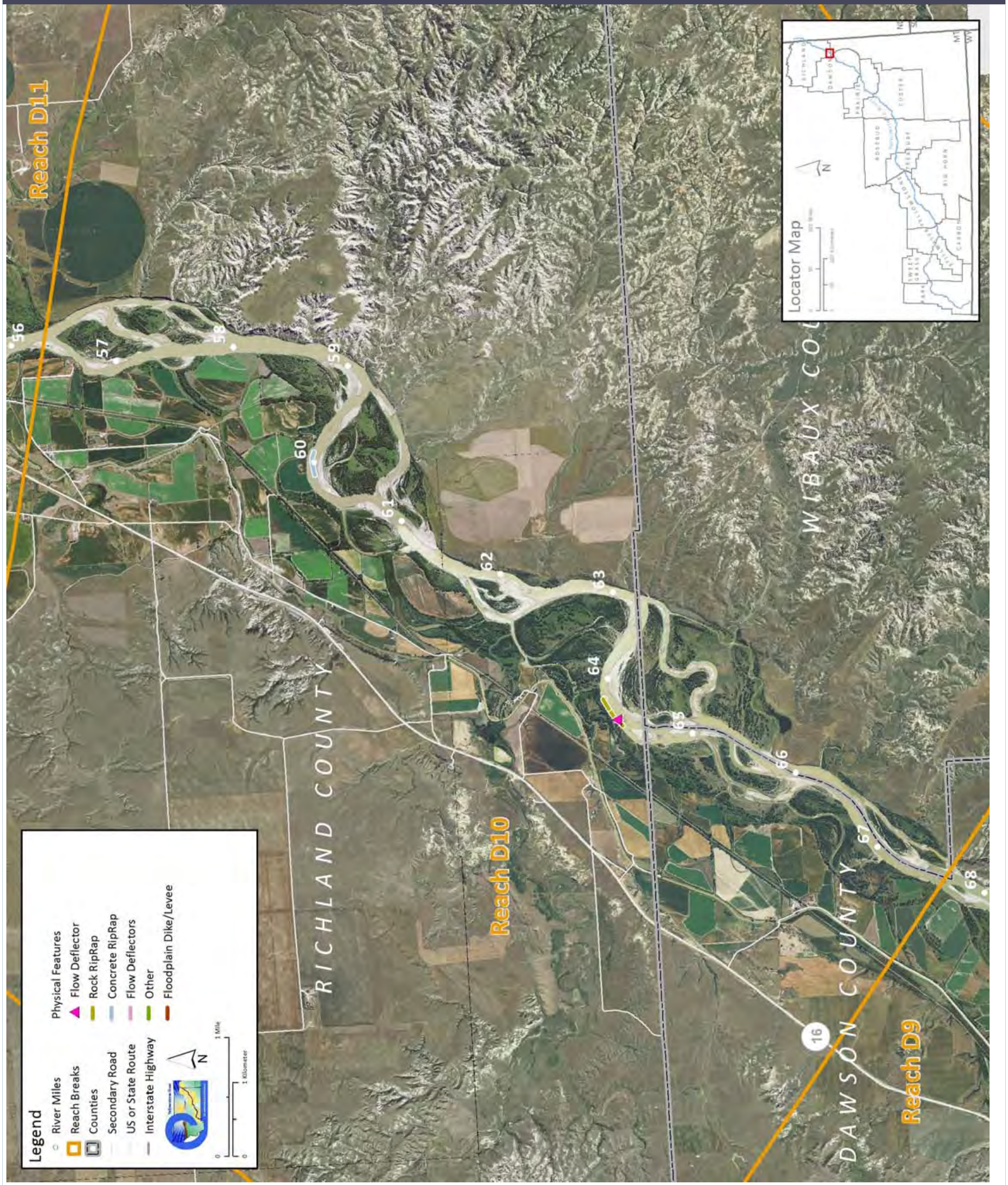
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%
	11.9	0.2%

Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

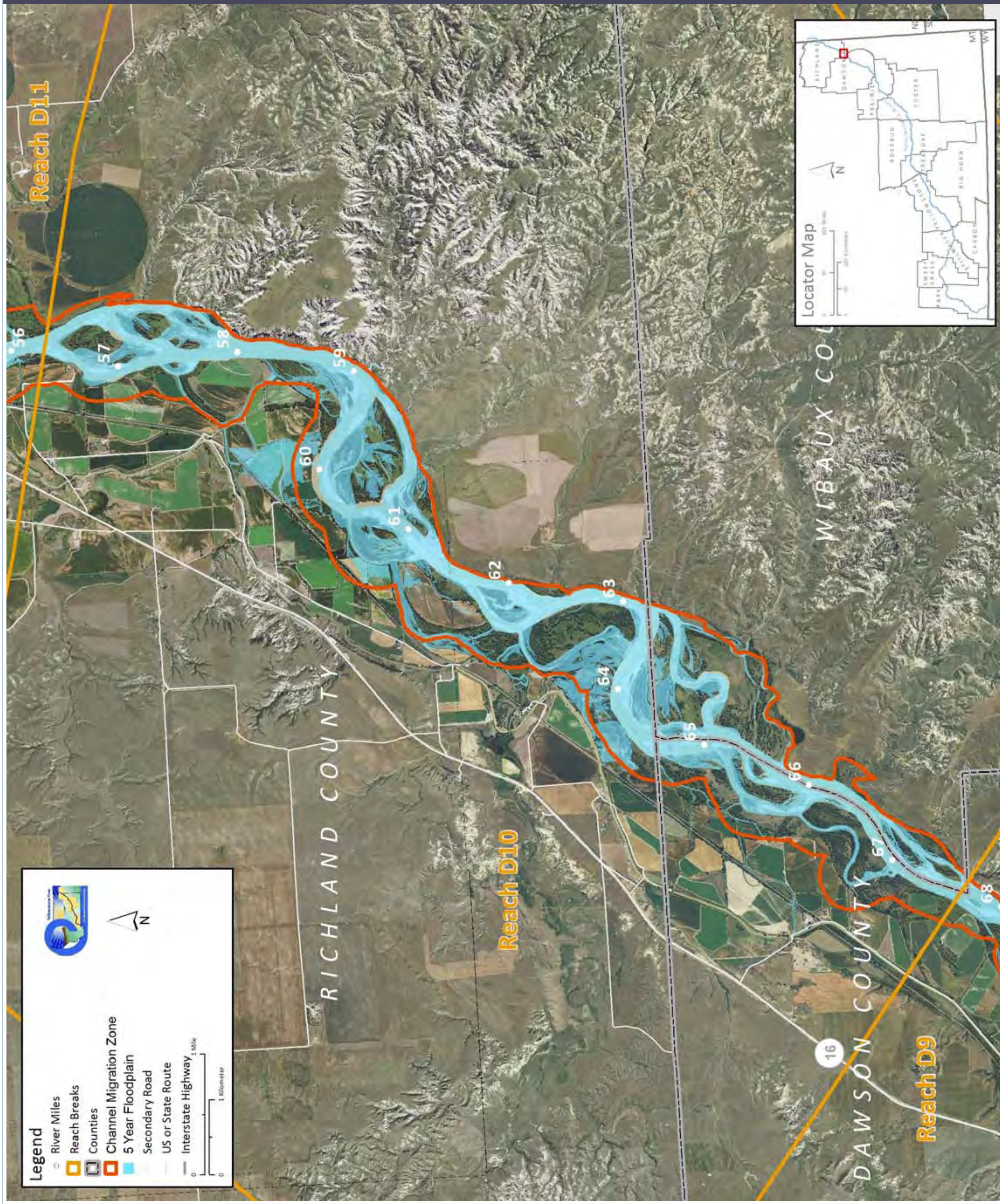
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011
	92.0	111.0	111.8	19.8

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Richland	**Upstream River Mile**	56.3
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	49.9
General Location	Savage; Elk Island	**Length**	6.40 mi (10.30 km)

Narrative Summary

Reach D11 is 10.3 miles long, located near Savage and Elk Island. It is a Partially Confined Anabranching reach type (PCA) indicating distinct side channels around vegetated islands with some valley wall influences. The valley wall is comprised of Tertiary-age Fort Union Formation, and a distinct terrace surface borders the active stream corridor. Fort Union Formation rocks are exposed on a right bank bluff on the downstream end of the reach.

There is no mapped bank armor in Reach D11. Prior to 1950, however, about three miles of side channel had been blocked, mostly around Elk Island.

The most striking change in Reach D11 since 1950 is the encroachment of riparian vegetation onto old sand bars. Between 1950 and 2001, the size of the channel has dropped by 313 acres, and there has been 294 acres of riparian encroachment into old channel areas. Much of this encroachment converted open sand bars into forested islands. There has been a loss of over 100 acres of sand bar since 1950. This change has resulted in a conversion of almost 7 miles low flow channels around gravel bars to anabranching side channels around islands.

Reach D11 has had six ice jams-related floods reported since 1943. They all occurred in February or March, and several of them reported flood damages.

Approximately 36% of the historic 5-year floodplain has become isolated, largely due to flow alterations.

Land use in the reach is dominated by flood irrigation.

There are about 32 acres of Russian olive mapped in the reach.

Reach D11 was sampled as part of the avian study. A total of 61 bird species were identified in the reach, indicating high bird species richness. Five bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) were found, the Black and white Warbler, Chimney Swift, Dicksissel, Ovenbird, and Plumbeous vireo. The Red-headed woodpecker was also observed, which has been identified as a Species of Concern (SOC). Reach D11 has seen an increase in the amount of forest area considered at low risk of cowbird parasitism. In 1950, there were 216.4 acres per valley mile of such forest, and by 2001, that number had increased to 247.2 acres per valley mile.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,370 cfs to 2,220 cfs with human development, a reduction of 50%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,540 cfs under unregulated conditions to 2,750cfs under regulated conditions, a reduction of 59%. Fall and winter low flows are about 3,500 cfs; these discharges are about 60% to 80% higher than they were prior to development.

CEA-Related observations in Reach D11 include:
•Reduction in 5-year floodplain footprint with flow alterations
•Increased fall and winter low flows with development
•Reduced summer low flows with development
•Reduced channel forming discharge causing channel contraction
•Extensive riparian encroachment with flow alterations
•Conversion of open sand bars to forested islands

Recommended Practices for Reach D11 include:
•Side channel reactivation RM 53L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,800	54,200	-22.3%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	144,000	131,000	-9.0%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,284.2	1,135.9	1,095.2	971.7	-312.5	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	0	0.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**0**	**0.0%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	15,601	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	387.4	178.3	294.92 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	14.9	7.1		
Acres/Year/Valley Mile	2.8	1.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-6.2	11.8	-108.9	-103.3	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	861.6	36%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	104.0	2%	

Restricted Migration Area	Acres	% of CMZ	
	62.2	1%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	3,337.6	4,457.3	Flood (Ac)	610.2	658.4	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	39.9	49.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	1.6	0.5	Pivot (Ac)	0.0	11.2	
Urban (Ac)	13.0	35.0				
Transportation (Ac)	31.4	39.1				

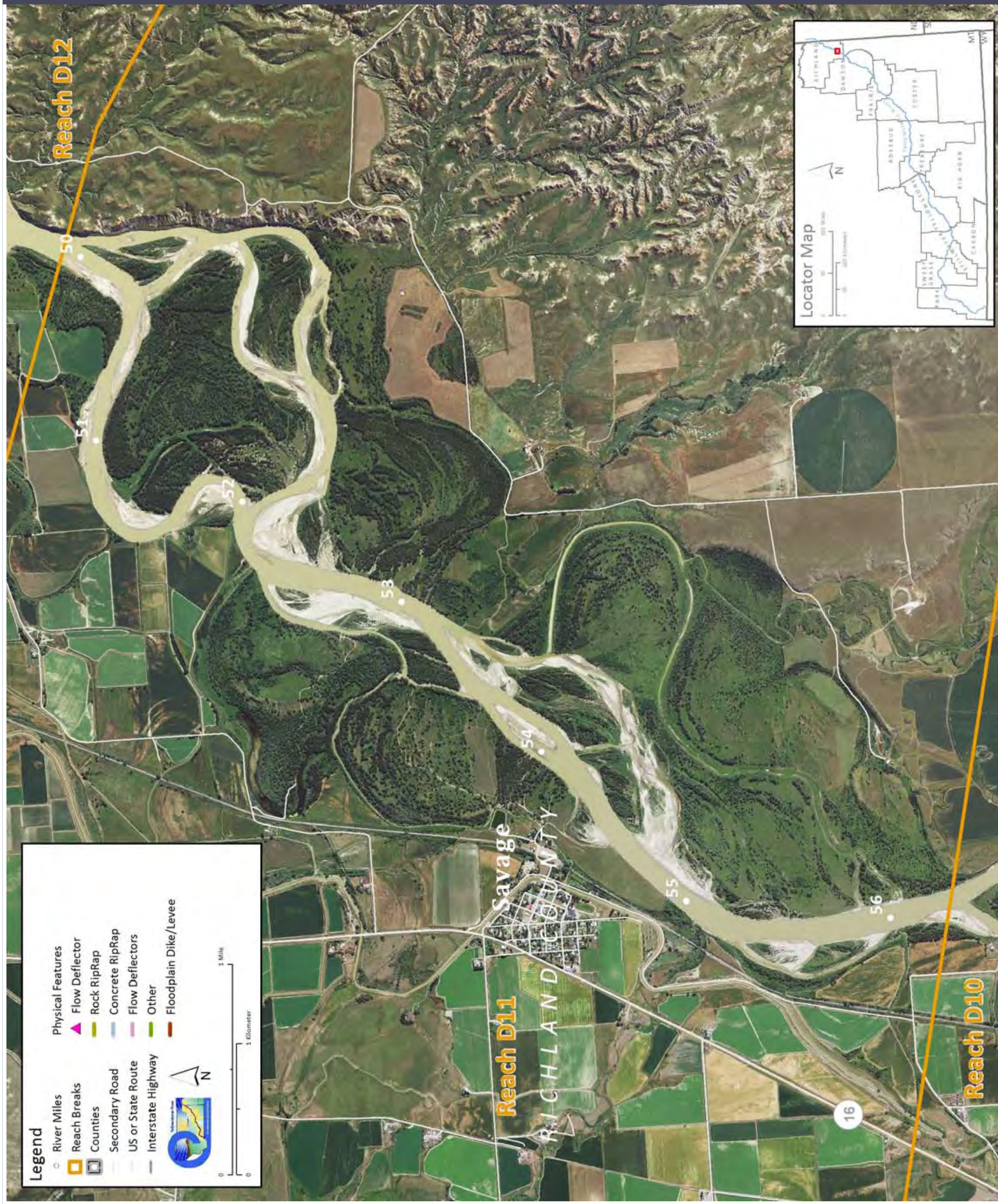
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	46.2	0.2	46.3	2.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	24.4	4.5	**188.2**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	119.1	22.1		
Scrub/Shrub	44.7	8.3		

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	31.8	1.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	216.4	252.2	247.2	30.8	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



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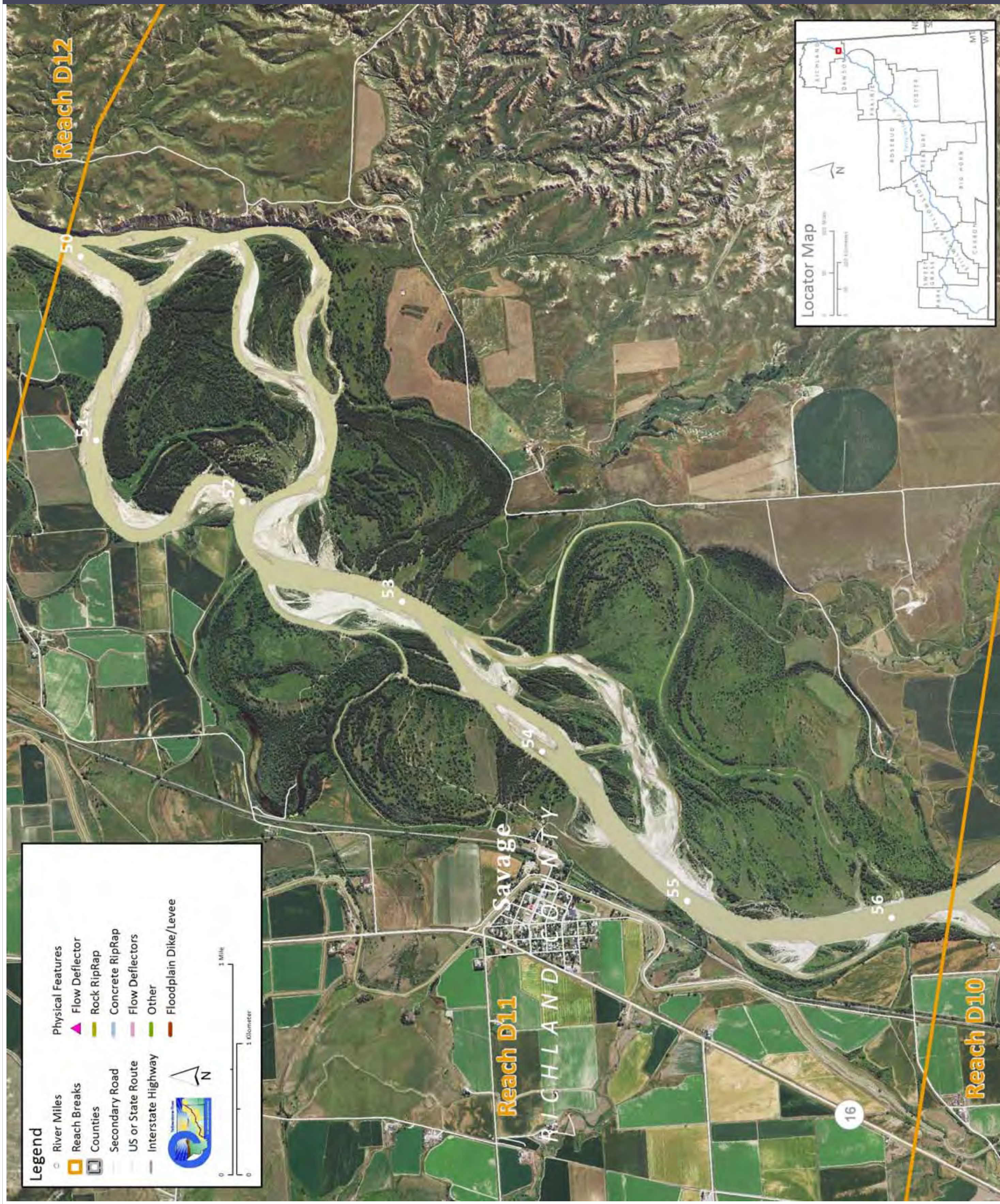

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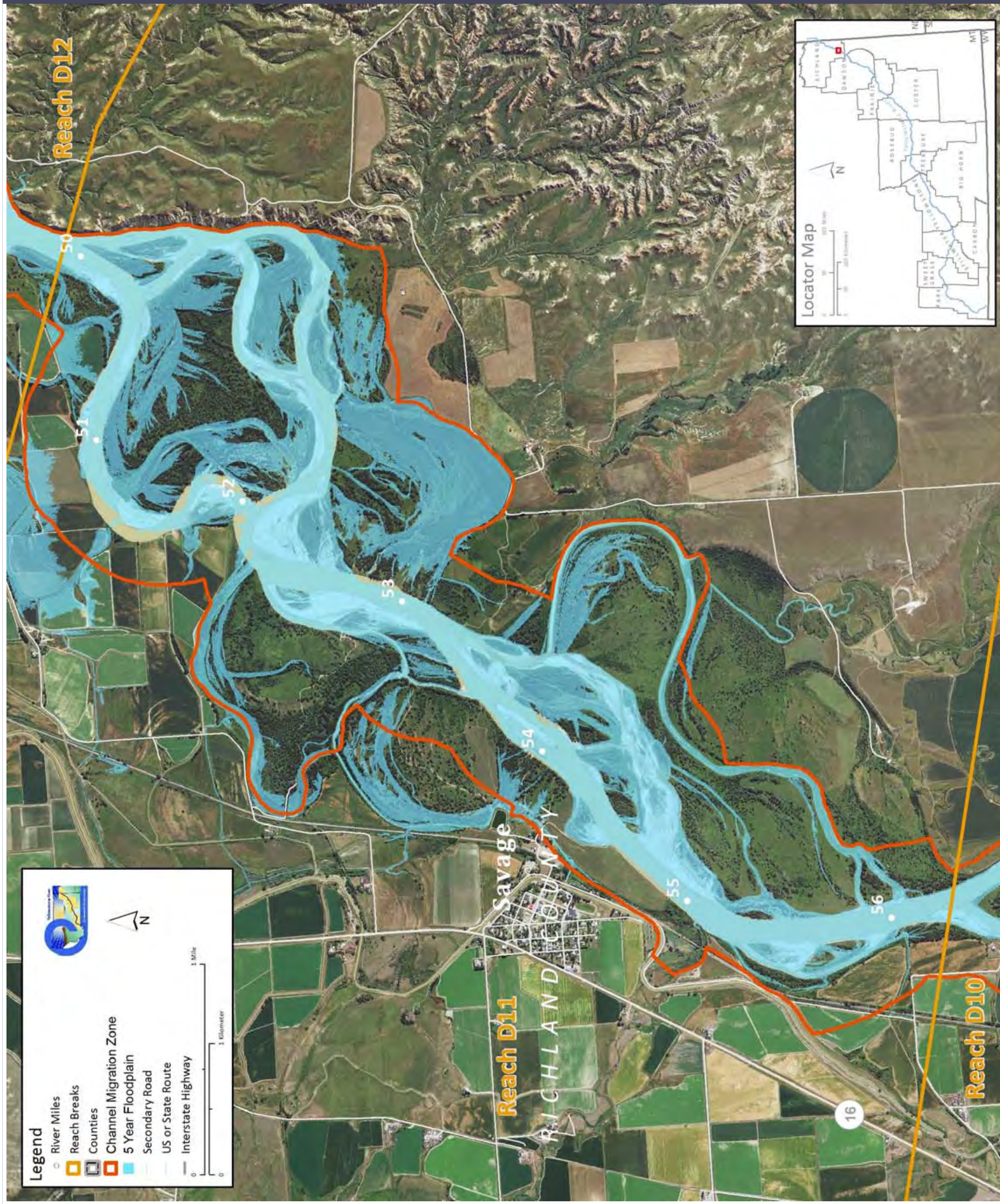

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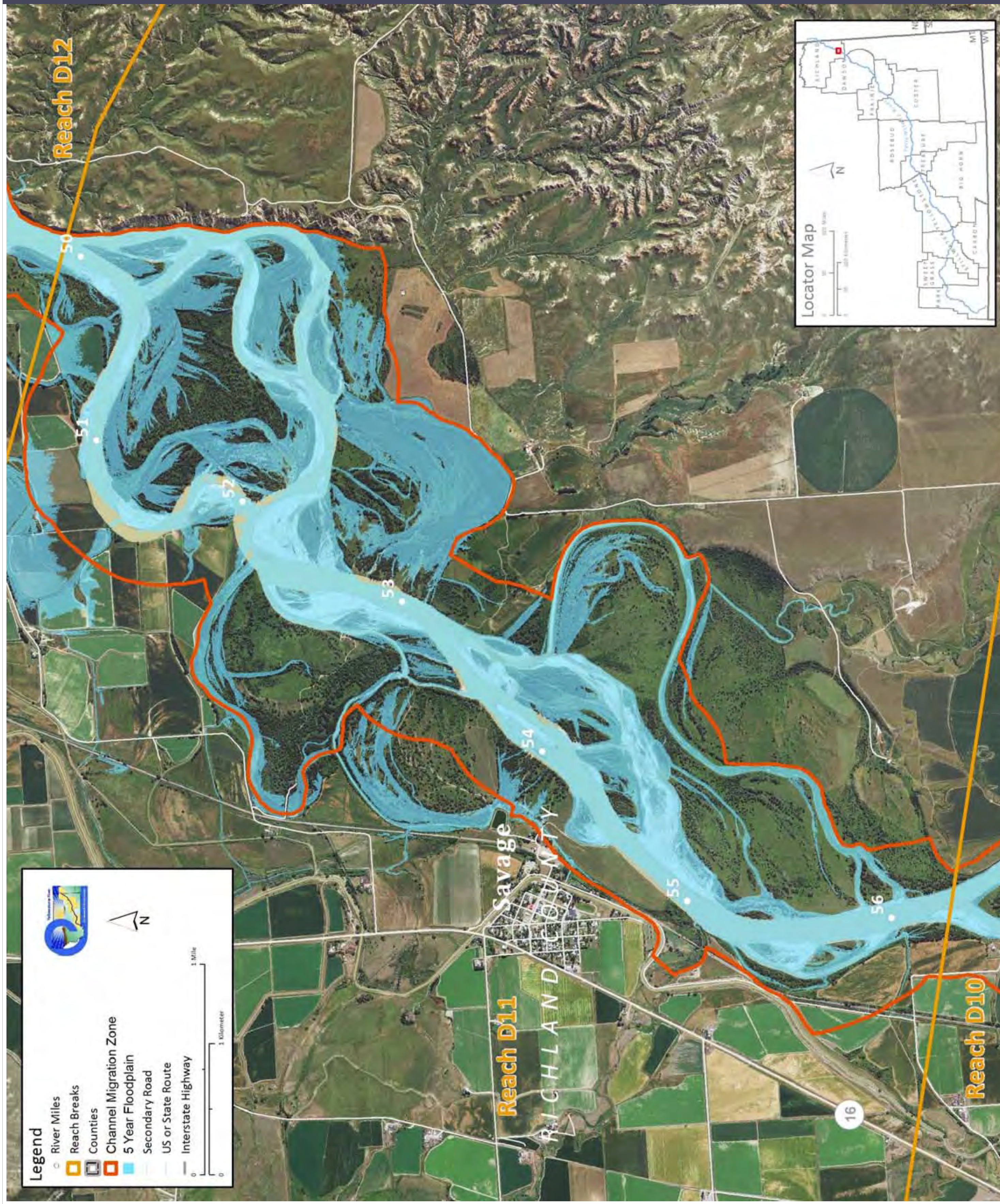


County	Richland	**Upstream River Mile**	49.9
Classification	PCA: Partially confined anabranching	**Downstream River Mile**	36.3
General Location	Seven Sisters	**Length**	13.60 mi (21.89 km)

Narrative Summary

Reach D12 is located in Richland County at Seven Sisters. The Seven Sisters Fishing Access Site is located in the lower portion of the reach. The reach is a 13.6 mile long Partially Confined Anabranching reach type, indicating some influence of the valley wall along with extensive forested islands. This reach supports over 20 miles of side channels, and islands that are miles long and over ½ mile wide.

There are almost 7,000 feet of bank armor in the reach, and about one third of that was built since 2001. Most of the armor (3,250 ft) is rock riprap, and there are about 2,000 feet each of concrete riprap and flow deflectors. A total of 5% of the bank is armored, which is a relatively low concentration of bank armor for the Yellowstone River. All of the armor is protecting agricultural land, most of it against a flood irrigated field on the left bank in the lower end of the reach at RM 37.

Since 1950, a side channel that is almost three miles long was blocked at RM 45.3L. There have also been some gains in side channel length in the reach, such that the net change in length is a loss of approximately one mile. As of 2001, this reach supported almost 21 miles of anabranching channel.

Land use is dominated by agriculture, with 583 acres of pivot irrigation development since 1950. Physical features such as bank armor, dikes, and levees have isolated 3% of the Channel Migration Zone in Reach D12, and as of 2011 there were 224 acres of land in the CMZ under pivot irrigation, and 900 acres under flood.

Reach D12 shows, like most other reaches below the Bighorn River, a shrinking channel with reduced rates of erosion and floodplain turnover. For example, the bankfull channel area in the reach dropped by 480 acres since 1950, and there was almost 600 acres of riparian encroachment into old channel areas. Floodplain turnover rates have dropped from 2.1 acres/valley mile/year from 1950-1976 to 1.3 acres/valley mile/year from 1976-2001. This equates to 330 fewer acres of floodplain turnover since 1976. There has also been a net loss of 159 acres of open bar area as the channel has become smaller and more forested. On the floodplain, riparian acreage has decreased; about 350 acres or 9% of the total riparian area was cleared for irrigation since 1950.

There are 75 acres of Russian olive in the reach.

The 100-year floodplain has been isolated in this reach, but compared to other reaches it has been fairly minor. About 300 acres of 100-year floodplain has been isolated by human development, which is 5% of the total 100-year floodplain. Although only about 5% of the 100-year floodplain has been isolated, the impact of flow alterations on the smaller 5-year floodplain has been much more severe; 42% of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, which is due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 300 acres of flood irrigated land and within the historic 5-year floodplain footprint.

There is an animal feeding facility on the right bank at RM 46.8

Reach D12 was sampled as part of the fisheries study. A total of 37 fish species were sampled in the reach. Three species collected in the reach have been identified by the Montana Natural Heritage Program as Species of Concern (SOC): Pallid sturgeon, Sauger, and Sturgeon chub.

Reach D12 was also sampled as part of the avian study. A total of 59 bird species were identified in the reach. All five bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) on the Yellowstone River were also found, the Black and white Warbler, the Chimney Swift, the Dickcissel, the Ovenbird, and the Plumbeous Vireo.. Similarly, all three bird species identified as Species of Concern (SOC) were identified: the Black-billed Cuckoo, Bobolink, and Red-headed Woodpecker. In contrast to most other reaches, Reach D12 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 103 acres per valley mile of such forest, and that number increased to 115 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,310 cfs to 2,410 cfs with human development, a reduction of 50%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,470 cfs under unregulated conditions to 2,680cfs under regulated conditions, a reduction of 59%.

CEA-Related observations in Reach D12 include:
•Increase in area at low risk of cowbird parasitism with riparian encroachment

Recommended Practices for Reach D12 include:
•Nutrient management at animal handling facility at RM 46.8R
•Side channel reactivation at RM 45.3R
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,800	54,300	-22.2%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	144,000	132,000	-8.3%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	2,239.4	1,957.5	1,919.3	1,754.7	-484.8	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	3,251	2.3%	2,655	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	1,945	1.4%	0	
Flow Deflectors	1,801	1.3%	118	
Total	**6,997**	**4.9%**	**2,773**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	14,624	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	596.0	338.4	597.01 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	22.9	13.5		
Acres/Year/Valley Mile	2.1	1.3		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	-205.7	27.4	19.8	-158.5	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	2,113.3	42%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	344.5	5%	

Restricted Migration Area	Acres	% of CMZ	
	197.9	3%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	5,885.9	6,086.8	Flood (Ac)	2,107.6	2,364.7	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	59.8	154.9	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	1.7	Pivot (Ac)	0.0	582.7	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	43.7	58.6				

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	353.9	0.8	354.7	9.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	28.0	2.6	**285.0**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	117.2	10.9		
Scrub/Shrub	139.8	13.0		

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	74.8	1.4%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	103.2	104.8	115.5	12.3	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)

CHANNEL MIGRATION ZONE MAP

County	Richland	**Upstream River Mile**	36.3
Classification	PCM/I: Partly confined meandering/islands	**Downstream River Mile**	27.8
General Location	To Sidney	**Length**	8.50 mi (13.68 km)

Narrative Summary

Reach D13 is located just upstream of Sidney. It is 8.5 miles long, and is a PCM/I reach type, indicating a primary meandering channel thread with distinct islands largely formed by historic bendway cutoffs. The reach has multiple pipeline crossings, and the Highway 23 Bridge and approach have confined the river and isolated floodplain area. Floodplain development for irrigated agricultural is extensive, and in many cases irrigated fields intersect the channel bank. These locations are commonly armored, and low field dikes affect floodplain access.

In 2011 there was almost 16,000 feet of bank armor in the reach, protecting 16 % of the total bank line. That includes 2,440 feet of car bodies. The car body revetments are all located off of the main channel at RM 32.2L. About ½ mile of rock riprap was constructed between 2001 and 2011.

Although no side channels have been intentionally blocked in the reach, there has still been a net loss of almost two miles of side channel since 1950, reflecting passive abandonment of side channels with flow alterations.

There are three mapped pipeline crossings in the reach, two at the Sidney Bridge and another about a mile upstream. The two on the bridge are apparently installed on the bridge structure itself. The one upstream at RM 32.1 is described as an LPG pipeline installed in 1997; however no more information was available.

Reach D13 has had 28 reported ice jam events since 1917. Especially severe damages were reported in the ice jam of March 25, 1943.

Human development has resulted in isolation of 18% of the historic 100-year floodplain and 26% of the 5-year floodplain. This isolation includes the effects of transportation infrastructure embankments (mainly Highway 23), low agricultural dikes on the edges of irrigated fields, and reduced flood magnitudes. There has been fairly extensive land use encroachment into the Channel Migration Zone: as of 2011 there were 250 acres of pivot irrigation and 137 acres of urban/exurban land uses within the CMZ, making these areas especially prone to the threat of river erosion. One drill pad was mapped within 1,500 feet of the river at RM32. There is also a large animal handling facility that drains to an irrigation return flow point at RM29.

Reach D13 shows, like most other reaches below the Bighorn River, a shrinking channel with reduced rates of erosion and floodplain turnover. The bankfull channel area in the reach dropped by 220 acres since 1950, and there was a similar amount of mapped riparian encroachment into old channel areas. Floodplain turnover rates have dropped from 14.3 acres per year from 1950-1976 to 6.1 acres per year from 1976-2001. There has also been a net loss of 45 acres of open bar area as the channel has become smaller and more forested. On the floodplain, riparian acreage has decreased; about 424 acres or 27% of the total riparian area was cleared for irrigation since 1950.

Like numerous reaches below the Bighorn River confluence, Reach D13 exhibits a shift from a largely braided pattern in 1950 to an anabranching pattern today. The pattern shift reflects the fact that side channels that used to flow around open bars (braided) now flow around wooded islands (anabranching). This shift appears largely due to riparian encroachment onto sand bars since 1950. This encroachment reflects the flow alterations identified in the reach, and may also be due to the altered sediment regime imposed by upstream influences including Yellowtail Dam. Changes in sediment loading have not been quantified in the CEA.

There are 45 acres of Russian olive mapped in the reach.

Reach D13 was sampled as part of the fisheries study. A total of 38 fish species were sampled in the reach, including six Species of Concern: the Blue sucker, Pallid Sturgeon, Sauger, Shortnose gar, Sicklefin chub, and Sturgeon chub.

Reach D13 was also sampled as part of the avian study. A total of 39 bird species were identified in the reach. The Red-headed Woodpecker was found, which is a Species of Concern. In contrast to most other reaches, Reach D12 has seen a reduction in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 27.6 acres per valley mile of such forest, and that number decreased to 18.1 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 134,000 cfs, which 6% lower than it was pre-development (143,000cfs). The 2-year flood, which strongly influences overall channel form, has dropped by 22%. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,190cfs to 2,000 cfs with human development, a reduction of 52%. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,340 cfs under unregulated conditions to 2,550 cfs under regulated conditions, a reduction of 60%.

Seasonal low flows have increased by 82% in the fall and 63% in the winter. Both fall and winter base flows are currently about 3,500 cfs.

CEA-Related observations in Reach D13 include:
•Conversion of river pattern from braided to anabranching due to riparian encroachment onto sand bars since 1950.
•Passive side channel abandonment due to hydrologic alterations and potentially downcutting due to CMZ confinement.
•100-year floodplain isolation due to low agricultural field dikes.

•100-year floodplain isolation due to transportation infrastructure.
•Channel Migration Zone (CMZ) restrictions that significantly confine the river corridor, potentially causing downcutting. This may be an important
Increase in area at low risk of cowbird parasitism with riparian encroachment

Recommended Practices for Reach D13 include:
•Nutrient Management at Animal Handling Facility at RM 29L
•Pipeline Crossing BMP RM 32.1
•Old car body removal RM 32.2L
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge

	Undev.	Developed	% Change
2 Year (cfs)	69,900	54,300	-22.3%
100 Year (cfs)	143,000	134,000	-6.3%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
1,163.3	1,160.8	991.3	942.8	-220.5

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	6,386	7.1%	2,410
Concrete Riprap	3,329	3.7%	0
Flow Deflectors	4,179	4.6%	143
Total	**13,894**	**15.4%**	**2,553**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
0	0

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres	371.6	151.8
Acres/Year	14.3	6.1
Acres/Year/Valley Mile	1.9	0.8

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

291.7 acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)	-58.3	-10.5	23.6	-45.3

The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation

	Acres	% of FP
5 Year	466.6	26%
100 Year	766.0	18%

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
639.4	18%

Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use

	1950	2011
Agricultural Land (Ac)	5,052.4	4,997.8
Ag. Infrastructure (Ac)	73.2	210.1
Exurban (Ac)	5.1	216.3
Urban (Ac)	0.0	0.0
Transportation (Ac)	53.4	56.8

	1950	2011
Flood (Ac)	3,209.5	2,324.4
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	893.5

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)

To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.
424.0	19.4	443.4	27.0%

Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory

	Acres	Acres per Valley Mi
Riverine	65.0	8.5
Emergent	126.5	16.6
Scrub/Shrub	60.6	7.9

Total Wetland Acres **252.0**

Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
44.7	3.2%

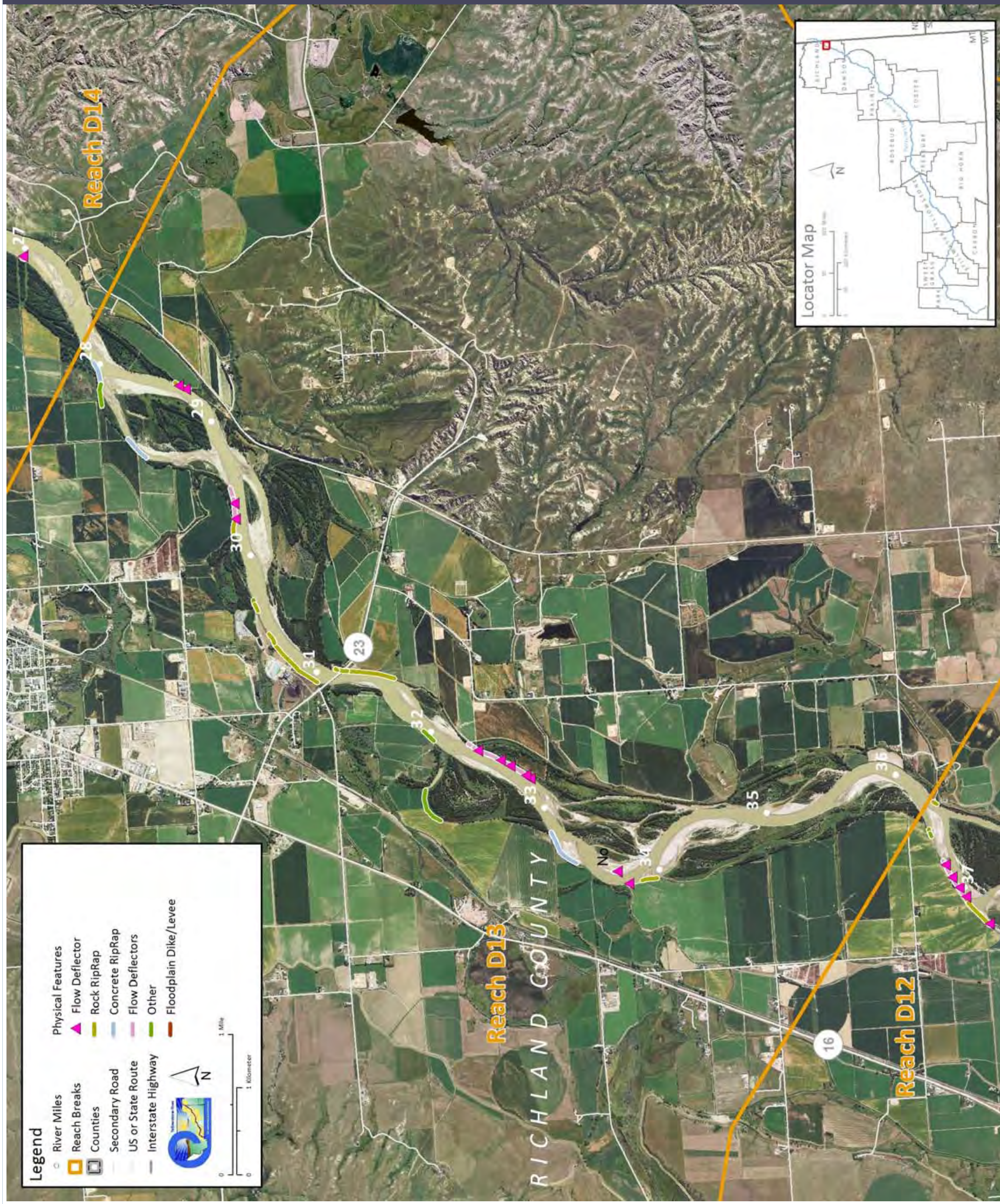
Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)

1950	1976	2001	Change 1950-2011
27.6	23.0	18.1	-9.4

Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

County	Richland	**Upstream River Mile**	27.8
Classification	PCM/I: Partly confined meandering/islands	**Downstream River Mile**	13.5
General Location	To Fariview	**Length**	14.30 mi (23.01 km)

Narrative Summary

Reach D14 is located upstream of Fairview. The reach is a 14.3 mile long Partially Confined Meandering with Islands (PCM/I), indicating some valley wall influence, and a meandering main thread with cutoff channels through meander cores forming persistent forested islands.

There is just over a mile of bank armor in the reach, including 3,900 feet of rock riprap and 2,500 feet of flow deflectors. Most of the rock riprap was constructed between 2001 and 2011 (2,300 ft).

Prior to 1950, 3,600 feet of side channel was blocked in the reach at RM 23L.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D14 has gotten smaller since 1950. The channel contracted by about 309 acres in this reach since 1950, and about 460 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development. Floodplain turnover rates have dropped from 14.4 acres per year pre-1976 to 6.1 acres per year post-1976. There has also been a major loss of open bar habitat area in the channel; between 1950 and 2001, there was a loss of 510 acres of mid-channel bar area, which can be important habitat to certain species such as least tern.

Land use is predominantly agricultural, with just over a thousand acres of pivot irrigation development since 1950. Development in the reach included conversion of 1,063 acres of 1950s riparian area to other land uses (mostly irrigated agriculture); that represented 36% of the entire 1950s riparian footprint. There are 93 acres of pivot irrigated land and 113 acres of urban/exurban development within the Channel Migration Zone (CMZ), making these areas especially susceptible to river erosion. At RM26L there are three drill pads within the CMZ.

Several dump sites have been mapped on the banks: RM 25R, RM24.3L, RM 17L, RM15.8L, and RM 15.8R.

There is one pipeline crossing in Reach D14 at RM27. It is an 8-inch crude oil pipeline that has been Horizontally Directionally Drilled.

About 41% of the historic 5-year floodplain has become isolated, primarily due to flow alterations.

One ice jam was reported in the reach. It was a break-up flood event on March 17, 2011.

There are about 36 acres of mapped Russian olive in the reach.

Reach D14 was sampled as part of the avian study. A total of 30 bird species were identified in the reach. Two bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) on the Yellowstone River were found, the Ovenbird and the Plumbeous Vireo. Reach D14 has seen a decrease in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 25.6 acres per valley mile of such forest, and that number dropped to 19.6 acres per valley mile by 2001.

CEA-Related observations in Reach D14 include:
•Flow alteration impacts on floodplain access

Recommended Practices for Reach D14 include:
•Solid waste removal at dump sites at RM 25R, RM24.3L, RM 17L, RM15.8L, and RM 15.8R.
•Side channel reactivation at RM 23L
•Pipeline crossing BMP at RM 27.
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,900	54,300	-22.3%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	143,000	134,000	-6.3%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	2,206.2	2,091.0	1,933.5	1,896.8	-309.4	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	3,906	2.6%	2,293	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	2,505	1.7%	273	
Total	**6,411**	**4.2%**	**2,566**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	3,595	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres	375.2	152.5	459.11 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year	14.4	6.1		
Acres/Year/Valley Mile	1.1	0.5		

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	9.8	94.4	-510.3	-406.1	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	1,046.3	41%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	1,450.6	17%	

Restricted Migration Area	Acres	% of CMZ	
	160.9	3%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011	
Agricultural Land (Ac)	8,402.4	8,078.6	
Ag. Infrastructure (Ac)	49.0	153.3	
Exurban (Ac)	0.0	161.4	
Urban (Ac)	0.0	0.0	
Transportation (Ac)	65.0	73.2	

	1950	2011
Flood (Ac)	3,832.7	3,990.2
Sprinkler (Ac)	0.0	0.0
Pivot (Ac)	0.0	1,003.3

Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
	940.2	123.1	1,063.3	36.0%	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	8.1	0.6	**289.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	137.1	10.9		
Scrub/Shrub	144.3	11.5		

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	35.7	0.8%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	25.6	38.1	19.6	-5.9	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)

CHANNEL MIGRATION ZONE MAP

County	Mckenzie	**Upstream River Mile**	13.5
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	7.5
General Location	Downstream of Fairview	**Length**	6.00 mi (9.66 km)

Narrative Summary

Reach D15 is located downstream of Fairview. The reach is a 6 mile long Partially Confined Meandering with Islands (PCM/I), indicating some valley wall influence, and a meandering main thread with cutoff channels through meander cores forming persistent forested islands.

No bank armor was mapped in the reach, and no side channels have been blocked.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D15 has gotten smaller since 1950. The channel contracted by about 190 acres in this reach since 1950, and about 210 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development.

Land use is predominantly agricultural, with 71 acres of pivot irrigation development since 1950. A total of 54 percent of the 100 year floodplain has become isolated (1,885 acres), and most of this isolation is from agricultural dikes. Approximately 23% of the 5-year floodplain has become isolated (168 acres).

There is a drill pad on the edge of the CMZ at RM 10.8L.

One ice jam was reported in the reach. It was a break-up flood event on February 12, 1996.

Reach D15 was sampled as part of the avian study. A total of 30 bird species were identified in the reach. Two bird species identified by the Montana Natural Heritage Program as potential species of concern (PSOC) on the Yellowstone River were found, the Ovenbird and the Plumbeous Vireo.. Reach D15 has seen a decrease in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 25.6 acres per valley mile of such forest, and that number dropped to 19.6 acres per valley mile by 2001.

CEA-Related observations in Reach D15 include:
•Flow alteration impacts on floodplain access

Recommended Practices for Reach D15 include:
•Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,900	54,300	-22.3%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	143,000	134,000	-6.3%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	988.3		887.9	798.9	-189.3	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	0	0.0%	0	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**0**	**0.0%**	**0**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres			208.49 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year				
Acres/Year/Valley Mile				

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	0	89.7	-57.5	32.2	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	168.1	23%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	1,884.7	54%	

Restricted Migration Area	Acres	% of CMZ	
	21.1	1%	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	6,215.4	7,485.3	Flood (Ac)	3,955.0	6,101.5	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	86.2	192.8	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	35.8	Pivot (Ac)	0.0	71.3	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	79.3	70.6				

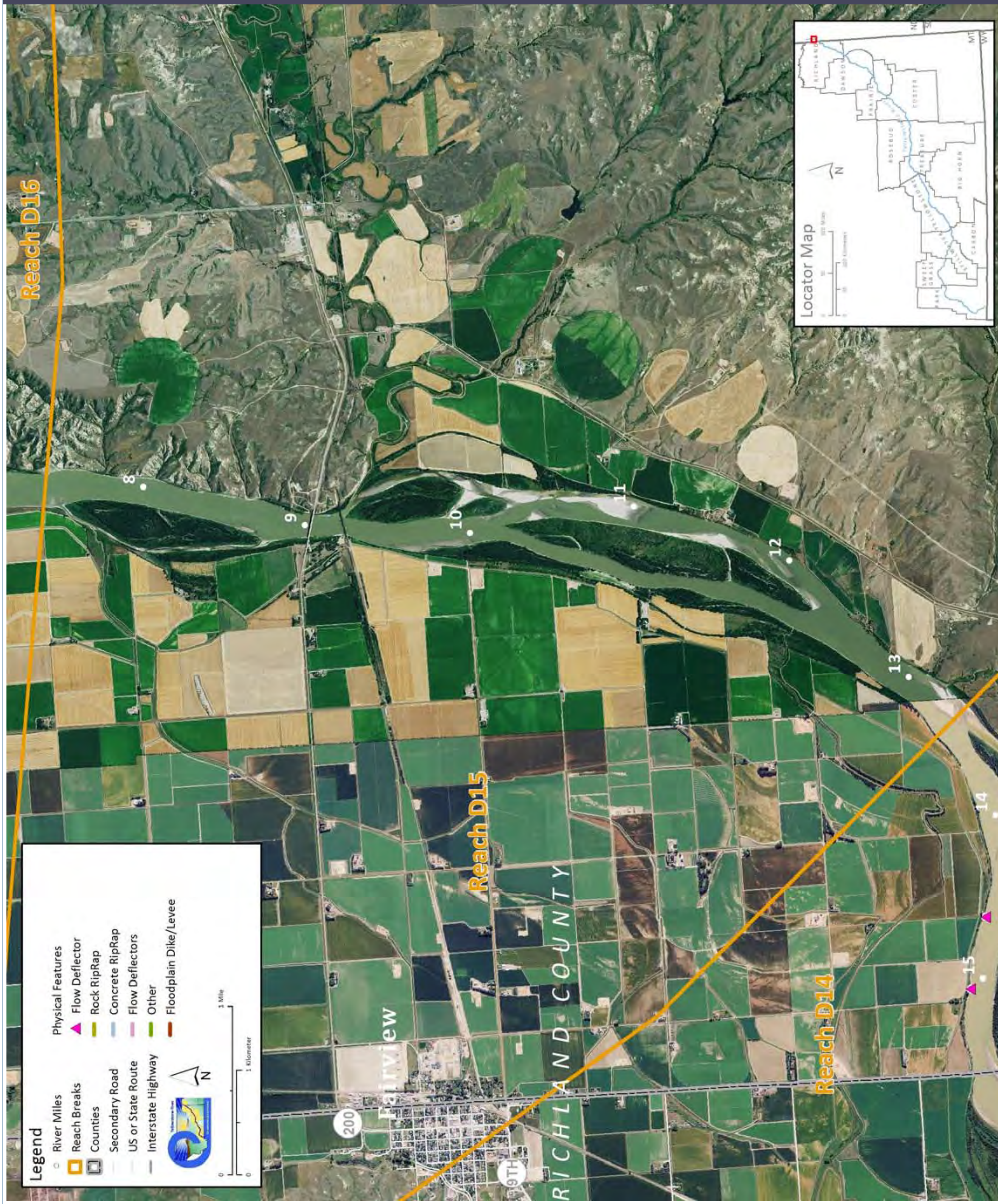
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
					Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	1.6	0.3	**90.5**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	20.2	3.5		
Scrub/Shrub	68.7	11.9		

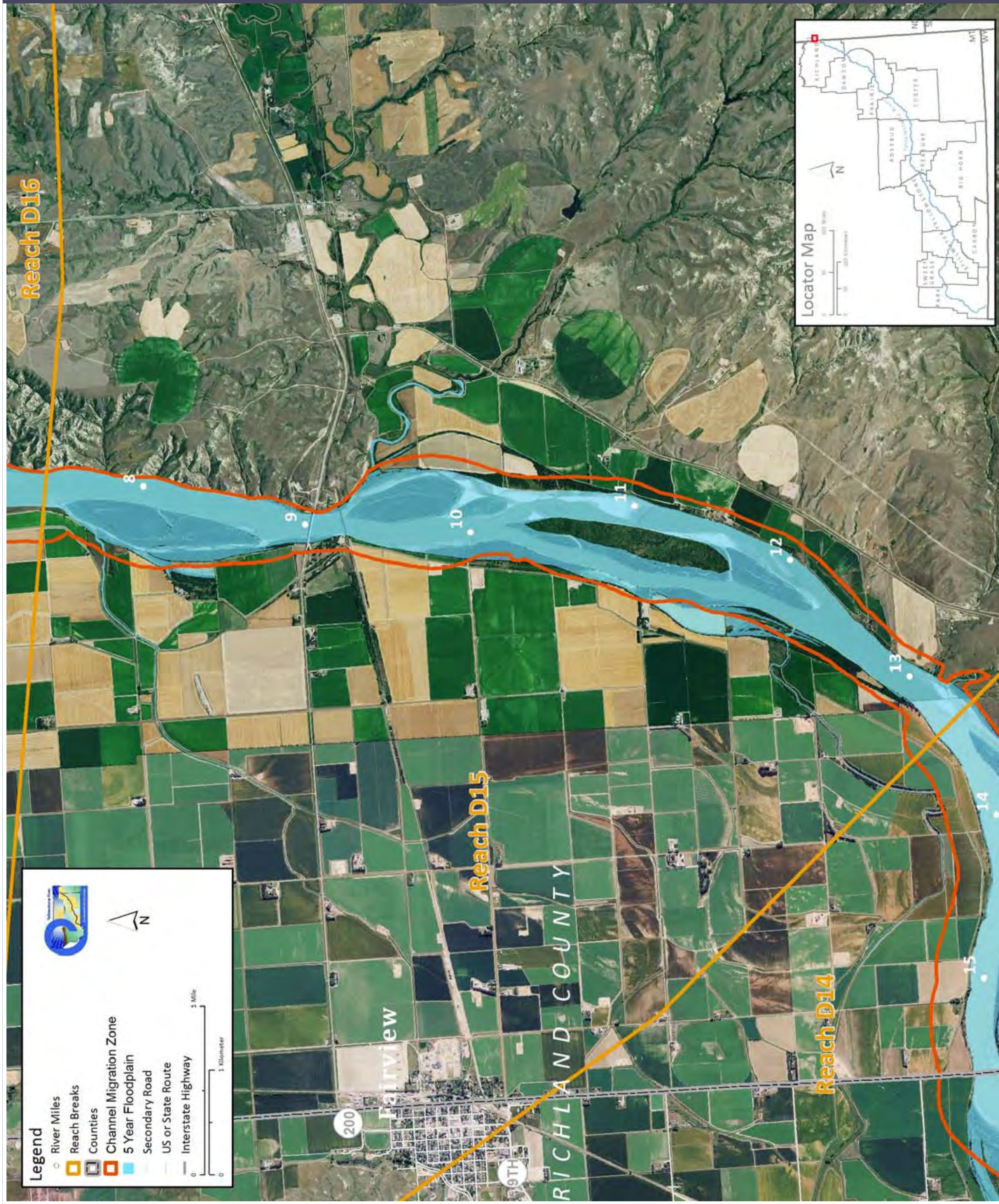
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	0.8	0.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	10.1		23.0	12.9	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Mckenzie	**Upstream River Mile**	7.5
Classification	US/I: Unconfined straight/islands	**Downstream River Mile**	0
General Location	To Missouri River	**Length**	7.50 mi (12.07 km)

Narrative Summary

Reach D16 is the lowermost reach of the Yellowstone River, extending 7.5 miles to the confluence with the Missouri River. It is a unique reach type, referred to as Unconfined Straight (US), and it has numerous forested islands that have developed since the 1950s.

Reach D16 has only a few hundred feet of rock riprap along its 7.5 mile length, and all of that was built since 2001. No side channels have been blocked.

The most striking change in Reach D16 since 1950 is the encroachment of riparian vegetation onto old sand bars. Between 1950 and 2001, the size of the channel has dropped by 550 acres, and there has been 472 acres of riparian encroachment into old channel areas. Much of this encroachment converted open sand bars into forested islands. There has been a loss of over 150 acres of sand bar since 1950. This change has resulted in a conversion of almost 7 miles low flow channels around gravel bars to anabranching side channels around islands.

Land use in the reach is dominated by flood irrigation. The extent of flood irrigated lands increased from 4,600 acres in 1950 to about 8,500 acres in 2011. The floodplain is very flat and broad in this lowermost portion of the Yellowstone River valley, and as a result, floodplain development for agriculture has substantially altered floodplain access. About 29% of the 100-year floodplain has become isolated from the river, and a fraction of this (1.6%) has been attributed to flow alterations, where as 27% has been associated with agricultural features on the floodplain such as roads and ditches. There are about 480 acres of flood irrigated land within the Channel Migration Zone of Reach D16.

Land use mapping shows several drill pads in the lower portion of the reach that are within several thousand feet of the river. There are four drill pads on a narrow strip of land at the mouth that lies between the Yellowstone and Missouri Rivers.

Reach D16 has a notably high concentration of mapped wetlands. There are about 580 acres of mapped wetland in the reach, which translates to about 80 acres per valley mile. Along the rest of the river, wetland densities rarely exceed 50 acres per valley mile. Reach D16 only has 3.5 acres of mapped Russian olive, which is a relatively low density for reaches below Billings.

Because of the riparian encroachment, Reach D16 has seen an increase in the area of riparian forest considered at low risk of cowbird parasitism; in 1950 there were about 250 acres of such forest per valley mile, and in 2001 there were 308 acres per valley mile.

The changes in Reach D16 are due in part to major flow alterations in the reach. The 2-year discharge, which is considered to have a large influence on channel size, has been reduced by 22% due to human development.

CEA-Related observations in Reach D16 include:
•Extensive riparian encroachment with flow alterations
•Conversion of open sand bars to forested islands

Recommended Practices for Reach D16 include:
•Drill pad considerations
•Riparian protections

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	
2 Year (cfs)	69,900	54,300	-22.3%	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.
100 Year (cfs)	143,000	134,000	-6.3%	

Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	
	1,515.1		1,157.3	960.1	-555.0	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	
Rock RipRap	266	0.3%	266	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.
Concrete Riprap	0	0.0%	0	
Flow Deflectors	0	0.0%	0	
Total	**266**	**0.3%**	**266**	

Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	
	0	0	Numerous side channels have been blocked by small dikes.

Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	
Total Acres			472.19 acres	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.
Acres/Year				
Acres/Year/Valley Mile				

Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	
Change in Area '50 - '01 (Ac)	10.3	45.8	-208.4	-152.3	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.

Floodplain Isolation	Acres	% of FP	
5 Year	105.9	31%	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.
100 Year	390.4	29%	

Restricted Migration Area	Acres	% of CMZ	
			Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.

Land Use	1950	2011		1950	2011	
Agricultural Land (Ac)	10,472.2	14,362.1	Flood (Ac)	4,631.0	8,492.4	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.
Ag. Infrastructure (Ac)	87.1	270.2	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	63.7	Pivot (Ac)	0.0	0.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	0.0	17.9				

1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	
					Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.

National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	
Riverine	25.3	3.6	**558.4**	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).
Emergent	254.9	36.2		
Scrub/Shrub	278.2	39.5		

Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	
	3.5	0.1%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.

Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	
	230.3		307.9	77.6	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.

PHYSICAL FEATURES MAP (2011)

CHANNEL MIGRATION ZONE MAP