| | | | |
|---|---|---|---|
| **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) |
| **General Comments** | Valley bottom crossover | | |

**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 percent 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 most 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 acres per valley mile.

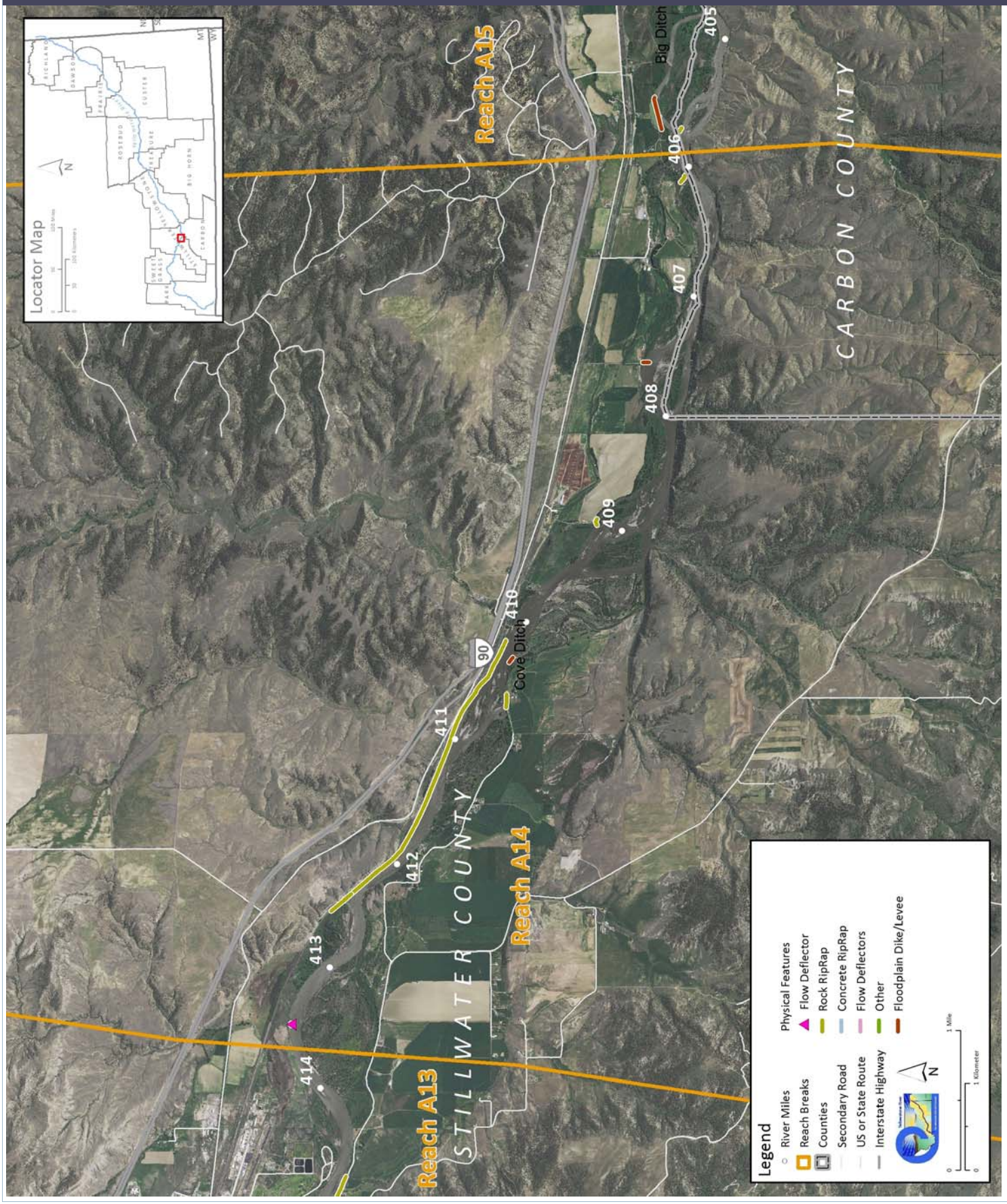
Reach A14 has approximately 2.5 acres of mapped Russian olive, which is concentrated along ditches and low riparian/wetland areas north of the river. There are also over 250 acres of mapped wetland in the each, most of which is emergent marshes and wet meadows. About 27 acres of emergent wetland have 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 16,200 cfs to 15,100 cfs, a drop of about 7 percent. 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 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760 cfs under unregulated conditions to 1,680 cfs under regulated conditions at the Livingston gage, a reduction of 4.6 percent.

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 (may include Yellowstone River Recommended Practices--YRRPs) 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

## PHYSICAL FEATURES MAP (2011)



# HYDROLOGIC SUMMARY

**Hydrologic data available for the Reach Narratives include data from representative gaging stations, modeling from the COE from the Big Horn river upstream, and modeling by the USGS for the Big Horn River to the Missouri River confluence. Gaging stations that best represent the watershed area within any reach are used to describe the flood history within the reach. Hydrology modeling results generated for all reaches provides unregulated and regulated flow values. Seasonal and annual flow duration data generated by the USGS are available for reaches C10 through D13.**

## Gage Representation (Gage-Based): Livingston

### Flood History

| Year | Date | Flow on Date | Return Interval |
|---|---|---|---|
| 1971 | Jun 23 | 29,200 | 10-25 yr |
| 1902 | Jun 11 | 30,100 | 10-25 yr |
| 1943 | Jun 20 | 30,600 | 10-25 yr |
| 1974 | Jun 17 | 36,300 | 50-100 yr |
| 1996 | Jun 10 | 37,100 | 50-100 yr |
| 1997 | Jun 6 | 38,000 | 50-100 yr |
| 2011 | Jun 30 | 40,600 | >100-yr |

| | Downstream Gage | Upstream Gage |
|---|---|---|
| Gage No | 6214500 | 6192500 |
| Location | Billings | Livingston |
| Period of Record | 1929-2015 | 1929-2015 |
| Distance To (miles) | 41.5 | 92.9 |

### Discharge

| | 1.01 Yr | 2 Yr | 5 Yr | 10 Yr | 50 Yr | 100 Yr | 500 Yr | 7Q10 Summer | 95% Sum. Duration |
|---|---|---|---|---|---|---|---|---|---|
| Unregulated | 16,200 | 31,000 | 38,600 | 43,300 | 52,700 | 56,600 | 65,200 | 2,280 | 1,760 |
| Regulated | 15,100 | 29,800 | 37,500 | 42,300 | 51,900 | 55,900 | 64,800 | 1,770 | 1,680 |
| % Change | -6.79% | -3.87% | -2.85% | -2.31% | -1.52% | -1.24% | -0.61% | -22.37% | -4.55% |

## AERIAL PHOTOGRAPHY

**A variety of aerial photographic sources provide the basis for much of the Cumulative Effects Assessment analysis. The table below lists the air photos compiled for the reach and the associated discharge at the most representative USGS gaging station.**

| | Source | Acquisition Date | Type | Scale | Gage | Discharge |
|---|---|---|---|---|---|---|
| 1950 | USGS-EROS | 22-May-51 | B/W | 1:28,400 | 6192500 | 10600 |
| 1976 | USCOE | 28-Sep-76 | B/W | 1:24,000 | 6192500 | 2560 |
| 1995 | USGS DOQQ | 8/28/97 - 8/26/96 - 7/27/96 | B/W | | 6192500 | 6960 |
| 2001 | NRCS | August 2-8, 2001 | CIR | 1:24,000 | 6192500 | 2000 |
| 2004 | Merrick | 14-May-04 | Color | 1:15,840 | 6192500 | 4520 |
| 2005 | NAIP | 07/15/2005 | color | 1-meter pixels | 6192500 | 5000 |
| 2005 | NAIP | 07/12/2005 | color | 1-meter pixels | 6192500 | 5960 |
| 2009 | NAIP | 7/22/2009 | Color | 1-meter pixels | 6192500 | 6990 |
| 2009 | NAIP | 7/7/2009 | Color | 1-meter pixels | 6192500 | 11300 |
| 2009 | NAIP | 6/29/2009 | Color | 1-meter pixels | 6192500 | 13900 |
| 2011 | USCOE | October 2012 | color | 1-ft pixel | 6192500 | 2530 |
| 2011 | NAIP | 7/24/2011 | Color | 1-meter pixels | 6192500 | 13100 |
| 2013 | NAIP | 06/15/2013 | color | 1-meter pixels | 6192500 | |

# PHYSICAL FEATURES

**Several efforts to capture the types and extents of physical features in the corridor have been generated by the CEA study. The 2001 Physical Features Inventory was performed through helicopter/video Rapid Aerial Assessment by the NRCS (NRCS, 2001) and did not include Park County. This inventory includes point and linear features that represent bank armor, irrigation structures, transportation encroachments, and areas of accelerated erosion. Bank armor mapped in the 2001 inventory only reflects features on the active channel margin, and thus excludes off-channel features on historic side channels. Some floodplain restriction features such as dikes and levees in the 2001 Physical Features Inventory may extend well beyond the active channel. In 2013, the 2001 inventory was revised to include Park County. At that time, some attribute inconsistencies in the original data were addressed. This dataset was then updated to reflect conditions in the 2011 NAIP imagery.**

**For Stillwater, Yellowstone and Dawson Counties, a Physical Features Timeline was generated that includes additional mapping based on aerial photography and assigns approximate dates of feature construction based on observed presence/absence in historic imagery between the 1950s and 2005 (DTM and AGI, 2008). The Physical Features Timeline contains features that were not mapped in the 2001 inventory (e.g. bank armor abandoned in floodplain areas by 2001). As such the total bank armor extent in the 2005 data is commonly greater than that identified in 2001 or 2013.**

**Note: As the goal for each physical features mapping effort were different, with differing mapping extents, there will be descrepancies between total feature lengths (e.g. length of rock riprap) in each data set.**

## 2001 and 2011 Physical Features Bankline Inventories

| Feature Class | Feature Type | 2001 Length (ft) | % of Bankline | 2011 Length (ft) | % of Bankline | 2001-2011 Change |
|---|---|---|---|---|---|---|
| Stream Stabilization | | | | | | |
| | Rock RipRap | 11,650 | 14.2% | 13,458 | 16.4% | 1,807 |
| | Flow Deflectors | 64 | 0.1% | 64 | 0.1% | 0 |
| | **Feature Type Totals** | **11,714** | **14.3%** | **13,521** | **16.5%** | **1,807** |
| Other In Channel | | | | | | |
| | Bedrock Control | 676 | 0.8% | 676 | 0.8% | 0 |
| | **Feature Type Totals** | **676** | **0.8%** | **676** | **0.8%** | **0** |
| Floodplain Control | | | | | | |
| | Transportation Encroachment | 1,605 | 2.0% | 1,605 | 2.0% | 0 |
| | Floodplain Dike/Levee | 230 | 0.3% | 225 | 0.3% | -5 |
| | **Feature Type Totals** | **1,835** | **2.2%** | **1,831** | **2.2%** | **-5** |
| | **Reach Totals** | **14,225** | **17.3%** | **16,028** | **19.5%** | **1,803** |

## Intent of Bank Protection: 2001

The 2001 bank protection features were assessed for the 'intent' of what they protect.

| Feature Type | Irrigated | Non-Irrig. | Ag. Infrastr. | Road | Interstate | Railroad | Urban | Exurban |
|---|---|---|---|---|---|---|---|---|
| Flow Deflectors/Between FDs | 62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rock RipRap | 249 | 0 | 0 | 0 | 0 | 11,398 | 0 | 0 |
| **Totals** | **312** | **0** | **0** | **0** | **0** | **11,398** | **0** | **0** |

## Bankline/Floodplain Inventory: Time Series

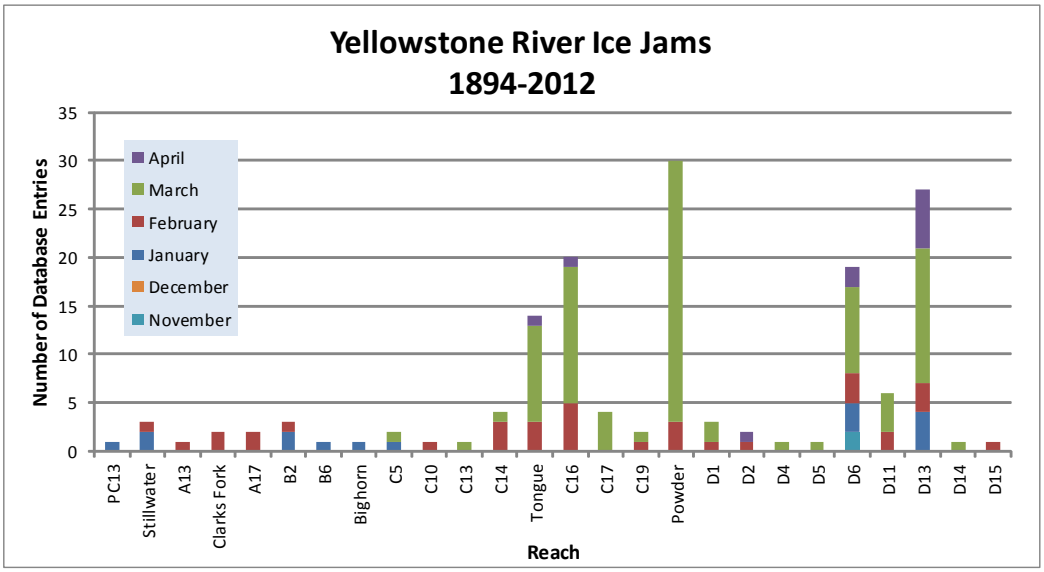
The Human Impacts Timeline assessed physical feature development through time for Yellowstone, Stillwater, and Dawson Counties.

| | | Sum of Feature Length (ft) | | | | | |
|---|---|---|---|---|---|---|---|
| Feature Class | Feature Type | 1950 | 1976 | 1995 | 2001 | 2004 | 2005 |
| Irrigation | | | | | | | |
| | In Channel Diversion | 0 | 207 | 207 | 207 | 207 | 207 |
| | Floodplain Dike/Levee | 6,820 | 6,820 | 6,820 | 6,820 | 6,820 | 6,820 |
| | **Totals** | **6,820** | **7,027** | **7,027** | **7,027** | **7,027** | **7,027** |
| Other Off Channel | | | | | | | |
| | Floodplain Dike/Levee | 0 | 258 | 258 | 471 | 471 | 471 |
| | Floodplain Dike/Levee | 2,576 | 2,576 | 2,576 | 2,866 | 2,866 | 2,866 |
| | **Totals** | **2,576** | **2,834** | **2,834** | **3,337** | **3,337** | **3,337** |
| Stream Stabilization | | | | | | | |
| | Rock RipRap | 13,555 | 13,555 | 14,157 | 14,157 | 14,157 | 14,157 |
| | Flow Deflector | 0 | 185 | 185 | 185 | 400 | 400 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Totals** | **13,555** | **13,740** | **14,341** | **14,341** | **14,557** | **14,557** |
| Transportation Encroachment | | | | | | |
| Railroad | 10,381 | 10,381 | 10,381 | 10,381 | 10,381 | 10,381 |
| Other | 10,900 | 10,900 | 10,900 | 10,900 | 10,900 | 10,900 |
| County Road | 1,729 | 1,729 | 1,729 | 1,729 | 1,729 | 1,729 |
| **Totals** | **23,010** | **23,010** | **23,010** | **23,010** | **23,010** | **23,010** |

## ICE JAMS

Ice jam data were obtained from the National Ice Jam Database maintained by the Ice Engineering Group at Army Corps of Engineers Cold Regions Research and Engineering Laboratory (https://rsgis.crrel.usace.army.mil/icejam/). From this database, Yellowstone River ice jams are summarized by reach in the Yellowstone River Historic Events Timeline (DTM and AGI, 2008b). The basic information for each ice jam is presented as a list of events. The graph represents the number of database entries for a reach. Note that a single jam event may have multiple entries.




## GEOMORPHIC

The geomorphology data presented below consist of measured changes in Braiding Parameter since 1950 and blocked side channels. Braiding parameter is a measure of the total length of side channels relative to that of the main channel. The braiding parameter is calculated as the sum of anabranching and primary channel lengths divided by the primary channel length. Secondary channels within the bankfull margins are a function of flow stage and hence were not included in the braiding parameter calculation. If a reach has a braiding parameter of 3, then the total bankfull channel length is three times that of the main channel. The mean braiding parameter measured for all 88 reaches is 1.8.

Blocked side channels that were either plugged with a small dike or cutoff by larger features such as a levee or road prism were identified for the pre and post-1950s eras.

Additional geomorphic parameters are discussed in more detail in the study report and appendices.

### Braiding (Bankfull)

| | Primary Chan. Length (ft) | Anab. Ch. Length (ft) | Bankfull Braiding Parameter | | % Change in Braiding |
|---|---|---|---|---|---|
| 1950 | 42,099 | 56,155 | 2.33 | 1950 to 1976: | -3.61% |
| 1976 | 40,060 | 50,059 | 2.25 | 1976 to 1995: | -15.02% |
| 1995 | 41,418 | 37,765 | 1.91 | 1995 to 2001: | 1.51% |
| 2001 | 41,087 | 38,652 | 1.94 | 1950 to 2001: | -16.84% |
| Change 1950 - 2001 | **-1,012** | **-17,502** | **-0.39** | | |

### Length of Side Channels Blocked

| | |
|---|---|
| Pre-1950s (ft) | 9,672 |
| Post-1950s (ft) | 9,176 |

## HYDRAULICS

Available hydraulic information includes county-based HEC-RAS modeling efforts by the Army Corps of Engineers with the exclusion of Park County. Floodplain modeling was performed for four conditions representing a developed and undeveloped floodplain, and unregulated and regulated flows for the 1.5, 2, 5, 10, 20, 50, 100, 200, and 500-year events. Park County has limited FEMA hydraulic modeling and was not included in the analysis.

The results of HEC-RAS modeling for the 5 and 100-year flood events were assessed to compare the extents of inundated area for the pristine (undeveloped floodplain, unregulated flows) and developed (developed floodplain, regulated flows) conditions. The data sets provided for each flow condition were unioned in the GIS to identify areas where the inundated extent differed. These area areas of human-caused floodplain isolation due to either flow alterations or physical features such as levees. For the 100-year flood event, isolated areas greater than 5 acres were attributed with the interpreted reason for isolation (railroad, levee, etc.). The resulting values are presented as acres and percent of the pristine floodplain that has been isolated. The pristine floodplain is defined as the total floodplain footprint minus the area of the mapped 2001 bankfull channel (mapped islands were included in the floodplain area).

### Floodplain Isolation

| | 100-Year | | 5-Year | |
|---|---|---|---|---|
| | Isolated Acres | % of Floodplain | Isolated Acres | % of Floodplain |
| Non-Structural (hydrology, geomorphic, etc.) | 0 | 0.0% | | |
| Agriculture (generally relates to field boundaries) | 0 | 0.0% | | |
| Agriculture (isloated by canal or large ditch) | 0 | 0.0% | | |
| Levee/Riprap (protecting agricultural lands) | 0 | 0.0% | | |
| Levee/Riprap (protecting urban, industrial, etc.) | 0 | 0.0% | | |
| Railroad | 0 | 0.0% | | |
| Abandoned Railroad | 0 | 0.0% | | |
| Transportation (Interstate and other roads) | 0 | 0.0% | | |
| Total Not Isolated (Ac) | 838 | | 997 | |
| Total Floodplain Area (Ac) | 838 | | 1037 | |
| **Total Isolated (Ac)** | **0** | **0.0%** | **41** | **13.1%** |

The 5-year floodplain is a good allegory for the extent of the riparian zone. Thus, irrigated areas within the 5-year floodplain tend to represent riparian zones that have been converted to agrigulture and may result in additional bank protection to protect the agricultural production and irrigation infrastructure.

| | Flood | Sprinkler | Pivot | Total |
|---|---|---|---|---|
| Irrigated Acres within the 5 Year Flooplain: | 12 | 0 | 0 | **12** |

## CHANNEL MIGRATION ZONE

**A series of Channel Migration Maps were developed for the Yellowstone River from Gardiner to its mouth in McKenzie County, North Dakota (Thatcher, Swindell, and Boyd, 2009). These maps and their accompanying report can be accessed from the YRCDC Website. The channel migration zone (CMZ) developed for the Yellowstone River is defined as a composite area made up of the existing channel, the historic channel since 1950 (Historic Migration Zone, or HMZ), and an Erosion Buffer that encompasses areas prone to channel erosion over the next 100 years. Areas within this CMZ that have been isolated by constructed features such as armor or floodplain dikes are attributed as "Restricted Migration Areas" (RMA). Beyond the CMZ boundaries, outlying areas that pose risks of channel avulsion are identified as "Avulsion Potential Zones".**

| Mean 50-Yr Migration Distance (ft) | Erosion Buffer (ft) | Total CMZ Acreage | Restricted CMZ Acreage | % Restricted Migration Area | Total AHZ Acreage | Restricted AHZ Acreage | % Restricted Avulsion Area |
|---|---|---|---|---|---|---|---|
| 293 | 587 | 1,671 | 27 | 2% | 181 | 0 | 0% |

### 2011 Restricted Migration Area Summary

Note that these data reflect the observed conditions in the 2011 aerial photography (NAIP for Park and Sweet Grass Counties, COE for the rest of the river).

| Reason for Restriction | Land Use Protected | RMA Acres | Percent of CMZ |
|---|---|---|---|
| RipRap | | | |
| | Railroad | 26 | 1.4% |
| | **Totals** | **26** | **1.4%** |

### Land Uses within the CMZ (Acres)

| Flood Irrigation | Sprinkler Irrigation | Pivot Irrigation | Urban/ ExUrban | Trans-portation |
|---|---|---|---|---|
| 215.4 | 0.0 | 0.0 | 0.0 | 11.4 |

# LAND USE

**Land uses were mapped from aerial photography Gardiner to the confluence of the Missouri River in North Dakota for four time periods: 1950s, 1976, 2001, and 2011. Mapping was performed at approximately 1:6,000 to ensure consistent mapping across all data sets. Typically, if a feature could not be easily mapped at the target mapping scale, it was not separated out from the adjacent land use.**

**A four-tiered system was used to allow analysis at a variety of levels. Tier 1 breaks land use into Agricultural and Non-Agricultural uses. Tier two subdivided uses into productive Agricultural Land and Infrastructure for the Agricultural land, and Urban, Exurban and Transportation categories for the Non-Agricultural land. Tier three further breaks down land uses into more refined categories such as Irrigated or Non-Irrigated and Residential, Commercial, or Industrial. Finally, Tier 4 focuses primarily on the productive agricultural lands, identifying the type of irrigation (Pivot, Sprinkler or Flood).**

## Land Use Timeline - Tiers 2 and 3

| | | Acres | | | | % of Reach Area | | | |
|---|---|---|---|---|---|---|---|---|---|
| Feature Class | Feature Type | 1950 | 1976 | 2001 | 2011 | 1950 | 1976 | 2001 | 2011 |
| Agricultural Infrastructure | | | | | | | | | |
| | Canal | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Agricultural Roads | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Other Infrastructure | 74 | 112 | 249 | 259 | 1.3% | 1.9% | 4.3% | 4.4% |
| | **Totals** | **74** | **112** | **249** | **259** | **1.3%** | **1.9%** | **4.3%** | **4.4%** |
| Agricultural Land | | | | | | | | | |
| | Non-Irrigated | 3,052 | 2,969 | 3,002 | 2,980 | 52.2% | 50.7% | 51.3% | 50.9% |
| | Irrigated | 1,664 | 1,644 | 1,467 | 1,464 | 28.4% | 28.1% | 25.1% | 25.0% |
| | **Totals** | **4,716** | **4,613** | **4,470** | **4,444** | **80.6%** | **78.8%** | **76.4%** | **75.9%** |
| Channel | | | | | | | | | |
| | Channel | 973 | 929 | 934 | 962 | 16.6% | 15.9% | 16.0% | 16.4% |
| | **Totals** | **973** | **929** | **934** | **962** | **16.6%** | **15.9%** | **16.0%** | **16.4%** |
| ExUrban | | | | | | | | | |
| | ExUrban Other | 0 | 12 | 12 | 0 | 0.0% | 0.2% | 0.2% | 0.0% |
| | ExUrban Undeveloped | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | ExUrban Industrial | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | ExUrban Commercial | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | ExUrban Residential | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | **Totals** | **0** | **12** | **12** | **0** | **0.0%** | **0.2%** | **0.2%** | **0.0%** |
| Transportation | | | | | | | | | |
| | Public Road | 53 | 55 | 55 | 55 | 0.9% | 0.9% | 0.9% | 0.9% |
| | Interstate | 0 | 96 | 96 | 96 | 0.0% | 1.6% | 1.6% | 1.6% |
| | Railroad | 37 | 37 | 37 | 37 | 0.6% | 0.6% | 0.6% | 0.6% |
| | **Totals** | **90** | **188** | **189** | **189** | **1.5%** | **3.2%** | **3.2%** | **3.2%** |
| Urban | | | | | | | | | |
| | Urban Other | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Urban Residential | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Urban Commercial | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Urban Undeveloped | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Urban Industrial | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | **Totals** | **0** | **0** | **0** | **0** | **0.0%** | **0.0%** | **0.0%** | **0.0%** |

## Land Use Timeline - Tiers 3 and 4

| | | Acres | | | | % of Reach Area | | | | Change Between Years (% of Agricultural Land) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feature Class | Feature Type | 1950 | 1976 | 2001 | 2011 | 1950 | 1976 | 2001 | 2011 | '50-76 | '76-01 | '01-11 | '50-11 |
| Irrigated | | | | | | | | | | | | | |
| | Sprinkler | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| | Pivot | 0 | 0 | 0 | 144 | 0.0% | 0.0% | 0.0% | 3.2% | 0.0% | 0.0% | 3.2% | 3.2% |
| | Flood | 1,664 | 1,644 | 1,467 | 1,320 | 35.3% | 35.6% | 32.8% | 29.7% | 0.4% | -2.8% | -3.1% | -5.6% |
| | **Totals** | **1,664** | **1,644** | **1,467** | **1,464** | **35.3%** | **35.6%** | **32.8%** | **32.9%** | **0.4%** | **-2.8%** | **0.1%** | **-2.3%** |

Non-Irrigated

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Multi-Use | 2,649 | 2,532 | 2,599 | 2,532 | 56.2% | 54.9% | 58.1% | 57.0% | -1.3% | 3.3% | -1.2% | 0.8% |
| Hay/Pasture | 403 | 436 | 403 | 448 | 8.6% | 9.5% | 9.0% | 10.1% | 0.9% | -0.4% | 1.1% | 1.5% |
| **Totals** | **3,052** | **2,969** | **3,002** | **2,980** | **64.7%** | **64.4%** | **67.2%** | **67.1%** | **-0.4%** | **2.8%** | **-0.1%** | **2.3%** |

## RIPARIAN

Riparian mapping data are derived from the Yellowstone River Riparian Vegetation Mapping study (DTM/AGI 2008). This study coarsely mapped the riparian vegetation communities using 1950's, 1976-1977, and 2001 aerial imagery in a GIS environment. The polygons are digitized at a scale of approximately 1:7,500, with a minimum mapping unit of approximately 10 acres. The goal of the delineation was to capture areas of similar vegetation structure as they appeared on the aerial imagery, while maintaining a consistent scale.

The "Riparian Turnover" values quantify the total area within the active channel area that converted from either woody vegetation to open bar or water, or from open bar or water to woody vegetation. A comparison of these values allows some consideration of overall riparian encroachment into the river corridor from 1950 to 2001.

### Riparian Mapping

| | Shrub (Acres) | | | Closed Timber (Acres) | | | Open Timber (Acres) | | |
|---|---|---|---|---|---|---|---|---|---|
| Statistic | 1950 | 1976 | 2001 | 1950 | 1976 | 2001 | 1950 | 1976 | 2001 |
| Min | 1.2 | 0.2 | 1.3 | 1.3 | 0.5 | 0.9 | 0.4 | 1.6 | 0.7 |
| Max | 4.8 | 10.0 | 20.9 | 146.2 | 107.9 | 137.3 | 33.2 | 114.5 | 35.7 |
| Average | 3.0 | 2.4 | 4.9 | 22.1 | 15.6 | 20.3 | 11.8 | 25.9 | 15.9 |
| Sum | 6.0 | 24.3 | 44.2 | 729.0 | 563.0 | 629.8 | 106.2 | 181.0 | 111.0 |

### Riparian Turnover

Conversion of riparian areas to channel, or from channel to riparian between the 1950's and 2001 data set.

| | |
|---|---|
| Riparian to Channel (acres) | 182.5 |
| Channel to Riparian (acres) | 150.7 |
| **Riparian Encroachment (acres)** | **-31.8** |

### Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

| | |
|---|---|
| 1950s Channel Mapped as 2011 Riparian (Ac) | 0.0 |
| 1950s Floodplain Mapped as 2011 Channel (Ac) | 2.5 |
| **Total Recruitment (1950s to 2011)(Ac)** | **2.5** |

## WETLANDS

Wetland areas were mapped to National Wetland Inventory standards by the Montana Natural Heritage Program. Palustrine wetlands within the mapped 100-year inundation boundary were extracted and summarized into four categories: Riverine (Unconsolidated Bottom - UB, Aquatic Bed - AB, and Unconsolidated Shore - US), Emergent - EM, Scrub-Shrub - SS, and Forested - FO.

| | Riverine | Emergent | Scrub/Shrub | Forested | Total |
|---|---|---|---|---|---|
| Mapped Acres | 14.4 | 211.3 | 57.6 | 0.0 | **283.3** |
| Acres/Valley Mile | 2.0 | 29.3 | 8.0 | 0.0 | |

## RUSSIAN OLIVE

Russian olive is considered an invasive species and its presence in the Yellowstone River corridor is fairly recent. As such, its spread can be used as a general indicator of invasive plants within the corridor. It has the added benefit of being easily identified in multi-spectral aerial photography, making it possible to inventory large areas using remote techniques.

In 2011, Natural Resources Conservation Service (NRCS) in Bozeman, MT conducted an inventory of Russian olive locations in the Yellowstone River watershed. This study utilized the Feature Analyst extension within ArcGIS to interpret multi-spectral 2008 NAIP imagery for the presence of Russian olive. The resulting analysis was converted from raster format to a polygon ESRI shape file for distribution and further analysis within a GIS environment.

This work scope was tasked with integrating the resulting Russian olive inventory into the Yellowstone River Conservation Districts Council (YRCDC) Cumulative Effects Assessment (CEA) GIS and associated reach-based database. Additionally, analysis of Russian olive within the corridor was conducted to characterize its distribution in throughout the corridor and its association with other corridor data sets.

| | Floodplain Area (Ac) | % of Floodplain | Other Area (Ac) | Inside RMA (Ac) | Inside '50s Channel (Ac) | Inside 50s Island (Ac) |
|---|---|---|---|---|---|---|
| Russian Olive in Reach | 2.55 | 0.12% | 1.00 | 0.00 | 0.25 | 0.10 |

## FISHERIES SUMMARY

**Fisheries data available for the Reach Narratives include low-flow and high-flow habitat mapping of 2001 conditions for 406 miles of river, extending from the mouth upstream to a point approximately 8 miles upstream of Park City. Habitat mapping was performed remotely on the 2001 CIR aerial photography utilizing habitat classifications developed by Montana Fish, Wildlife, and Parks (DTM 2009). Historic habitat mapping using the 1950's imagery is limited to Reach B1 (high-flow) and D9 (low and high-flow).**

**Fisheries field sampling data have been provided by Ann Marie Reinhold (MSU). In this study, the Yellowstone River from Park City to Sidney was divided into five segments. Within each segment, fish were sampled in reaches modified by riprap ("treatment reaches") and relatively unmodified reaches ("control reaches"). Fish sampling was conducted during summer and autumn of 2009, 2010, and 2011. Boat electrofishing, trammel nets, mini-fyke nets and bag seines were used to collect data from river bends.**

**Fish presence data is only presented for those reaches that were sampled.**

**The Low Flow Habitat Mapping followed schema deveoped by Montana Fish Wildlife and Parks to identify key habitat units for certain aquatic species.**

## AVIAN

Birds were sampled in 2006 and 2007 by Danielle Jones of Montana State University. Point count methods were used at 304 randomly chosen sites in 21 braided or anabranching reaches. Each site was visited multiple times within a season, and sites were visited in both years. Birds were sampled in grassland, shrubland, and cottonwood forest habitats. Additional bird data was collected by Amy Cilimburg of Montana Audubon in summer 2012. High priority areas for data collection were identified with the assistance of the YRCDC Technical Advisory Committee. The Audubon methodology recorded data for a wider variety of bird species relative to the MSU study, including raptors and waterfowl.

### Bird Species Observed in Reach/Region

Species of Concern | Potential Species of Concern

| Reach | Region | | Reach | Region | | Reach | Region | | Reach | Region | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | ☑ | American Robin | ☑ | ☑ | Chipping Sparrow | ☐ | ☐ | Killdeer | ☑ | ☑ | Song Sparrow |
| ☑ | ☑ | American Crow | ☐ | ☑ | Clay-collared Sparrow | ☐ | ☐ | Lark Bunting | ☐ | ☐ | Spotted Sandpiper |
| ☑ | ☑ | American Goldfinch | ☐ | ☑ | Cliff Swallow | ☐ | ☑ | Lark Sparrow | ☑ | ☑ | Spotted Towhee |
| ☐ | ☐ | American Kestrel | ☑ | ☑ | Common Grackle | ☑ | ☑ | Lazuli Bunting | ☐ | ☐ | Sharp-shinned Hawk |
| ☑ | ☑ | American Redstart | ☐ | ☐ | Common Merganser | ☑ | ☑ | Least Flycatcher | ☑ | ☑ | Swainson's Thrush |
| ☐ | ☐ | Bald Eagle | ☐ | ☐ | Common Nighthawk | ☐ | ☐ | Mallard | ☐ | ☐ | Sandhill Crane |
| ☑ | ☑ | Baltimore Oriole | ☐ | ☐ | Common Raven | ☐ | ☑ | Mountain Bluebird | ☑ | ☑ | Tree Swallow |
| ☐ | ☑ | Barn Swallow | ☑ | ☑ | Common Yellowthroat | ☑ | ☑ | Mourning Dove | ☐ | ☐ | Turkey Vulture |
| ☐ | ☐ | Belted Kingfisher | ☐ | ☐ | Cooper's Hawk | ☑ | ☑ | Northern Flicker | ☐ | ☐ | Upland Sandpiper |
| ☐ | ☐ | Black-billed Cuckoo | ☐ | ☑ | Dickcissel | ☐ | ☐ | Orchard Oriole | ☐ | ☑ | Vesper Sparrow |
| ☑ | ☑ | Black-billed Magpie | ☑ | ☑ | Downy Woodpecker | ☐ | ☐ | Osprey | ☑ | ☑ | Violet-green Swallow |
| ☑ | ☑ | Black-capped Chickadee | ☐ | ☐ | Eastern Bluebird | ☐ | ☑ | Ovenbird | ☑ | ☑ | Warbling Vireo |
| ☐ | ☑ | Black-and-white Warbler | ☑ | ☑ | Eastern Kingbird | ☐ | ☐ | Plumbeous Vireo | ☐ | ☑ | Western Kingbird |
| ☑ | ☑ | Black-headed Grosbeak | ☐ | ☐ | Eurasian Collared-dove | ☐ | ☐ | Red-headed Woodpecker | ☐ | ☑ | Western Meadowlark |
| ☐ | ☑ | Blue Jay | ☑ | ☑ | European Starling | ☐ | ☑ | Red-naped Sapsucker | ☑ | ☑ | Western Wood-pewee |
| ☐ | ☑ | Bobolink | ☐ | ☑ | Field Sparrow | ☐ | ☐ | Red Crossbill | ☑ | ☑ | White-breasted Nuthatch |
| ☑ | ☑ | Brewer's Blackbird | ☐ | ☐ | Franklin's Gull | ☐ | ☐ | Ring-necked Pheasant | ☑ | ☑ | White-throated Swift |
| ☑ | ☑ | Brown-headed Cowbird | ☐ | ☐ | Grasshopper Sparrow | ☐ | ☐ | Red-tailed hawk | ☐ | ☐ | Wild Turkey |
| ☐ | ☐ | Brown Creeper | ☑ | ☑ | Gray Catbird | ☐ | ☐ | Rock Dove | ☐ | ☐ | Wood Duck |
| ☐ | ☑ | Brown Thrasher | ☐ | ☐ | Great Blue Heron | ☑ | ☑ | Red-winged Blackbird | ☐ | ☐ | Yellow-bellied Sapsucker |
| ☑ | ☑ | Bullock's Oriole | ☐ | ☐ | Great Horned Owl | ☐ | ☑ | Red-eyed Vireo | ☐ | ☐ | Yellow-billed Cuckoo |
| ☐ | ☐ | Canada Goose | ☑ | ☑ | Hairy Woodpecker | ☐ | ☐ | Red-breasted Grosbeak | ☑ | ☑ | Yellow-breasted Chat |
| ☑ | ☑ | Cedar Waxwing | ☐ | ☐ | House Finch | ☐ | ☐ | Say's Phoebe | ☐ | ☑ | Yellow-headed Blackbird |
| ☐ | ☑ | Chimney Swift | ☑ | ☑ | House Wren | ☐ | ☑ | Savannah Sparrow | ☑ | ☑ | Yellow Warbler |

## CULTURAL INVENTORY SUMMARY

**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.**

### Summary of Cultural Views in Region A

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.