| | | | |
|---|---|---|---|
| **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) |
| **General Comments** | To Myers Br (RM 285.5); Railroad adjacent to channel on valley wall; low sinuosity | | |

**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 percent 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 recently 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 foot-long side channel has prompted clearing and farming of the old island area that is currently accessible. In total, about 18 percent (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 percent 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 percent of the total 100-year floodplain. The 5-year floodplain is even more affected; 59 percent 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 percent 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 percent. The 2-year flood, which strongly influences overall channel form, has dropped by 20 percent. 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 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,150 cfs under unregulated conditions to 3,320 cfs under regulated conditions at Reach C10 downstream where the analysis begins, a reduction of 46 percent.

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 (may include Yellowstone River Recommended Practices--YRRPs) for Reach C2 include:
•Side channel reactivation at RM 293
•Side channel reactivation at RM 289
•Nutrient management at corrals associated with an animal handling facility at RM 288.8L
•Russian olive removal

## 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): Miles City

### Flood History

| Year | Date | Flow on Date | Return Interval |
|---|---|---|---|
| 1974 | Jun 22 | 75,400 | 10-25 yr |
| 1997 | Jun 15 | 83,300 | 10-25 yr |
| 1943 | Jun 26 | 83,700 | 10-25 yr |
| 2011 | May 24 | 85,400 | 10-25 yr |
| 1944 | Jun 19 | 96,300 | 50-100 yr |
| 1978 | May 22 | 102,000 | 50-100 yr |

| | Downstream Gage | Upstream Gage |
|---|---|---|
| Gage No | 6309000 | 6214500 |
| Location | Miles City | Billings |
| Period of Record | 1929-2015 | 1929-2015 |
| Distance To (miles) | 102.8 | 72.1 |

### Discharge

| | 1.01 Yr | 2 Yr | 5 Yr | 10 Yr | 50 Yr | 100 Yr | 500 Yr | 7Q10 Summer | 95% Sum. Duration |
|---|---|---|---|---|---|---|---|---|---|
| Unregulated | | 60,900 | 76,600 | 87,000 | 110,000 | 119,000 | 142,000 | 4,610 | 3,846 |
| Regulated | | 47,100 | 61,300 | 70,700 | 91,200 | 100,000 | 121,000 | 2,950 | 2,227 |
| % Change | | -22.66% | -19.97% | -18.74% | -17.09% | -15.97% | -14.79% | -36.01% | -42.10% |

## 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 | 26-Aug-49 | B/W | 1:14,800 | 6309000 | 3620 |
| 1976 | USCOE | 29-Sep-76 | B/W | 1:24,000 | 6309000 | 9520 |
| 1995 | USGS DOQQ | 8-Aug-96 | B/W | | 6295000 | 9110 |
| 2001 | NRCS | August 2-8, 2001 | CIR | 1:24,000 | 6295000 | 3500 |
| 2005 | NAIP | 07/13/2005 | color | 1-meter pixels | 6309000 | 17700 |
| 2007 | Woolpert | 10/15/2007 - 11/2/0007 | Color | | | |
| 2009 | NAIP | 7/30/2009 | Color | 1-meter pixels | 6309000 | 13800 |
| 2009 | NAIP | 6/29/2009 | Color | 1-meter pixels | 6309000 | 42200 |
| 2011 | USCOE | October 2012 | color | 1-ft pixel | 6309000 | 8100 |
| 2011 | NAIP | 7/20/2011 | Color | 1-meter pixels | 6309000 | 46100 |
| 2013 | NAIP | 07/21/2013 | color | 1-meter pixels | 6309000 | |

# 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 | | | | | | |
| | Tree Revetments | 702 | 1.2% | 702 | 1.2% | 0 |
| | Rock RipRap | 25,527 | 43.8% | 25,537 | 43.9% | 10 |
| | Flow Deflectors | 0 | 0.0% | 387 | 0.7% | 387 |
| | Between Flow Deflectors | 0 | 0.0% | 869 | 1.5% | 869 |
| | **Feature Type Totals** | **26,229** | **45.0%** | **27,495** | **47.2%** | **1,266** |
| Floodplain Control | | | | | | |
| | Floodplain Dike/Levee | 1,508 | 2.6% | 1,508 | 2.6% | 0 |
| | **Feature Type Totals** | **1,508** | **2.6%** | **1,508** | **2.6%** | **0** |
| | **Reach Totals** | **27,737** | **47.6%** | **29,003** | **49.8%** | **1,266** |

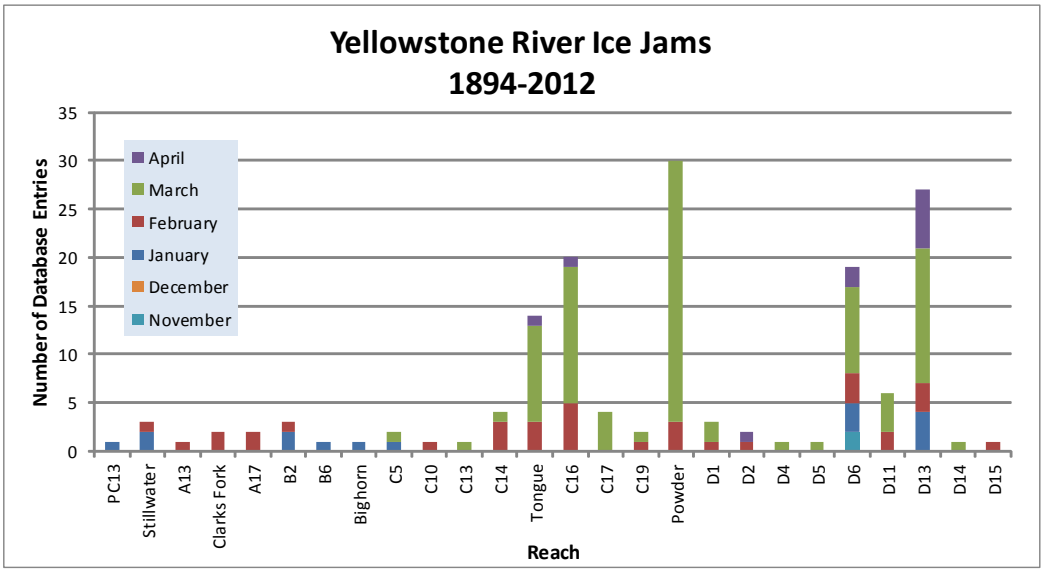
## Intent of Bank Protection: 2001

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 |
|---|---|---|---|---|---|---|---|---|
| Rock RipRap | 1,168 | 0 | 0 | 0 | 0 | 24,708 | 0 | 0 |
| Tree Revetments | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Totals** | **1,168** | **0** | **0** | **0** | **0** | **24,708** | **0** | **0** |

## 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 | 29,638 | 28,656 | 1.97 | 1950 to 1976: | 7.47% |
| 1976 | 29,979 | 33,391 | 2.11 | 1976 to 1995: | -36.35% |
| 1995 | 29,256 | 10,104 | 1.35 | 1995 to 2001: | -1.76% |
| 2001 | 29,112 | 9,366 | 1.32 | 1950 to 2001: | -32.80% |
| Change 1950 - 2001 | **-526** | **-19,291** | **-0.65** | | |

### Length of Side Channels Blocked

| | |
|---|---|
| Pre-1950s (ft) | 1,014 |
| Post-1950s (ft) | 10,614 |

## 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) | 129 | 4.7% | | |
| Agriculture (isloated by canal or large ditch) | 476 | 17.3% | | |
| Levee/Riprap (protecting agricultural lands) | 19 | 0.7% | | |
| 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) | 2123 | | 1250 | |
| Total Floodplain Area (Ac) | 2747 | | 2209 | |
| Total Isolated (Ac) | **624** | **22.7%** | **959** | **59.3%** |

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: | 217 | 0 | 0 | **217** |

## 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 |
|---|---|---|---|---|---|---|---|
| 331 | 663 | 1,517 | 143 | 9% | 126 | 15 | 12% |

### 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 | | | |
| | Irrigated | 47 | 2.8% |
| Flow Deflectors | | | |
| | Non-Irrigated | 10 | 0.6% |
| Dike/Levee | | | |
| | Public Road | 2 | 0.1% |
| | Irrigated | 109 | 6.6% |
| | **Totals** | **168** | **10.2%** |

### Land Uses within the CMZ (Acres)

| Flood Irrigation | Sprinkler Irrigation | Pivot Irrigation | Urban/ ExUrban | Trans-portation |
|---|---|---|---|---|
| 244.3 | 0.0 | 0.0 | 0.0 | 0.1 |

## 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 | 69 | 170 | 187 | 190 | 1.1% | 2.7% | 3.0% | 3.0% |
| | **Totals** | **69** | **170** | **187** | **190** | **1.1%** | **2.7%** | **3.0%** | **3.0%** |
| Agricultural Land | | | | | | | | | |
| | Non-Irrigated | 2,677 | 2,590 | 2,755 | 2,700 | 42.3% | 41.0% | 43.6% | 42.7% |
| | Irrigated | 2,465 | 2,434 | 2,566 | 2,610 | 39.0% | 38.5% | 40.6% | 41.3% |
| | **Totals** | **5,141** | **5,024** | **5,321** | **5,311** | **81.3%** | **79.5%** | **84.1%** | **84.0%** |
| Channel | | | | | | | | | |
| | Channel | 1,057 | 1,076 | 758 | 765 | 16.7% | 17.0% | 12.0% | 12.1% |
| | **Totals** | **1,057** | **1,076** | **758** | **765** | **16.7%** | **17.0%** | **12.0%** | **12.1%** |
| ExUrban | | | | | | | | | |
| | ExUrban Other | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 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 | 5 | 5 | 0.0% | 0.0% | 0.1% | 0.1% |
| | **Totals** | **0** | **0** | **5** | **5** | **0.0%** | **0.0%** | **0.1%** | **0.1%** |
| Transportation | | | | | | | | | |
| | Public Road | 24 | 21 | 21 | 21 | 0.4% | 0.3% | 0.3% | 0.3% |
| | Interstate | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Railroad | 33 | 33 | 33 | 33 | 0.5% | 0.5% | 0.5% | 0.5% |
| | **Totals** | **57** | **54** | **54** | **54** | **0.9%** | **0.8%** | **0.8%** | **0.8%** |
| 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 | 77 | 79 | 0.0% | 0.0% | 1.4% | 1.5% | 0.0% | 1.4% | 0.0% | 1.5% |
| | Pivot | 0 | 0 | 138 | 138 | 0.0% | 0.0% | 2.6% | 2.6% | 0.0% | 2.6% | 0.0% | 2.6% |
| | Flood | 2,465 | 2,434 | 2,351 | 2,394 | 47.9% | 48.4% | 44.2% | 45.1% | 0.5% | -4.3% | 0.9% | -2.9% |
| | **Totals** | **2,465** | **2,434** | **2,566** | **2,610** | **47.9%** | **48.4%** | **48.2%** | **49.2%** | **0.5%** | **-0.2%** | **0.9%** | **1.2%** |

Non-Irrigated

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Multi-Use | 2,601 | 2,510 | 2,736 | 2,697 | 50.6% | 49.9% | 51.4% | 50.8% | -0.6% | 1.5% | -0.6% | 0.2% |
| Hay/Pasture | 76 | 81 | 19 | 3 | 1.5% | 1.6% | 0.4% | 0.1% | 0.1% | -1.3% | -0.3% | -1.4% |
| **Totals** | **2,677** | **2,590** | **2,755** | **2,700** | **52.1%** | **51.6%** | **51.8%** | **50.8%** | **-0.5%** | **0.2%** | **-0.9%** | **-1.2%** |

# 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 | 0.9 | 0.3 | 1.4 | 0.1 | 0.0 | 2.0 | 4.7 | 0.3 | 1.8 |
| Max | 28.3 | 27.0 | 86.8 | 78.9 | 156.8 | 107.5 | 167.0 | 96.0 | 126.0 |
| Average | 9.6 | 8.2 | 16.1 | 19.8 | 37.8 | 31.2 | 59.9 | 22.7 | 29.9 |
| Sum | 172.2 | 180.1 | 241.1 | 276.7 | 416.0 | 374.0 | 479.1 | 182.0 | 149.7 |

## 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) | 90.0 |
| Channel to Riparian (acres) | 128.7 |
| **Riparian Encroachment (acres)** | **38.8** |

## Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

| | |
|---|---|
| 1950s Channel Mapped as 2011 Riparian (Ac) | 136.8 |
| 1950s Floodplain Mapped as 2011 Channel (Ac) | 56.3 |
| **Total Recruitment (1950s to 2011)(Ac)** | **193.1** |

# 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 | 2.3 | 68.1 | 33.6 | 0.0 | **104.1** |
| Acres/Valley Mile | 0.4 | 12.7 | 6.3 | 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 | 45.84 | 0.87% | 1.02 | 4.89 | 7.04 | 6.59 |

## 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.

### Fish Species Observed in Reach/Region

Species of Concern

| Reach | Region | | Reach | Region | | Reach | Region | | Reach | Region | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☑ | Bigmouth buffalo | ☑ | ☑ | Flathead chub | ☐ | ☐ | Northern redbelly dace | ☑ | ☑ | Stonecat |
| ☑ | ☑ | Black bullhead | ☑ | ☑ | Freshwater drum | ☐ | ☐ | Pallid sturgeon | ☐ | ☐ | Sturgeon chub |
| ☑ | ☑ | Black crappie | ☑ | ☑ | Goldeye | ☑ | ☑ | Pumpkinseed | ☑ | ☑ | Sucker species |
| ☐ | ☑ | Blue sucker | ☑ | ☑ | Green sunfish | ☐ | ☐ | Rainbow trout | ☐ | ☑ | Sunfish species |
| ☑ | ☑ | Bluegill | ☐ | ☑ | Lake chub | ☑ | ☑ | River carpsucker | ☑ | ☑ | Walleye |
| ☑ | ☑ | Brook stickleback | ☑ | ☑ | Largemouth bass | ☐ | ☑ | Rock bass | ☑ | ☑ | Western silvery minnow |
| ☑ | ☑ | Brown trout | ☑ | ☑ | Longnose dace | ☑ | ☑ | Sand shiner | ☐ | ☐ | White bass |
| ☑ | ☑ | Burbot | ☑ | ☑ | Longnose sucker | ☑ | ☑ | Sauger | ☐ | ☑ | White crappie |
| ☐ | ☐ | Catfish species | ☑ | ☑ | Minnow species | ☑ | ☑ | Shorthead redhorse | ☑ | ☑ | White sucker |
| ☑ | ☑ | Channel catfish | ☐ | ☐ | Mottled sculpin | ☐ | ☐ | Shortnose gar | ☐ | ☑ | Yellow bullhead |
| ☑ | ☑ | Common carp | ☑ | ☑ | Mountain sucker | ☐ | ☑ | Shovelnose sturgeon | ☐ | ☐ | Yellow perch |
| ☑ | ☑ | Creek chub | ☐ | ☑ | Mountain whitefish | ☐ | ☐ | Sicklefin chub | | | |
| ☑ | ☑ | Emerald shiner | ☐ | ☑ | Northern pike | ☑ | ☑ | Smallmouth bass | | | |
| ☑ | ☑ | Fathead minnow | ☐ | ☑ | Northern plains killifish | ☑ | ☑ | Smallmouth buffalo | | | |

### Low Flow Fisheries Habitat Mapping

| Habitat | 2001 (Acres) Bankfull | Low Flow | % of Low Flow |
|---|---|---|---|
| Scour Pool | 100.3 | 50.4 | 6.6% |
| Rip Rap Bottom | | 3.1 | 0.4% |
| Rip Rap Margin | 166.6 | 127.3 | 16.8% |
| Secondary Channel | 78.8 | 71.6 | 9.4% |
| Secondary Channel (Seasonal) | 111.0 | 52.4 | 6.9% |
| Channel Crossover | 133.3 | 103.8 | 13.7% |
| Point Bar | | 6.4 | 0.8% |
| Side Bar | | 29.0 | 3.8% |
| Mid-channel Bar | | 97.1 | 12.8% |
| Island | 167.6 | 167.6 | 22.1% |
| Dry Channel | | 49.0 | 6.5% |

## 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.**

# 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 C

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.