

| | | | |
|-------------------------|--|------------------------------|---------------------|
| 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) |
| General Comments | Vegatated islands | | |

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 were just about 730 feet of rock riprap in the reach armoring 0.6 percent 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 rates 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 percent 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 percent 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, Dickcissel, Ovenbird, and Plumbeous Vireo. 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 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 4,850 cfs to 2,810 cfs with human development, a reduction of 43 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270 cfs under regulated conditions, a reduction of 53 percent.

CEA-Related observations in Reach D10 include:

- Armor flanking and accelerated erosion behind

Recommended Practices (May include Yellowstone River Recommended Practices--YRRPs) for Reach D10 include:

- Removal of flanked armor at RM 60 and RM 64.2L
- 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): Sidney

Flood History

| Year | Date | Flow on Date | Return Interval | Gage No | Downstream Gage | Upstream Gage |
|------|--------|--------------|-----------------|---------|---------------------|---------------|
| 1978 | May 23 | 111,000 | 10-25 yr | | 6329500 | 6309000 |
| 1912 | Mar 29 | 114,000 | 10-25 yr | | Sidney | Miles City |
| 1944 | Jun 21 | 120,000 | 10-25 yr | | Period of Record | 1911-2015 |
| 2011 | May 24 | 124,000 | 10-25 yr | | Distance To (miles) | 25.5 |
| 1918 | Jun 20 | 126,000 | 25-50 yr | | | 116.2 |
| 1943 | Mar 29 | 132,000 | 25-50 yr | | | |
| 1923 | Oct 3 | 134,000 | 25-50 yr | | | |
| 1952 | Mar 31 | 138,000 | 25-50 yr | | | |
| 1921 | Jun 21 | 159,000 | 100-yr | | | |

Discharge

| | 1.01 Yr | 2 Yr | 5 Yr | 10 Yr | 50 Yr | 100 Yr | 500 Yr | 7Q10 Summer | 95% Sum. Duration |
|--------------------|---------|---------|---------|---------|---------|---------|---------|-------------|-------------------|
| Unregulated | | 69,700 | 90,000 | 103,000 | 132,000 | 144,000 | 173,000 | 4,450 | 6,620 |
| Regulated | | 54,200 | 74,700 | 88,100 | 118,000 | 130,000 | 159,000 | 2,310 | 2,840 |
| % Change | | -22.24% | -17.00% | -14.47% | -10.61% | -9.72% | -8.09% | -48.09% | -57.10% |

Flow Duration

Streamflow, in ft³/s, which was equaled or exceeded for indicated percent of time

Note that these statistics are only available from Reach C10 downstream. See the USGS report for detailed information.

| Season | | 5% | 50% | 95% |
|---------------|-----------------|-------------|-------------|-------------|
| Spring | Unregulated | 67,400 | 24,900 | 7,100 |
| | Regulated | 52,000 | 14,600 | 5,150 |
| | % Change | -23% | -41% | -27% |
| Summer | Unregulated | 47,500 | 14,700 | 6,620 |
| | Regulated | 35,300 | 8,540 | 2,840 |
| | % Change | -26% | -42% | -57% |
| Fall | Unregulated | 9,870 | 5,870 | 1,970 |
| | Regulated | 11,300 | 7,370 | 3,530 |
| | % Change | 14% | 26% | 79% |
| Winter | Unregulated | 15,600 | 5,500 | 2,130 |
| | Regulated | 16,200 | 6,670 | 3,480 |
| | % Change | 4% | 21% | 63% |
| Annual | Unregulated | 49,800 | 8,860 | 2,830 |
| | Regulated | 37,000 | 8,000 | 3,530 |
| | % Change | -26% | -10% | 25% |

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 | 6329500 | 2750 |
| 1976 | MDT | 28-Oct-77 | B/W | 1:12,000 | 6329500 | 5800 |
| 1995 | USGS DOQQ | 7/9/96 - 7/15/96 - 8/8/96 | B/W | | 6329500 | 35000 |
| 2001 | NRCS | August 2-8, 2001 | CIR | 1:24,000 | 6329500 | 4000 |
| 2004 | Merrick | 3-Jun-04 | Color | 1:15,840 | 6329500 | 9950 |
| 2005 | NAIP | 07/14/2005 | color | 1-meter pixels | 6329500 | 15900 |
| 2009 | NAIP | 7/11/2009 | Color | 1-meter pixels | 6329500 | 32600 |
| 2011 | USCOE | October 2012 | color | 1-ft pixel | 6329500 | 9030 |
| 2011 | NAIP | 7/21/2011 | Color | 1-meter pixels | 6329500 | 46600 |
| 2013 | NAIP | 07/19/2013 | color | 1-meter pixels | 6329500 | |
| 2013 | NAIP | 07/27/2013 | color | 1-meter pixels | 6329500 | |

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 discrepancies 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 | 1,175 | 1.0% | 728 | 0.6% | -447 |
| | Concrete RipRap | 1,051 | 0.9% | 0 | 0.0% | -1,051 |
| | Feature Type Totals | 2,226 | 1.9% | 728 | 0.6% | -1,498 |
| Other In Channel | | | | | | |
| | Bedrock Outcrop | 787 | 0.7% | 787 | 0.7% | 0 |
| | Feature Type Totals | 787 | 0.7% | 787 | 0.7% | 0 |
| | Reach Totals | 3,012 | 2.5% | 1,515 | 1.3% | -1,498 |

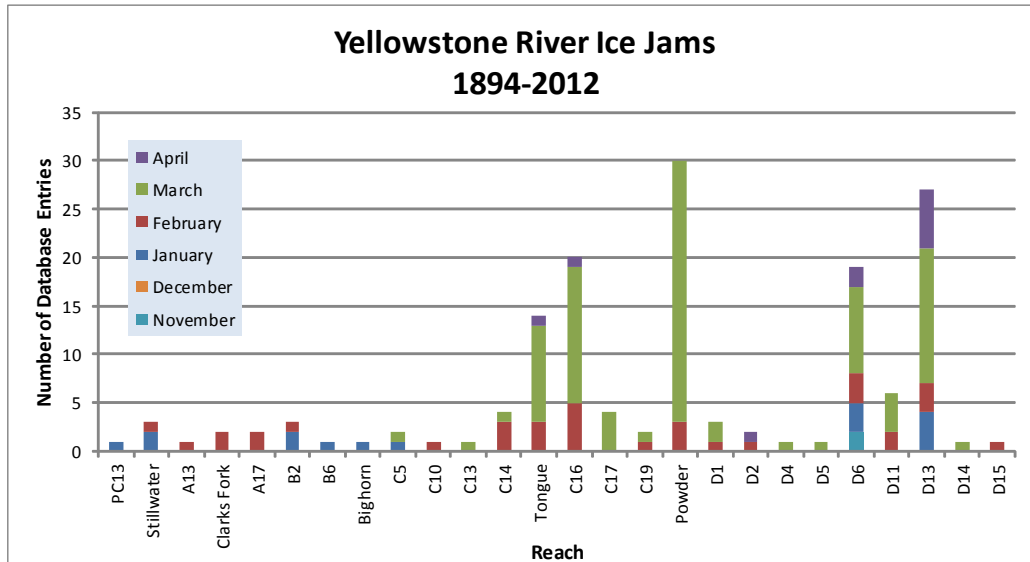
Intent of Bank Protection: 2001

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 |
|-----------------|--------------|--------------|---------------|----------|------------|----------|----------|----------|
| Concrete RipRap | 1,050 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rock RipRap | 0 | 1,174 | 0 | 0 | 0 | 0 | 0 | 0 |
| Totals | 1,050 | 1,174 | 0 | 0 | 0 | 0 | 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 | 59,537 | 92,853 | 2.56 | 1950 to 1976: | -4.18% |
| 1976 | 60,364 | 87,686 | 2.45 | 1976 to 1995: | -3.62% |
| 1995 | 61,165 | 83,424 | 2.36 | 1995 to 2001: | 11.88% |
| 2001 | 59,913 | 98,546 | 2.64 | 1950 to 2001: | 3.33% |
| Change 1950 - 2001 | 376 | 5,693 | 0.09 | | |

Length of Side Channels Blocked

| | |
|-----------------|---|
| Pre-1950s (ft) | 0 |
| Post-1950s (ft) | 0 |

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.) | 94 | 1.9% | | |
| Agriculture (generally relates to field boundaries) | 13 | 0.3% | | |
| Agriculture (isolated by canal or large ditch) | 121 | 2.5% | | |
| Levee/Riprap (protecting agricultural lands) | 0 | 0.0% | | |
| Levee/Riprap (protecting urban, industrial, etc.) | 0 | 0.0% | | |
| Railroad | 423 | 8.7% | | |
| Abandoned Railroad | 0 | 0.0% | | |
| Transportation (Interstate and other roads) | 0 | 0.0% | | |
| Total Not Isolated (Ac) | 4236 | | 2758 | |
| Total Floodplain Area (Ac) | 4887 | | 3576 | |
| Total Isolated (Ac) | 651 | 13.3% | 818 | 38.3% |

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 agriculture 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: | 121 | 0 | 0 | 121 |

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 |
|------------------------------------|---------------------|-------------------|------------------------|-----------------------------|-------------------|------------------------|----------------------------|
| 526 | 1,051 | 4,753 | 95 | 2% | 233 | 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 |
|------------------------|--------------------|-----------|----------------|
| Road/Railroad | Prism | | |
| | Railroad | 8 | 0.2% |
| RipRap | Non-Irrigated | 44 | 0.9% |
| Totals | | 52 | 1.0% |

Land Uses within the CMZ (Acres)

| Flood Irrigation | Sprinkler Irrigation | Pivot Irrigation | Urban/ ExUrban | Transportation |
|------------------|----------------------|------------------|----------------|----------------|
| 540.6 | 0.0 | 96.5 | 5.7 | 1.8 |

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

| Feature Class | Feature Type | Acres | | | | % of Reach Area | | | |
|-----------------------------|----------------------|--------------|--------------|--------------|--------------|-----------------|--------------|--------------|--------------|
| | | 1950 | 1976 | 2001 | 2011 | 1950 | 1976 | 2001 | 2011 |
| Agricultural Infrastructure | | | | | | | | | |
| | Canal | 26 | 26 | 26 | 26 | 0.3% | 0.3% | 0.3% | 0.3% |
| | Agricultural Roads | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Other Infrastructure | 18 | 18 | 29 | 26 | 0.2% | 0.2% | 0.4% | 0.3% |
| | Totals | 44 | 44 | 55 | 53 | 0.5% | 0.5% | 0.7% | 0.6% |
| Agricultural Land | | | | | | | | | |
| | Non-Irrigated | 3,863 | 4,018 | 4,158 | 3,825 | 47.1% | 49.0% | 50.7% | 46.6% |
| | Irrigated | 723 | 1,130 | 1,533 | 1,505 | 8.8% | 13.8% | 18.7% | 18.3% |
| | Totals | 4,586 | 5,148 | 5,692 | 5,330 | 55.9% | 62.8% | 69.4% | 65.0% |
| Channel | | | | | | | | | |
| | Channel | 3,546 | 2,979 | 2,424 | 2,788 | 43.2% | 36.3% | 29.6% | 34.0% |
| | Totals | 3,546 | 2,979 | 2,424 | 2,788 | 43.2% | 36.3% | 29.6% | 34.0% |
| 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 | 5 | 6 | 6 | 0.0% | 0.1% | 0.1% | 0.1% |
| | Totals | 0 | 5 | 6 | 6 | 0.0% | 0.1% | 0.1% | 0.1% |
| Transportation | | | | | | | | | |
| | Public Road | 5 | 5 | 5 | 5 | 0.1% | 0.1% | 0.1% | 0.1% |
| | Interstate | 0 | 0 | 0 | 0 | 0.0% | 0.0% | 0.0% | 0.0% |
| | Railroad | 21 | 21 | 21 | 21 | 0.3% | 0.3% | 0.3% | 0.3% |
| | Totals | 26 | 26 | 26 | 26 | 0.3% | 0.3% | 0.3% | 0.3% |
| 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

| Feature Class | Feature Type | Acres | | | | % of Reach Area | | | | Change Between Years (% of Agricultural Land) | | | |
|---------------|---------------|------------|--------------|--------------|--------------|-----------------|--------------|--------------|--------------|--|-------------|-------------|--------------|
| | | 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 | 232 | 229 | 0.0% | 0.0% | 4.1% | 4.3% | 0.0% | 4.1% | 0.2% | 4.3% |
| | Flood | 723 | 1,130 | 1,301 | 1,275 | 15.8% | 21.9% | 22.9% | 23.9% | 6.2% | 0.9% | 1.1% | 8.2% |
| | Totals | 723 | 1,130 | 1,533 | 1,505 | 15.8% | 21.9% | 26.9% | 28.2% | 6.2% | 5.0% | 1.3% | 12.5% |

Non-Irrigated

| | | | | | | | | | | | | |
|---------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| Multi-Use | 3,442 | 3,567 | 3,909 | 3,594 | 75.1% | 69.3% | 68.7% | 67.4% | -5.8% | -0.6% | -1.2% | -7.6% |
| Hay/Pasture | 421 | 452 | 250 | 231 | 9.2% | 8.8% | 4.4% | 4.3% | -0.4% | -4.4% | -0.1% | -4.8% |
| Totals | 3,863 | 4,018 | 4,158 | 3,825 | 84.2% | 78.1% | 73.1% | 71.8% | -6.2% | -5.0% | -1.3% | -12.5% |

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

| Statistic | Shrub (Acres) | | | Closed Timber (Acres) | | | Open Timber (Acres) | | |
|-----------|---------------|-------|-------|-----------------------|---------|---------|---------------------|-------|-------|
| | 1950 | 1976 | 2001 | 1950 | 1976 | 2001 | 1950 | 1976 | 2001 |
| Min | 0.8 | 0.3 | 0.1 | 0.3 | 1.3 | 1.6 | 0.0 | 7.0 | 5.6 |
| Max | 148.9 | 156.3 | 88.8 | 213.5 | 693.9 | 870.0 | 80.0 | 32.7 | 42.8 |
| Average | 27.8 | 13.6 | 16.9 | 48.9 | 59.9 | 53.4 | 20.8 | 17.3 | 24.7 |
| Sum | 1,251.2 | 680.8 | 796.1 | 1,760.9 | 1,797.3 | 2,083.2 | 228.3 | 138.1 | 172.7 |

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) 343.0

Channel to Riparian (acres) 748.9

Riparian Encroachment (acres) 405.9

Riparian Recruitment

| | | |
|--|--|--------------|
| Creation of riparian areas between 1950s and 2001. | 1950s Channel Mapped as 2011 Riparian (Ac) | 758.1 |
| | 1950s Floodplain Mapped as 2011 Channel (Ac) | 164.3 |
| | Total Recruitment (1950s to 2011)(Ac) | 922.3 |

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 | 21.6 | 136.8 | 120.4 | 0.0 | 278.7 |
| Acres/Valley Mile | 2.3 | 14.7 | 12.9 | 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 (YRDC) 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 | 11.90 | 0.22% | 5.79 | 0.02 | 5.83 | 2.33 |

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 developed by Montana Fish Wildlife and Parks to identify key habitat units for certain aquatic species.

Low Flow Fisheries Habitat Mapping

| Habitat | 2001 (Acres) | | |
|------------------------------|--------------|----------|---------------|
| | Bankfull | Low Flow | % of Low Flow |
| Scour Pool | 307.2 | 219.2 | 9.0% |
| Rip Rap Bottom | 115.7 | 62.0 | 2.6% |
| Bluff Pool | 188.0 | 134.9 | 5.6% |
| Secondary Channel | 103.1 | 73.2 | 3.0% |
| Secondary Channel (Seasonal) | 449.9 | 415.5 | 17.1% |
| Channel Crossover | 275.2 | 148.3 | 6.1% |
| Point Bar | | 248.7 | 10.3% |
| Side Bar | | 20.5 | 0.8% |
| Mid-channel Bar | | 21.3 | 0.9% |
| Island | 985.0 | 989.2 | 40.8% |
| Dry Channel | | 91.3 | 3.8% |

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

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.