

County	Yellowstone	Upstream River Mile	318
Classification	PCM: Partially confined meandering	Downstream River Mile	310.8
General Location	Waco	Length	7.20 mi (11.59 km)
General Comments	Encroached		

Narrative Summary

Reach B10 is located in lower Yellowstone County and contains the Captain Clark Fishing Access Site. The Reach is 7.2 miles long and is a Partially Confined Meandering reach type, (PCM), indicating the presence of a primary meandering channel thread with substantial valley wall influence on the river. The Captain Clark Fishing Access Site is located in the middle of the reach.

There are about 1,150 feet of rock riprap and 800 feet of flow deflectors in the reach, which collectively armor about 3 percent of the total bankline. About one half of the armor is protecting the active railroad, and the other half is protecting agricultural land. High resolution 2011 imagery shows the complete flanking of the mapped flow deflectors since 2001. The river has since eroded over 100 feet of bank behind the flanked barbs, eroding into a series of old corrals. The barbs are readily visible in the river.

One abandoned side channel that is about 3,300 feet long at RM 315R appears to be very old, however has several crossings that currently form plugs along its course. The channel is still within the 5-year floodplain, so the plugs have likely affected its function as a flood channel, and perhaps historically as a seasonal channel. This historic side channel is located landward (south) of the Fishing Access Site, which is on an old island. The lower end of this old channel supports a high density of Russian olive.

Reach B10 has lost almost 5.5 miles of side channel length since 1950. In the uppermost portion of the reach, the main river channel flipped from the south side of the corridor to the north sometime between 1976 and 2001, progressively abandoning a mile long channel and focusing the river into a single thread that flows along the north valley bluff line. This is where the flow deflectors described above have been flanked. This pattern has been common all through the reach; major secondary channels from the 1950s have been abandoned and the river has shifted to much more of a single thread meandering river. Some of the 1950's channels have potentially been blocked, and others appear to have been passively abandoned.

On the south side of the river at RM 312.5, the rail line currently isolates about 42 acres of historic 100-year floodplain. The river is currently against the rail line at this location, so that the separation between the river and the isolated remnant is only about 200 feet. This area is also adjacent to about 20 acres of mapped emergent wetland.

Overall, land uses in reach B10 are primarily agricultural, with about 860 acres of flood irrigated land mapped as of 2011. About one third of that irrigated acreage is within the CMZ. The railroad has encroached into 19 acres of the CMZ. In total, just under 7 percent of the CMZ has been restricted, and all of that restriction is due to bank armor protecting the rail line.

The modern 5-year floodplain contains about 72 acres of flood-irrigated ground. Reach B10 also supports almost 40 acres of mapped wetlands per valley mile, which is a relatively high density for the corridor.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The mean annual flood is estimated to have dropped from 30,200 cfs to 24,500 cfs, a drop of about 19 percent. The 2-year flood, which strongly influences overall channel form, has dropped by 11 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 3,070 cfs to 2,090 cfs with human development, a reduction of 32 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,846 cfs under unregulated conditions to 2,227 cfs under regulated conditions at the Billings gage, a reduction of 42 percent.

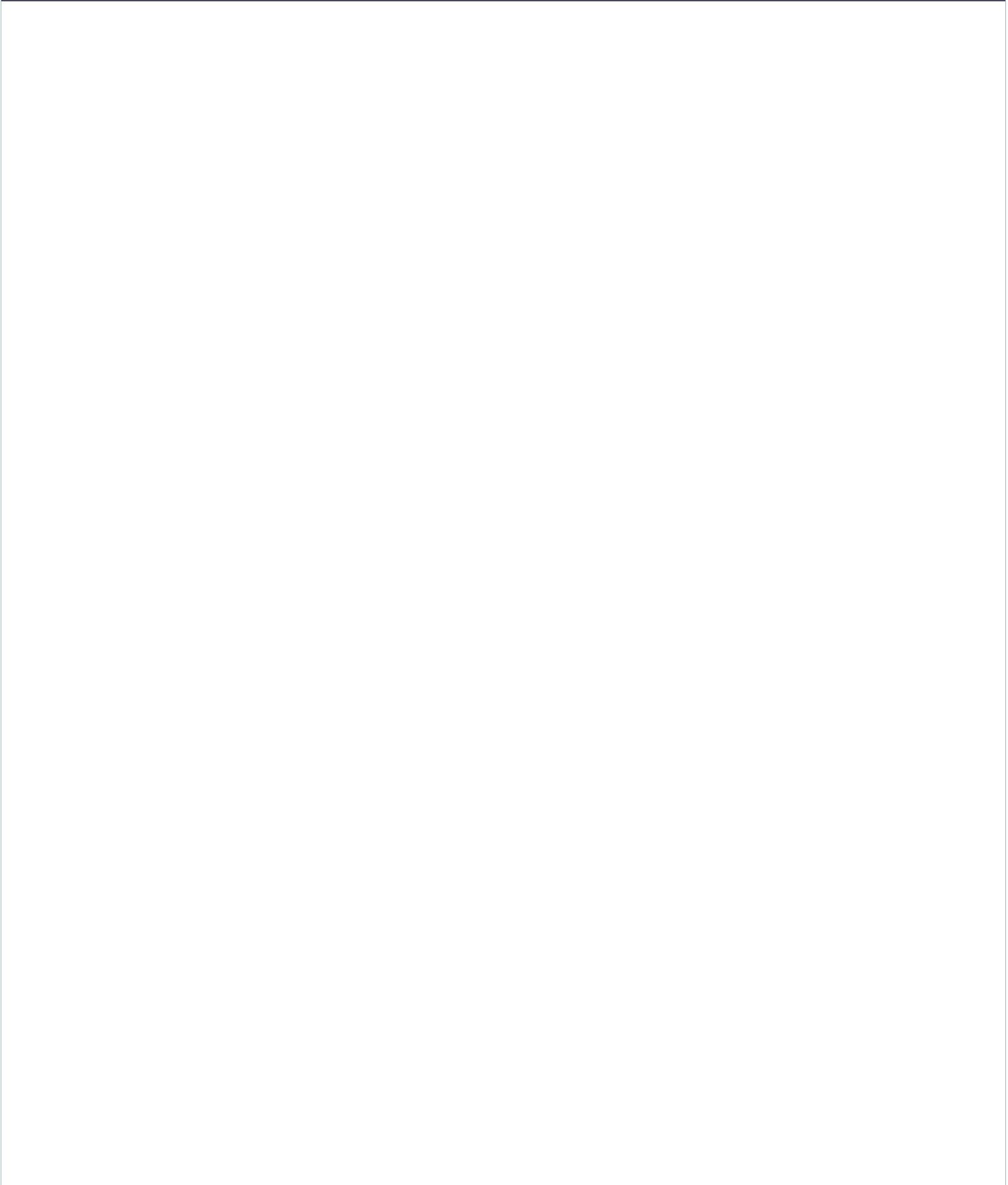
CEA-Related observations in Reach B10 include:

- Active and passive abandonment of over five miles of anabranching channel length since 1950
- Bank armor flanking associated with flow consolidation into single thread.

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach B10 include:

- Removal of flanked flow deflectors at RM 318
- Side channel reactivation throughout reach
- Floodplain reconnection at Rm 312.5R
- 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): Billings

Flood History

Year	Date	Flow on Date	Return Interval	Gage No	Downstream Gage	Upstream Gage
1943	Jun 21	61,200	10-25 yr		6309000	6214500
1996	Jun 12	61,900	10-25 yr		Miles City	Billings
1944	Jun 27	64,800	10-25 yr		1929-2015	1929-2015
1967	Jun 16	66,100	10-25 yr		Distance To (miles)	126.8
1975	Jul 7	67,600	10-25 yr			46.4
1974	Jun 19	69,500	25-50 yr			
2011	Jul 2	70,600	25-50 yr			
1918	Jun 15	78,100	50-100 yr			
1997	Jun 12	82,000	>100 yr			

Discharge

	1.01 Yr	2 Yr	5 Yr	10 Yr	50 Yr	100 Yr	500 Yr	7Q10 Summer	95% Sum. Duration
Unregulated	30,200	55,500	68,100	75,700	91,000	97,200	111,000	3,070	3,846
Regulated	24,500	49,400	62,400	70,400	86,900	93,600	108,800	2,090	2,227
% Change	-18.87%	-10.99%	-8.37%	-7.00%	-4.51%	-3.70%	-1.98%	-31.92%	-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	NARA	July 9-27, 1950	B/W		6214500	29500
1976	USCOE	29-Sep-76	B/W	1:24,000	6214500	5630
1995	USGS DOQQ	7/29/1996 - 8/26/96 - 8/19/96	B/W		6214500	10400
2001	NRCS	August 2-8, 2001	CIR	1:24,000	6214500	1700
2004	Merrick	14-May-04	Color	1:15,840	6214500	7010
2005	NAIP	07/14/2005	color	1-meter pixels	6214500	9730
2009	NAIP	6/29/2009	Color	1-meter pixels	6214500	26200
2011	USCOE	October 2012	color	1-ft pixel	6214500	3860
2011	NAIP	7/16/2011	Color	1-meter pixels	6214500	36000
2013	NAIP	06/16/2013	color	1-meter pixels	6214500	

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	1,153	1.5%	1,153	1.5%	0
	Flow Deflectors	194	0.3%	194	0.3%	0
	Between Flow Deflectors	613	0.8%	613	0.8%	0
	Feature Type Totals	1,960	2.6%	1,960	2.6%	0
Floodplain Control						
	Transportation Encroachment	6,439	8.5%	6,439	8.5%	0
	Feature Type Totals	6,439	8.5%	6,439	8.5%	0
	Reach Totals	8,399	11.0%	8,399	11.0%	0

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	0	0	895	0	0	0	0	0
Rock RipRap	0	0	0	0	0	656	0	0
Totals	0	0	895	0	0	656	0	0

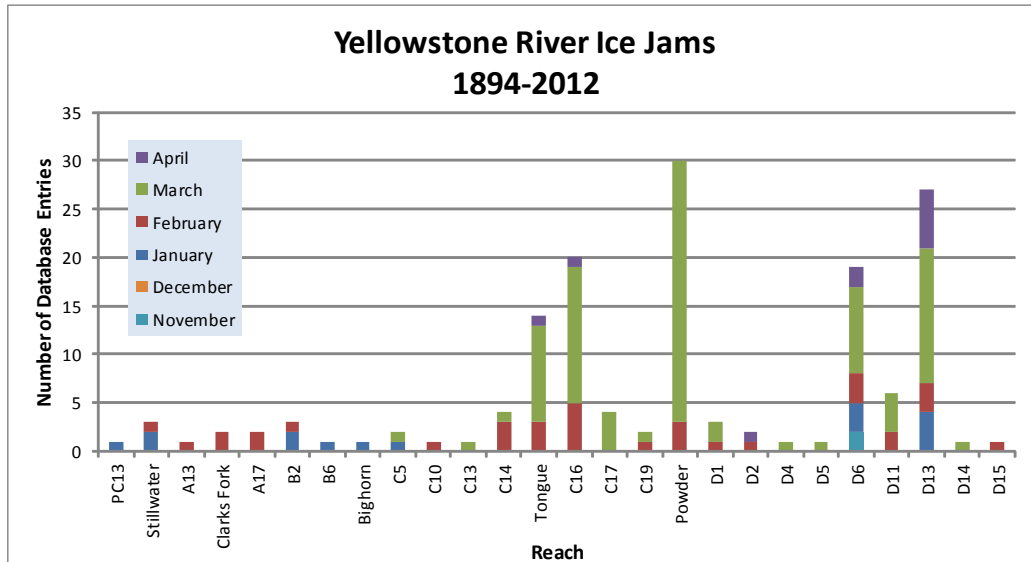
Bankline/Floodplain Inventory: Time Series

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

Feature Class	Feature Type	Sum of Feature Length (ft)					
		1950	1976	1995	2001	2004	2005
Stream Stabilization							
	Rock RipRap	1,048	1,956	2,172	2,172	2,172	2,172
	Flow Deflector	0	0	0	742	2,131	2,131
	Concrete RipRap	0	0	255	255	255	255
	Totals	1,048	1,956	2,427	3,169	4,558	4,558
Transportation Encroachment							
	Railroad	20,661	20,661	20,661	20,661	20,661	20,661
	Interstate	0	9,540	9,540	9,540	9,540	9,540
	County Road	19,403	19,403	19,403	19,403	19,403	19,403
	Totals	40,064	49,605	49,605	49,605	49,605	49,605

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	36,593	55,863	2.53	1950 to 1976:	-24.62%
1976	39,622	35,840	1.90	1976 to 1995:	12.29%
1995	37,698	42,926	2.14	1995 to 2001:	-19.85%
2001	38,094	27,208	1.71	1950 to 2001:	-32.15%
Change 1950 - 2001	1,501	-28,655	-0.81		

Length of Side Channels Blocked

Pre-1950s (ft)	3,344
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 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 (isolated 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	112	6.5%		
Abandoned Railroad	0	0.0%		
Transportation (Interstate and other roads)	0	0.0%		
Total Not Isolated (Ac)	1595		1648	
Total Floodplain Area (Ac)	1707		1850	
Total Isolated (Ac)	112	6.5%	202	18.7%

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:	72	0	0	72

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
668	1,336	2,332	164	7%	50	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	159	6.7%
RipRap/Flow Deflectors			
	Other Infrastructure	5	0.2%
	Totals	164	6.9%

Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ExUrban	Transportation
323.6	0.0	0.0	0.0	18.7

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	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	44	54	56	58	0.8%	1.0%	1.0%	1.1%
	Totals	44	54	56	58	0.8%	1.0%	1.0%	1.1%
Agricultural Land									
	Non-Irrigated	3,565	3,487	3,387	3,406	64.6%	63.2%	61.3%	61.7%
	Irrigated	637	749	909	858	11.5%	13.6%	16.5%	15.5%
	Totals	4,202	4,236	4,296	4,264	76.1%	76.7%	77.8%	77.2%
Channel									
	Channel	1,220	1,060	992	1,021	22.1%	19.2%	18.0%	18.5%
	Totals	1,220	1,060	992	1,021	22.1%	19.2%	18.0%	18.5%
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	2	8	8	0.0%	0.0%	0.1%	0.1%
	Totals	0	2	8	8	0.0%	0.0%	0.1%	0.1%
Transportation									
	Public Road	18	41	41	41	0.3%	0.7%	0.7%	0.7%
	Interstate	0	93	93	93	0.0%	1.7%	1.7%	1.7%
	Railroad	36	36	36	36	0.7%	0.7%	0.7%	0.7%
	Totals	55	170	170	170	1.0%	3.1%	3.1%	3.1%
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	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Flood	637	749	909	858	15.2%	17.7%	21.2%	20.1%	2.5%	3.5%	-1.0%	5.0%
	Totals	637	749	909	858	15.2%	17.7%	21.2%	20.1%	2.5%	3.5%	-1.0%	5.0%

Non-Irrigated

Multi-Use	3,089	2,948	3,006	2,985	73.5%	69.6%	70.0%	70.0%	-3.9%	0.4%	0.0%	-3.5%
Hay/Pasture	476	539	381	421	11.3%	12.7%	8.9%	9.9%	1.4%	-3.9%	1.0%	-1.5%
Totals	3,565	3,487	3,387	3,406	84.8%	82.3%	78.8%	79.9%	-2.5%	-3.5%	1.0%	-5.0%

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	0.0	0.2	0.4	0.0	1.4	1.8	0.8	1.6	5.3
Max	54.3	35.8	115.1	64.0	30.8	75.1	138.5	76.0	45.7
Average	8.1	7.8	19.2	15.8	12.8	27.3	16.2	19.0	17.5
Sum	276.3	321.3	422.2	427.9	166.8	327.2	226.1	304.3	157.7

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) 230.5

Channel to Riparian (acres) 237.2

Riparian Encroachment (acres) 6.7

Riparian Recruitment

Creation of riparian areas between 1950s and 2001.	1950s Channel Mapped as 2011 Riparian (Ac)	244.2
	1950s Floodplain Mapped as 2011 Channel (Ac)	170.4
	Total Recruitment (1950s to 2011)(Ac)	414.5

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	19.7	113.2	106.4	0.0	239.3
Acres/Valley Mile	3.3	18.9	17.8	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	38.82	1.47%	5.14	0.78	10.00	3.84

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	125.7	63.8	6.4%
Rip Rap Bottom	50.1	24.1	2.4%
Bluff Pool	329.4	145.6	14.7%
Secondary Channel (Seasonal)	163.8	145.2	14.6%
Channel Crossover	100.5	79.4	8.0%
Point Bar		54.4	5.5%
Side Bar		41.1	4.1%
Mid-channel Bar		62.7	6.3%
Island	222.3	222.3	22.4%
Dry Channel		153.0	15.4%

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 type="checkbox"/> Killdeer	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Song Sparrow
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> American Crow	<input type="checkbox"/> <input checked="" type="checkbox"/> Clay-collared Sparrow	<input type="checkbox"/> <input type="checkbox"/> Lark Bunting	<input 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 type="checkbox"/> <input checked="" type="checkbox"/> Lark Sparrow	<input type="checkbox"/> <input checked="" type="checkbox"/> Spotted Towhee
<input type="checkbox"/> <input type="checkbox"/> American Kestrel	<input type="checkbox"/> <input checked="" type="checkbox"/> Common Grackle	<input type="checkbox"/> <input checked="" type="checkbox"/> Lazuli Bunting	<input type="checkbox"/> <input type="checkbox"/> Sharp-shinned Hawk
<input type="checkbox"/> <input checked="" type="checkbox"/> American Redstart	<input type="checkbox"/> <input type="checkbox"/> Common Merganser	<input type="checkbox"/> <input checked="" type="checkbox"/> Least Flycatcher	<input type="checkbox"/> <input checked="" type="checkbox"/> Swainson's Thrush
<input type="checkbox"/> <input checked="" type="checkbox"/> Bald Eagle	<input type="checkbox"/> <input type="checkbox"/> Common Nighthawk	<input type="checkbox"/> <input checked="" type="checkbox"/> Mallard	<input type="checkbox"/> <input type="checkbox"/> Sandhill Crane
<input type="checkbox"/> <input type="checkbox"/> Baltimore Oriole	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Common Raven	<input type="checkbox"/> <input type="checkbox"/> Mountain Bluebird	<input type="checkbox"/> <input checked="" type="checkbox"/> Tree Swallow
<input type="checkbox"/> <input checked="" type="checkbox"/> Barn Swallow	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Common Yellowthroat	<input 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 type="checkbox"/> <input type="checkbox"/> Cooper's Hawk	<input 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 type="checkbox"/> <input checked="" type="checkbox"/> Dickcissel	<input type="checkbox"/> <input type="checkbox"/> Orchard Oriole	<input type="checkbox"/> <input checked="" type="checkbox"/> Vesper Sparrow
<input type="checkbox"/> <input checked="" type="checkbox"/> Black-billed Magpie	<input type="checkbox"/> <input checked="" type="checkbox"/> Downy Woodpecker	<input type="checkbox"/> <input checked="" type="checkbox"/> Osprey	<input type="checkbox"/> <input checked="" type="checkbox"/> Violet-green Swallow
<input type="checkbox"/> <input checked="" type="checkbox"/> Black-capped Chickadee	<input type="checkbox"/> <input type="checkbox"/> Eastern Bluebird	<input type="checkbox"/> <input checked="" type="checkbox"/> Ovenbird	<input type="checkbox"/> <input checked="" type="checkbox"/> Warbling Vireo
<input type="checkbox"/> <input checked="" type="checkbox"/> Black-and-white Warbler	<input type="checkbox"/> <input checked="" type="checkbox"/> Eastern Kingbird	<input type="checkbox"/> <input checked="" type="checkbox"/> Plumbeous Vireo	<input type="checkbox"/> <input checked="" type="checkbox"/> Western Kingbird
<input type="checkbox"/> <input checked="" type="checkbox"/> Black-headed Grosbeak	<input type="checkbox"/> <input type="checkbox"/> Eurasian Collared-dove	<input type="checkbox"/> <input checked="" type="checkbox"/> Red-headed Woodpecker	<input type="checkbox"/> <input checked="" type="checkbox"/> Western Meadowlark
<input 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 type="checkbox"/> <input checked="" type="checkbox"/> Western Wood-pewee
<input type="checkbox"/> <input type="checkbox"/> Bobolink	<input type="checkbox"/> <input checked="" type="checkbox"/> Field Sparrow	<input type="checkbox"/> <input type="checkbox"/> Red Crossbill	<input type="checkbox"/> <input checked="" type="checkbox"/> White-breasted Nuthatch
<input type="checkbox"/> <input checked="" type="checkbox"/> Brewer's Blackbird	<input type="checkbox"/> <input type="checkbox"/> Franklin's Gull	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Ring-necked Pheasant	<input type="checkbox"/> <input checked="" type="checkbox"/> White-throated Swift
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Brown-headed Cowbird	<input type="checkbox"/> <input type="checkbox"/> Grasshopper Sparrow	<input type="checkbox"/> <input checked="" type="checkbox"/> Red-tailed hawk	<input type="checkbox"/> <input type="checkbox"/> Wild Turkey
<input type="checkbox"/> <input type="checkbox"/> Brown Creeper	<input 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 type="checkbox"/> <input checked="" type="checkbox"/> Brown Thrasher	<input type="checkbox"/> <input type="checkbox"/> Great Blue Heron	<input type="checkbox"/> <input checked="" type="checkbox"/> Red-winged Blackbird	<input type="checkbox"/> <input type="checkbox"/> Yellow-bellied Sapsucker
<input type="checkbox"/> <input checked="" type="checkbox"/> Bullock's Oriole	<input type="checkbox"/> <input type="checkbox"/> Great Horned Owl	<input type="checkbox"/> <input checked="" type="checkbox"/> Red-eyed Vireo	<input type="checkbox"/> <input type="checkbox"/> Yellow-billed Cuckoo
<input type="checkbox"/> <input checked="" type="checkbox"/> Canada Goose	<input type="checkbox"/> <input checked="" type="checkbox"/> Hairy Woodpecker	<input type="checkbox"/> <input 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 checked="" 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 B

The study segment Big Horn to Laurel includes data from the people of one large county, Yellowstone County. Three themes dominate conversations with the four interest groups. One theme focuses on the evolving communities of Yellowstone County, most of which are influenced by the economic success and sheer growth of Billings. The second theme focuses on the evolving relationships that the people have with the river. While traditional agricultural activities continue in the county, many people discuss notions related to urban and residential experiences and how the river becomes an asset that improves one's quality of life as an urban dweller. The third theme involves a complex tangle of pressures and demands that require managerial strategies capable of dealing with a future that has arrived.