County	Rosebud	**Upstream River Mile**	208.1
Classification	PCM/I: Partially confined meandering/islands	**Downstream River Mile**	195.9
General Location	Sheffield	**Length**	12.20 mi (19.63 km)
General Comments	Series of meander bends		

Narrative Summary

Reach C14 is 12.2 miles long and is located near Sheffield, which is about 15 miles upstream of Miles City. The reach straddles the Rosebud/Custer County Line. The reach is characterized by a dominant main thread that shows a distinct meandering pattern, with several islands persisting where meander bends have historically cut off. The river intermittently flows along the south valley wall. As a result it is classified as Partially Confined Meandering with Islands (PCM/I). In this section of river the valley bottom is consistently about 1.8 miles wide, and bound by Tertiary-age Fort Union Formation. The active meanderbelt of the Yellowstone River is about 3,000 feet wide.

The large meander features in Reach C14 have experienced significant migration since 1950 and also in recent years; one site at RM 204.5 migrated 977 feet southward between 1950 and 2001, and then over the next ten years continued to migrate another 400 feet so that it is now at the toe of the active rail line. At RM 200.5, the river has migrated 700 feet northward since 2001; eroding out irrigated lands and threatening structures.

As of 2011 there were about four miles of armor protecting 17 percent of the total bankline in Reach C14, including 15,087 feet of rock riprap and 6,300 feet of flow deflectors. Most of the rock riprap is protecting the rail line as it flows along the south bluff of Fort Union Formation, whereas flow deflectors are more commonly used to protect agricultural land. Between 2001 and 2011, about 3,000 feet of flow deflectors were evidently destroyed. Barbs can be seen in the river at RM 205.3R; the bank behind has since been partially armored with rock riprap. Another barb was flanked at RM 204.7L, and the river has migrated over 200 feet behind that structure towards the rail line. Another series of barbs were flanked at RM 203.6L and have since been replaced by rock riprap. Those flanked rock structures are visible on the 2011 air photos almost 200 feet out into the channel. At RM 200.8L, new riprap was built after older armor scoured out in 2011, which was followed by hundreds of feet of northward bank migration during the 2011 flood. Some of the new riprap appears to be trenched behind the bank. About 1,300 feet of rock riprap mapped in 2001 on the left bank at RM 196.9 has been flanked, and is now up to 70 feet out in the river.

Prior to 1950, about 3 miles of side channels were blocked in Reach C14. Chute channels formed through meander tabs have been blocked by small dikes such as at RM 198. Several historic anabranching channels appear to have been blocked prior to 1950 such as at RM 207.8. These areas provide excellent restoration/mitigation opportunities for side channel re-activation.

Similar to other reaches downstream of the Bighorn River confluence, the river channel has become smaller in Reach C14 since 1950. In 1950, the bankfull footprint was about 38 acres larger than it was in 2001, and riparian mapping shows about 208 acres of riparian encroachment into old channel areas. Floodplain turnover rates are also slightly lower; from 1950-1975 the average annual rate of floodplain turnover was 15.6 acres per year, and since 1975 it has been 12.5 acres per year.

Over two thousand acres of the 100-year floodplain has become isolated from the river due to flow alterations, agricultural development, and the abandoned railroad grade. In total, 40 percent of the entire historic 100-year floodplain has become isolated. Most of the isolation is associated with agricultural land development (29 percent of the historic floodplain), with another 10 percent of the isolation due to the abandoned rail grade. Isolation of the 5-year floodplain has been even more substantial; 2,321 acres or 59 percent of the 5-year floodplain has become isolated at that frequency event. Much of this isolated 5-year floodplain is on flood irrigated fields north of the river.

Bank armor on the north side of the river commonly narrows the natural meanderbelt of the river, which has resulted in large extents of the CMZ being restricted to migration. About 740 acres which represents 16 percent of the total CMZ has become restricted by physical features.

Four ice jams have been reported in the reach, including February of 1996, 1997, and 1998, and March of 2003. All of the ice jams in the 1990s were associated with lowland flooding.

One dump site was mapped on the left bank at RM 196.3.

Reach C14 has seen extensive riparian clearing since 1950s. Typically, riparian clearing for agriculture occurred prior to 1950 along the Yellowstone River. In this reach, however, 760 acres of riparian area were cleared since 1950, which represents 30 percent of the total 1950s riparian corridor. In several cases, this includes riparian clearing on large meander tabs. With this clearing, the reach has seen a substantial loss of forest area considered at low risk of cowbird parasitism. In 1950, the reach had 91.8 acres of such forest per valley mile and by 2001 that forest extent had dropped to 51.4 acres per valley mile.

Reach C14 has fairly extensive mapped wetland area; there are over 45 acres of mapped wetlands per valley mile, most of which is emergent marsh and wet meadow. A total of 22 acres of Russian olive were mapped in the reach, which reflects an abrupt reduction in Russian olive extent relative to upstream, where Reaches C10 through C13 have on the order of 200 acres of RO over similar valley distances.

Reach C14 was sampled as part of the fisheries study. A total of 36 species were sampled in the reach, including Sauger which has been identified as Species of Concern by the Montana Natural Heritage Program.

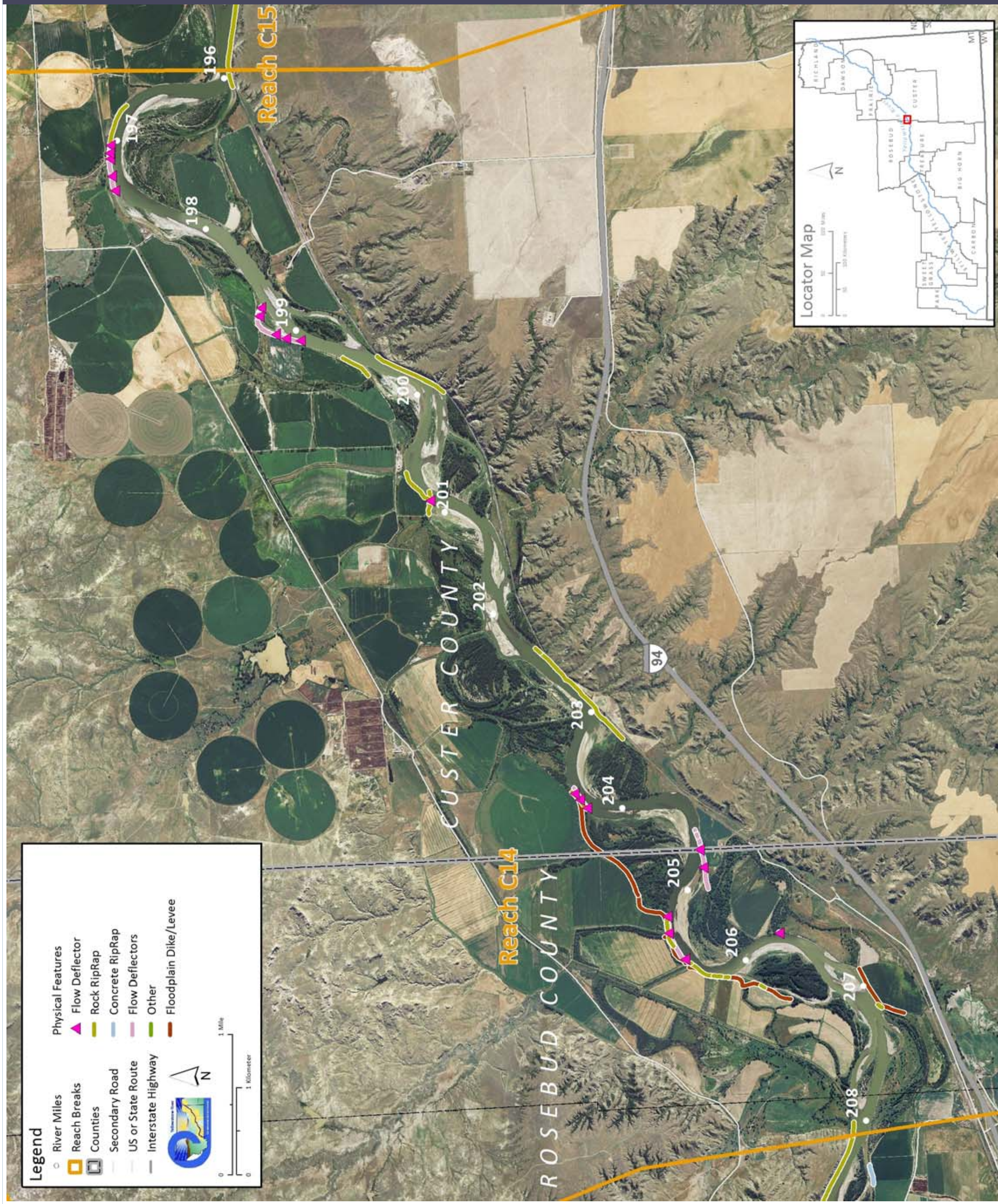
A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 18 percent and the 2-year flood, which strongly influences overall channel form, has dropped by 24 percent. Low flows have also been impacted; 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 3,070 cfs with human development, a reduction of 37 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,330 cfs under unregulated conditions to 3,390 cfs under regulated conditions, a reduction of 47 percent.

Fall and winter base flows have increased in Reach C14 by about 60 percent.

CEA-Related observations in Reach C14 include:
•Passive side channel abandonment due to flow alterations
•Flanking of barb structures on migrating meander bends
•Extensive floodplain isolation by agricultural dikes and abandoned railroad grade
•Pre-1950s blocking of side channels by agricultural dikes
•Armoring of bluff pool habitat against active railroad
•Floodplain isolation by the abandoned Milwaukee rail line on the north bank
•Post-1950s riparian clearing for irrigation development

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach C14 include:
•Removal of flanked barb at RM 205.3
•Side channel reactivation at RM 208L
•CMZ Management due to extent of CMZ restriction (11 percent)
•Dump removal on left bank at RM 196.3L
•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)	11.9	156.3

Discharge

	1.01 Yr	2 Yr	5 Yr	10 Yr	50 Yr	100 Yr	500 Yr	7Q10 Summer	95% Sum. Duration
Unregulated		61,900	77,800	88,100	110,000	120,000	142,000	4,850	6,330
Regulated		47,300	61,700	70,900	90,500	98,600	118,000	3,070	3,390
% Change		-23.59%	-20.69%	-19.52%	-17.73%	-17.83%	-16.90%	-36.70%	-46.45%

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	60,600	22,700	6,090
	Regulated	46,900	13,700	4,430
	% Change	**-23%**	**-40%**	**-27%**
Summer	Unregulated	42,800	13,500	6,330
	Regulated	32,500	8,330	3,390
	% Change	**-24%**	**-38%**	**-46%**
Fall	Unregulated	9,140	5,550	2,300
	Regulated	10,500	6,890	3,640
	% Change	**15%**	**24%**	**58%**
Winter	Unregulated	11,700	4,950	2,020
	Regulated	12,300	6,030	3,260
	% Change	**5%**	**22%**	**61%**
Annual	Unregulated	45,500	7,940	2,790
	Regulated	34,100	7,390	3,630
	% Change	**-25%**	**-7%**	**30%**

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	7/7/96 - 8/7/96	B/W		6295000	39800
2001	NRCS	August 2-8, 2001	CIR	1:24,000	6295000	3500
2005	NAIP	07/08/2005	color	1-meter pixels	6309000	18800
2007	Woolpert	10/15/2007 - 11/2/0007	Color			
2009	NAIP	7/17/2009	Color	1-meter pixels	6309000	23300
2009	NAIP	7/15/2009	Color	1-meter pixels	6309000	26400
2011	USCOE	October 2012	color	1-ft pixel	6309000	8100
2011	NAIP	7/16/2011	Color	1-meter pixels	6309000	57900
2011	NAIP	7/15/2011	Color	1-meter pixels	6309000	58000
2013	NAIP	07/21/2013	color	1-meter pixels	6309000	
2013	NAIP	07/20/2013	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						
	Rock RipRap	13,314	10.4%	15,087	11.7%	1,773
	Flow Deflectors	1,821	1.4%	1,638	1.3%	-184
	Between Flow Deflectors	7,431	5.8%	4,657	3.6%	-2,774
	Feature Type Totals	**22,567**	**17.6%**	**21,382**	**16.6%**	**-1,185**
Floodplain Control						
	Transportation Encroachment	4,433	3.5%	4,433	3.5%	0
	Floodplain Dike/Levee	14,808	11.5%	14,882	11.6%	73
	Feature Type Totals	**19,241**	**15.0%**	**19,315**	**15.0%**	**73**
	Reach Totals	**41,808**	**32.5%**	**40,697**	**31.7%**	**-1,111**

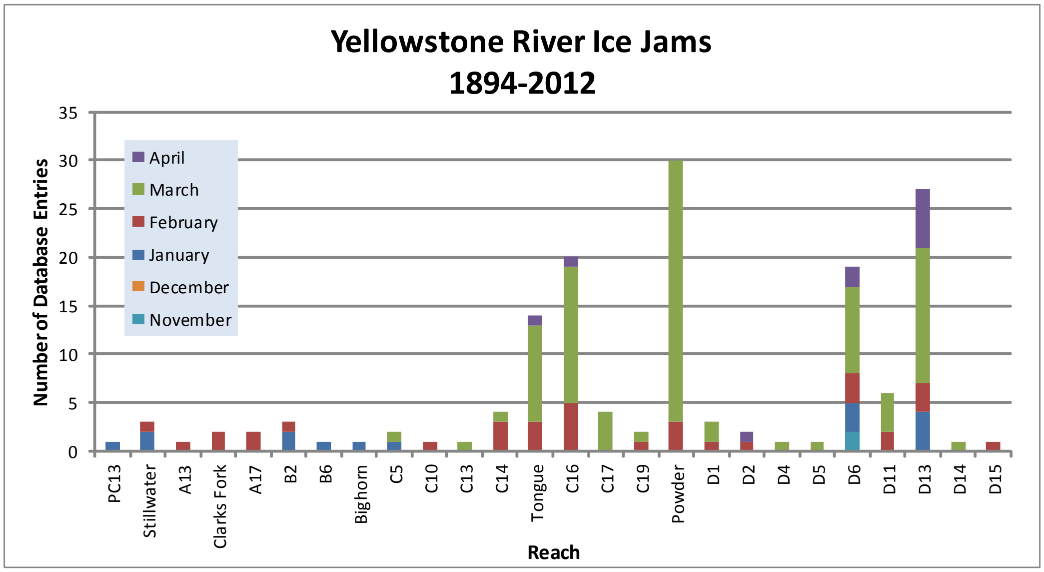
Intent of Bank Protection: 2001

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	4,257	2,286	0	0	0	1,761	0	0
Rock RipRap	4,562	0	0	0	0	11,110	0	0
Totals	**8,820**	**2,286**	**0**	**0**	**0**	**12,871**	**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.



Jam Date	Jam Type	River Mile	Damages
2/7/1996	Break-up	208	Flooding
2/20/1997	Freeze-up	208	Lowland flooding
2/3/1998	Break-up	208	Lowland flooding
3/15/2003	Break-up		?

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
1950	66,789	44,239	1.66
1976	61,868	58,008	1.94
1995	64,341	51,220	1.80
2001	64,232	24,859	1.39
Change 1950 - 2001	**-2,557**	**-19,380**	**-0.28**

	% Change in Braiding
1950 to 1976:	16.56%
1976 to 1995:	-7.30%
1995 to 2001:	-22.77%
1950 to 2001:	-16.56%

Length of Side Channels Blocked

Pre-1950s (ft)	14,986
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.)	27	0.5%		
Agriculture (generally relates to field boundaries)	0	0.0%		
Agriculture (isloated by canal or large ditch)	0	0.0%		
Levee/Riprap (protecting agricultural lands)	1474	29.0%		
Levee/Riprap (protecting urban, industrial, etc.)	0	0.0%		
Railroad	52	1.0%		
Abandoned Railroad	495	9.7%		
Transportation (Interstate and other roads)	0	0.0%		
Total Not Isolated (Ac)	3039		2922	
Total Floodplain Area (Ac)	5088		5243	
Total Isolated (Ac)	**2049**	**40.3%**	**2321**	**59.1%**

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

	Flood	Sprinkler	Pivot	Total
Irrigated Acres within the 5 Year Flooplain:	269	0	0	**269**

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
575	1,150	4,432	737	17%	306	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	63	1.3%
RipRap/Flow Deflectors			
	Irrigated	250	5.3%
RipRap			
	Railroad	41	0.9%
	Non-Irrigated	45	1.0%
Flow Deflectors			
	Other Infrastructure	17	0.4%
	Non-Irrigated	77	1.6%
Dike/Levee			
	Irrigated	247	5.2%
	Totals	**739**	**15.6%**

Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ ExUrban	Trans- portation
1015.0	0.0	112.6	3.9	23.9

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	77	141	109	106	0.7%	1.3%	1.0%	0.9%
	Totals	**77**	**141**	**109**	**106**	**0.7%**	**1.3%**	**1.0%**	**0.9%**
Agricultural Land									
	Non-Irrigated	6,908	5,532	5,146	4,958	61.7%	49.4%	45.9%	44.3%
	Irrigated	2,517	3,507	3,982	4,058	22.5%	31.3%	35.5%	36.2%
	Totals	**9,425**	**9,040**	**9,128**	**9,017**	**84.1%**	**80.7%**	**81.5%**	**80.5%**
Channel									
	Channel	1,569	1,806	1,786	1,901	14.0%	16.1%	15.9%	17.0%
	Totals	**1,569**	**1,806**	**1,786**	**1,901**	**14.0%**	**16.1%**	**15.9%**	**17.0%**
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	0	6	6	0.0%	0.0%	0.1%	0.1%
	Totals	**0**	**0**	**6**	**6**	**0.0%**	**0.0%**	**0.1%**	**0.1%**
Transportation									
	Public Road	35	47	47	47	0.3%	0.4%	0.4%	0.4%
	Interstate	0	66	66	66	0.0%	0.6%	0.6%	0.6%
	Railroad	95	101	58	58	0.9%	0.9%	0.5%	0.5%
	Totals	**131**	**214**	**171**	**171**	**1.2%**	**1.9%**	**1.5%**	**1.5%**
Urban									
	Urban Other	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Residential	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Undeveloped	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Industrial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Totals	**0**	**0**	**0**	**0**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Land Use Timeline - Tiers 3 and 4

		Acres				% of Reach Area				Change Between Years (% of Agricultural Land)			
Feature Class	Feature Type	1950	1976	2001	2011	1950	1976	2001	2011	'50-76	'76-01	'01-11	'50-11
Irrigated													
	Sprinkler	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pivot	0	154	345	660	0.0%	1.7%	3.8%	7.3%	1.7%	2.1%	3.5%	7.3%
	Flood	2,517	3,353	3,637	3,398	26.7%	37.1%	39.8%	37.7%	10.4%	2.7%	-2.2%	11.0%
	Totals	**2,517**	**3,507**	**3,982**	**4,058**	**26.7%**	**38.8%**	**43.6%**	**45.0%**	**12.1%**	**4.8%**	**1.4%**	**18.3%**

Non-Irrigated												
Multi-Use	6,439	5,123	4,666	4,531	68.3%	56.7%	51.1%	50.2%	-11.7%	-5.6%	-0.9%	-18.1%
Hay/Pasture	469	410	481	428	5.0%	4.5%	5.3%	4.7%	-0.4%	0.7%	-0.5%	-0.2%
Totals	**6,908**	**5,532**	**5,146**	**4,958**	**73.3%**	**61.2%**	**56.4%**	**55.0%**	**-12.1%**	**-4.8%**	**-1.4%**	**-18.3%**

RIPARIAN

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

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

Riparian Mapping

	Shrub (Acres)			Closed Timber (Acres)			Open Timber (Acres)		
Statistic	**1950**	**1976**	**2001**	**1950**	**1976**	**2001**	**1950**	**1976**	**2001**
Min	0.5	0.5	1.6	0.3	1.1	1.9	2.5	2.8	5.3
Max	87.1	38.7	28.2	471.6	149.2	189.5	82.1	98.0	63.9
Average	17.9	7.4	9.5	58.3	34.3	37.1	29.0	24.0	22.7
Sum	554.6	376.6	218.7	1,632.8	1,133.0	1,112.4	464.0	359.6	317.1

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)	412.8
Channel to Riparian (acres)	620.5
Riparian Encroachment (acres)	**207.7**

Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

1950s Channel Mapped as 2011 Riparian (Ac)	642.4
1950s Floodplain Mapped as 2011 Channel (Ac)	130.2
Total Recruitment (1950s to 2011)(Ac)	**772.5**

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	48.6	292.7	121.6	0.0	**462.9**
Acres/Valley Mile	5.0	30.0	12.5	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	21.65	0.24%	0.57	0.94	3.05	0.36

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

Low Flow Fisheries Habitat Mapping

2001 (Acres)

Habitat	Bankfull	Low Flow	% of Low Flow
Scour Pool	281.9	215.6	12.1%
Rip Rap Bottom	278.9	168.1	9.4%
Rip Rap Margin	83.7	60.1	3.4%
Secondary Channel	67.4	95.2	5.3%
Secondary Channel (Seasonal)	182.6	143.0	8.0%
Channel Crossover	384.3	216.9	12.1%
Point Bar		146.2	8.2%
Side Bar		68.1	3.8%
Mid-channel Bar		75.6	4.2%
Island	507.2	507.2	28.4%
Dry Channel		90.0	5.0%

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.