County	Richland	**Upstream River Mile**	36.3
Classification	PCM/I: Partly confined meandering/islands	**Downstream River Mile**	27.8
General Location	To Sidney	**Length**	8.50 mi (13.68 km)
General Comments			

Narrative Summary

Reach D13 is located just upstream of Sidney. It is 8.5 miles long, and is a PCM/I reach type, indicating a primary meandering channel thread with distinct islands largely formed by historic bendway cutoffs. The reach has multiple pipeline crossings, and the Highway 23 Bridge and approach have confined the river and isolated floodplain area. Floodplain development for irrigated agricultural is extensive, and in many cases irrigated fields intersect the channel bank. These locations are commonly armored, and low field dikes affect floodplain access.

In 2011 there was almost 16,000 feet of bank armor in the reach, protecting 16 percent of the total bank line. That includes 2,440 feet of car bodies. The car body revetments are all located off of the main channel at RM 32.2L. About ½ mile of rock riprap was constructed between 2001 and 2011.

Although no side channels have been intentionally blocked in the reach, there has still been a net loss of almost two miles of side channel since 1950, reflecting passive abandonment of side channels with flow alterations.

There are three mapped pipeline crossings in the reach, two at the Sidney Bridge and another about a mile upstream. The two on the bridge are apparently installed on the bridge structure itself. The one upstream at RM 32.1 is described as an LPG pipeline installed in 1997; however no more information was available.

Reach D13 has had 28 reported ice jam events since 1917. Especially severe damages were reported in the ice jam of March 25, 1943.

Human development has resulted in isolation of 18 percent of the historic 100-year floodplain and 26 percent of the 5-year floodplain. This isolation includes the effects of transportation infrastructure embankments (mainly Highway 23), low agricultural dikes on the edges of irrigated fields, and reduced flood magnitudes. There has been fairly extensive land use encroachment into the Channel Migration Zone: as of 2011 there were 250 acres of pivot irrigation and 137 acres of urban/exurban land uses within the CMZ, making these areas especially prone to the threat of river erosion. One drill pad was mapped within 1,500 feet of the river at RM 32. There is also a large animal handling facility that drains to an irrigation return flow point at RM 29.

Reach D13 shows, like most other reaches below the Bighorn River, a shrinking channel with reduced rates of erosion and floodplain turnover. The bankfull channel area in the reach dropped by 220 acres since 1950, and there was a similar amount of mapped riparian encroachment into old channel areas. Floodplain turnover rates have dropped from 14.3 acres per year from 1950-1976 to 6.1 acres per year from 1976-2001. There has also been a net loss of 45 acres of open bar area as the channel has become smaller and more forested. On the floodplain, riparian acreage has decreased; about 424 acres or 27 percent of the total riparian area was cleared for irrigation since 1950.

Like numerous reaches below the Bighorn River confluence, Reach D13 exhibits a shift from a largely braided pattern in 1950 to an anabranching pattern today. The pattern shift reflects the fact that side channels that used to flow around open bars (braided) now flow around wooded islands (anabranching). This shift appears largely due to riparian encroachment onto sand bars since 1950. This encroachment reflects the flow alterations identified in the reach, and may also be due to the altered sediment regime imposed by upstream influences including Yellowtail Dam. Changes in sediment loading have not been quantified in the CEA.

There are 45 acres of Russian olive mapped in the reach.

Reach D13 was sampled as part of the fisheries study. A total of 38 fish species were sampled in the reach, including six Species of Concern: the Blue Sucker, Pallid Sturgeon, Sauger, Shortnose Gar, Sicklefin Chub, and Sturgeon Chub.

Reach D13 was also sampled as part of the avian study. A total of 39 bird species were identified in the reach. The Red-headed Woodpecker was found, which is a Species of Concern (SOC). In contrast to most other reaches, Reach D12 has seen a reduction in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 27.6 acres per valley mile of such forest, and that number decreased to 18.1 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 134,000 cfs, which 6 percent lower than it was pre-development (143,000 cfs). 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 4,190 cfs to 2,000 cfs with human development, a reduction of 52 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,340 cfs under unregulated conditions to 2,550 cfs under regulated conditions, a reduction of 60 percent.

Seasonal low flows have increased by 82 percent in the fall and 63 percent in the winter. Both fall and winter base flows are currently about 3,500 cfs.

CEA-Related observations in Reach D13 include:
•Conversion of river pattern from braided to anabranching due to riparian encroachment onto sand bars since 1950.
•Passive side channel abandonment due to hydrologic alterations and potentially downcutting due to CMZ confinement.
•100-year floodplain isolation due to low agricultural field dikes.
•100-year floodplain isolation due to transportation infrastructure.
•Channel Migration Zone (CMZ) restrictions that significantly confine the river corridor, potentially causing downcutting. This may be an important Increase in area at low risk of cowbird parasitism with riparian encroachment

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D13 include:
•Nutrient Management at Animal Handling Facility at RM 29L
•Pipeline Crossing PRACTICE RM 32.1
•Old car body removal RM 32.2L
•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

	Downstream Gage	Upstream Gage
Gage No		6329500
Location	#Error	Sidney
Period of Record	#Error	1911-2015
Distance To (miles)	#Error	-5.5

Flood History

Year	Date	Flow on Date	Return Interval
1978	May 23	111,000	10-25 yr
1912	Mar 29	114,000	10-25 yr
1944	Jun 21	120,000	10-25 yr
2011	May 24	124,000	10-25 yr
1918	Jun 20	126,000	25-50 yr
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		69,900	90,500	104,000	132,000	143,000	170,000	4,190	6,340
Regulated		54,300	75,100	89,100	120,000	134,000	166,000	2,000	2,550
% Change		-22.32%	-17.02%	-14.33%	-9.09%	-6.29%	-2.35%	-52.27%	-59.78%

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	24,600	7,250
	Regulated	52,000	14,300	5,220
	% Change	**-23%**	**-42%**	**-28%**
Summer	Unregulated	47,800	14,600	6,340
	Regulated	35,300	8,230	2,550
	% Change	**-26%**	**-44%**	**-60%**
Fall	Unregulated	9,950	5,800	1,920
	Regulated	11,300	7,300	3,490
	% Change	**14%**	**26%**	**82%**
Winter	Unregulated	16,500	5,640	2,150
	Regulated	17,000	6,810	3,510
	% Change	**3%**	**21%**	**63%**
Annual	Unregulated	49,700	8,810	2,830
	Regulated	36,900	7,990	3,440
	% Change	**-26%**	**-9%**	**22%**

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	7/28/95 - 8/3/97	B/W		6329500	23000
2001	NRCS	August 2-8, 2001	CIR	1:24,000	6329500	4000
2005	NAIP	07/14/2005	color	1-meter pixels	6329500	15900
2007	Woolpert	10/15/2007 - 11/2/0007	Color		6329500	
2009	NAIP	7/11/2009	Color	1-meter pixels	6329500	32600
2011	USCOE	October 2012	color	1-ft pixel	6329500	9030
2011	NAIP	7/15/2011	Color	1-meter pixels	6329500	57900
2013	NAIP	07/19/2013	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 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						
	Tire Revetment	520	0.6%	0	0.0%	-520
	Rock RipRap	3,976	4.4%	6,387	7.1%	2,410
	Flow Deflectors	962	1.1%	944	1.0%	-18
	Concrete RipRap	3,329	3.7%	3,329	3.7%	0
	Car Bodies	2,437	2.7%	2,437	2.7%	0
	Between Flow Deflectors	3,074	3.4%	3,235	3.6%	161
	Feature Type Totals	**14,298**	**15.8%**	**16,332**	**18.1%**	**2,033**
	Reach Totals	**14,298**	**15.8%**	**16,332**	**18.1%**	**2,033**

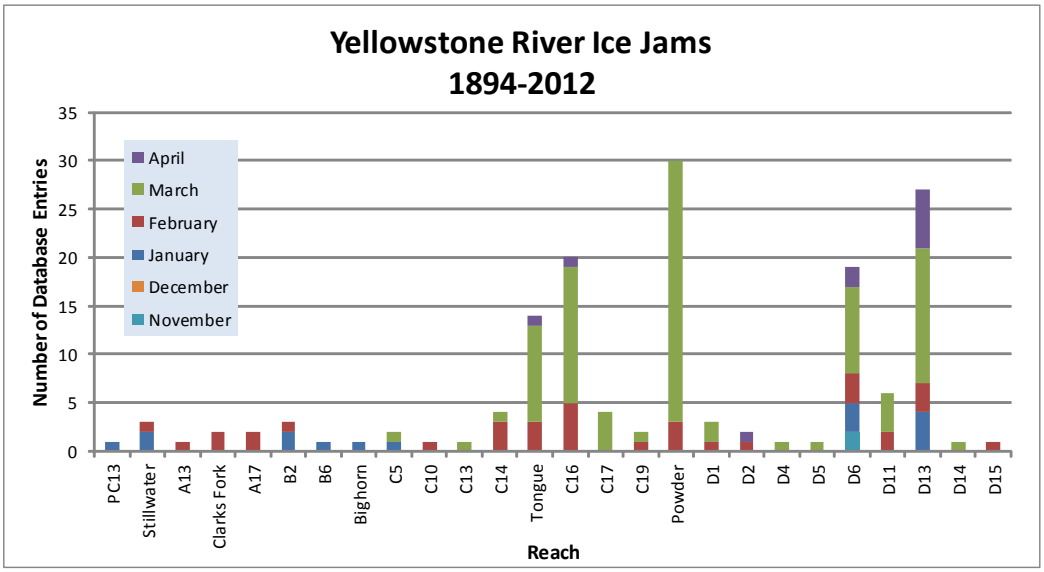
Intent of Bank Protection: 2001

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
Car Bodies	2,263	0	0	0	0	0	0	174
Concrete RipRap	2,522	0	0	0	0	0	0	807
Flow Deflectors/Between FDs	1,496	2,394	0	0	0	0	0	0
Rock RipRap	748	0	984	66	0	0	0	2,178
Tire Revetment	518	0	0	0	0	0	0	0
Totals	**7,547**	**2,394**	**984**	**66**	**0**	**0**	**0**	**3,159**

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
	NA	31	35K USD estimated rural damages
4/3/1917	NA	31	?
3/31/1923	NA	31	?
1/1/1927	NA	31	21,400 USD estimated rural damages
3/2/1938	NA	31	?
3/22/1939	NA	31	?
3/25/1943	NA	31	484,800 USD estimated rural damages
1/1/1944	NA	31	86,600 USD estimated rural damages
1/1/1946	NA	31	50,400 USD estimated rural damages
1/1/1948	NA	31	11,300 USD estimated rural damages
3/8/1949	NA	31	50,500 USD estimated rural damages
4/4/1950	NA	31	?
3/27/1951	NA	31	Severe flooding, evacuations, 100,000s USD in damages
4/1/1952	Freeze-up	31	44,900 USD estimated rural damages,severe flooding
4/3/1955	NA	31	1,800 USD estimated rural damages
3/26/1956	NA	31	?
3/21/1959	NA	31	30K USD estimated rural damages
3/21/1960	NA	31	69K USD estimated rural damages
3/17/1961	NA	31	?
4/7/1965	NA	31	?
4/7/1965	NA	31	?
3/26/1969	Break-up	31	230K USD and 14,000 acres flooded
3/19/1979	NA	31	?
2/27/1986	NA	31	?
3/6/1994	NA	31	?
2/13/1996	Break-up	31	High water
2/14/1997	NA	31	?
3/19/2011	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		% Change in Braiding
1950	44,020	49,325	2.12	1950 to 1976:	-1.37%
1976	43,740	47,743	2.09	1976 to 1995:	1.60%
1995	44,321	49,858	2.12	1995 to 2001:	-12.40%
2001	45,127	38,872	1.86	1950 to 2001:	-12.22%
Change 1950 - 2001	**1,106**	**-10,453**	**-0.26**		

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.)	31	0.7%		
Agriculture (generally relates to field boundaries)	552	13.1%		
Agriculture (isloated by canal or large ditch)	0	0.0%		
Levee/Riprap (protecting agricultural lands)	38	0.9%		
Levee/Riprap (protecting urban, industrial, etc.)	16	0.4%		
Railroad	0	0.0%		
Abandoned Railroad	0	0.0%		
Transportation (Interstate and other roads)	129	3.1%		
Total Not Isolated (Ac)	3434		2297	
Total Floodplain Area (Ac)	4200		2764	
Total Isolated (Ac)	**766**	**18.2%**	**467**	**25.6%**

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:	163	0	19	**183**

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
521	1,042	3,541	598	17%	0	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			
	Public Road	177	5.0%
RipRap/Flow Deflectors			
	Irrigated	233	6.6%
RipRap			
	Irrigated	128	3.6%
Flow Deflectors			
	Irrigated	101	2.9%
	Totals	**639**	**18.1%**

Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ ExUrban	Trans-portation
585.1	0.0	250.7	136.9	9.9

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	73	163	209	210	1.1%	2.4%	3.0%	3.1%
	Totals	**73**	**163**	**209**	**210**	**1.1%**	**2.4%**	**3.0%**	**3.1%**
Agricultural Land									
	Non-Irrigated	1,843	1,799	1,831	1,780	26.8%	26.2%	26.6%	25.9%
	Irrigated	3,210	3,141	3,230	3,218	46.7%	45.7%	46.9%	46.8%
	Totals	**5,052**	**4,940**	**5,061**	**4,998**	**73.4%**	**71.8%**	**73.6%**	**72.7%**
Channel									
	Channel	1,695	1,543	1,343	1,398	24.6%	22.4%	19.5%	20.3%
	Totals	**1,695**	**1,543**	**1,343**	**1,398**	**24.6%**	**22.4%**	**19.5%**	**20.3%**
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	158	185	192	0.0%	2.3%	2.7%	2.8%
	ExUrban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Residential	5	19	24	24	0.1%	0.3%	0.4%	0.4%
	Totals	**5**	**176**	**209**	**216**	**0.1%**	**2.6%**	**3.0%**	**3.1%**
Transportation									
	Public Road	44	47	47	47	0.6%	0.7%	0.7%	0.7%
	Interstate	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Railroad	9	9	9	9	0.1%	0.1%	0.1%	0.1%
	Totals	**53**	**57**	**57**	**57**	**0.8%**	**0.8%**	**0.8%**	**0.8%**
Urban									
	Urban Other	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Residential	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Undeveloped	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Industrial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Totals	**0**	**0**	**0**	**0**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Land Use Timeline - Tiers 3 and 4

		Acres				% of Reach Area				Change Between Years (% of Agricultural Land)			
Feature Class	Feature Type	1950	1976	2001	2011	1950	1976	2001	2011	'50-76	'76-01	'01-11	'50-11
Irr													
	Sprinkler	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pivot	0	0	316	894	0.0%	0.0%	6.3%	17.9%	0.0%	6.3%	11.6%	17.9%
	Flood	3,210	3,141	2,913	2,324	63.5%	63.6%	57.6%	46.5%	0.0%	-6.0%	-11.0%	-17.0%
	Totals	**3,210**	**3,141**	**3,230**	**3,218**	**63.5%**	**63.6%**	**63.8%**	**64.4%**	**0.1%**	**0.2%**	**0.6%**	**0.9%**

NoIrr

Multi-Use	1,549	1,546	1,731	1,747	30.7%	31.3%	34.2%	35.0%	0.6%	2.9%	0.7%	4.3%
Hay/Pasture	293	253	100	33	5.8%	5.1%	2.0%	0.7%	-0.7%	-3.2%	-1.3%	-5.1%
Totals	**1,843**	**1,799**	**1,831**	**1,780**	**36.5%**	**36.4%**	**36.2%**	**35.6%**	**-0.1%**	**-0.2%**	**-0.6%**	**-0.9%**

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	0.2	0.7	2.2	0.3	2.0	3.7	5.3	8.8
Max	175.6	31.2	43.2	110.3	279.9	346.3	51.5	31.8	19.4
Average	26.7	6.6	11.6	32.0	31.7	41.1	22.9	16.8	14.1
Sum	987.8	277.2	372.7	641.0	1,014.0	1,273.4	114.5	67.4	28.2

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)	231.2
Channel to Riparian (acres)	522.9
Riparian Encroachment (acres)	**291.7**

Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

1950s Channel Mapped as 2011 Riparian (Ac)	546.4
1950s Floodplain Mapped as 2011 Channel (Ac)	104.1
Total Recruitment (1950s to 2011)(Ac)	**650.5**

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	65.0	126.5	60.6	0.0	**252.0**
Acres/Valley Mile	8.5	16.6	7.9	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 (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	44.74	3.16%	145.58	2.81	22.19	6.15

FISHERIES SUMMARY

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

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

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

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

Fish Species Observed in Reach/Region

Species of Concern

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

Low Flow Fisheries Habitat Mapping

Habitat	2001 (Acres) Bankfull	Low Flow	% of Low Flow
Scour Pool	256.0	134.5	10.0%
Rip Rap Bottom	262.2	125.6	9.4%
Rip Rap Margin	25.8	18.2	1.4%
Secondary Channel (Seasonal)	222.7	209.0	15.6%
Channel Crossover	176.1	163.4	12.2%
Point Bar		88.1	6.6%
Side Bar		27.8	2.1%
Mid-channel Bar		37.7	2.8%
Island	400.6	401.2	29.9%
Dry Channel		137.9	10.3%

AVIAN

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

Bird Species Observed in Reach/Region

Species of Concern | Potential Species of Concern

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

CULTURAL INVENTORY SUMMARY

The Yellowstone River Cultural Inventory - 2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.
There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants' views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river's resources. Special attention is given to the ways in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

Summary of Cultural Views in Region 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.