Yellowstone River Reach Narratives — Reach B4

County	Yellowstone	**Upstream River Mile**	357.9
Classification	PCS: Partially confined straight	**Downstream River Mile**	354
General Location	Upstream of Huntley	**Length**	3.90 mi (6.28 km)
General Comments	Channel closely follows right valey wall; extensive bank armor		

Narrative Summary

Reach B4 is 3.9 miles long and located upstream of Huntley. It is classified as a Partially Confined Straight (PCS) reach type because within this area the river flows straight along the south valley wall with minimal meandering. The reach is characterized by the most extensive bank armoring of any reach on the river.

In total there are about 29,000 feet of bank protection in Reach B4, such that 74 percent of the bankline is armored. Most of the armor is rock riprap, although there are over 8,000 feet of concrete riprap mapped in the reach, as well as over 9,000 feet of floodplain dikes. Between 2001 and 2011, 500 feet of concrete riprap and 1,050 feet of flow deflectors were eroded out in the reach. The failed flow deflectors and concrete riprap have been largely replaced by rock riprap, although at the upstream end of the reach at RM 357.8, about 300 feet of flanked flow deflectors are in the river about 75 feet off of the left (north) bank.

The predominant land use in the reach is agriculture, with about 1,200 acres of land in flood irrigation in 2011. A total of 204 acres of developed land uses have encroached into the Channel Migration Zone (CMZ), including 193 acres of flood irrigation and 11 acres of transportation corridor. In order to protect these land uses, bank armor installations have isolated about one half of the river's CMZ.

Huntley Diversion Dam is located at RM 355.8. The structure diverts flow into the Huntley Main Canal, which follows the southern margin of the Yellowstone River floodplain. The diversion capacity of Huntley Dam is 600 cfs, and the project has the capacity to provide irrigation water to 30,000 acres of farm land. The crest length of the structure is 325 feet, and its structural height is 10.5 feet (http://www.usbr.gov/dataweb/dams/yellowstone_river_diversion.htm). The Huntley diversion structure was originally constructed as a temporary earthfill dam in 1931. In 1934, the temporary structure was modified to a concrete weir. In 1959, the dam underwent considerable rehabilitation due to undermining caused by settling and cracking of the concrete structure. As part of repairs required after recent flooding on the river, a fish passage channel was constructed around the north end of the dam. The structure is located at a point of split flow on the river, and blocks only the main channel. However, 2001 color infrared air photos of the site show that at low flows, the unblocked secondary channels are essentially dry and therefore incapable of passing fish.

Land has been developed in commonly flooded areas. About 280 acres of flood irrigated land is within the 5-year floodplain area.

There are corrals that are part of an animal handling facility adjacent to the north bank of the river at RM 355.

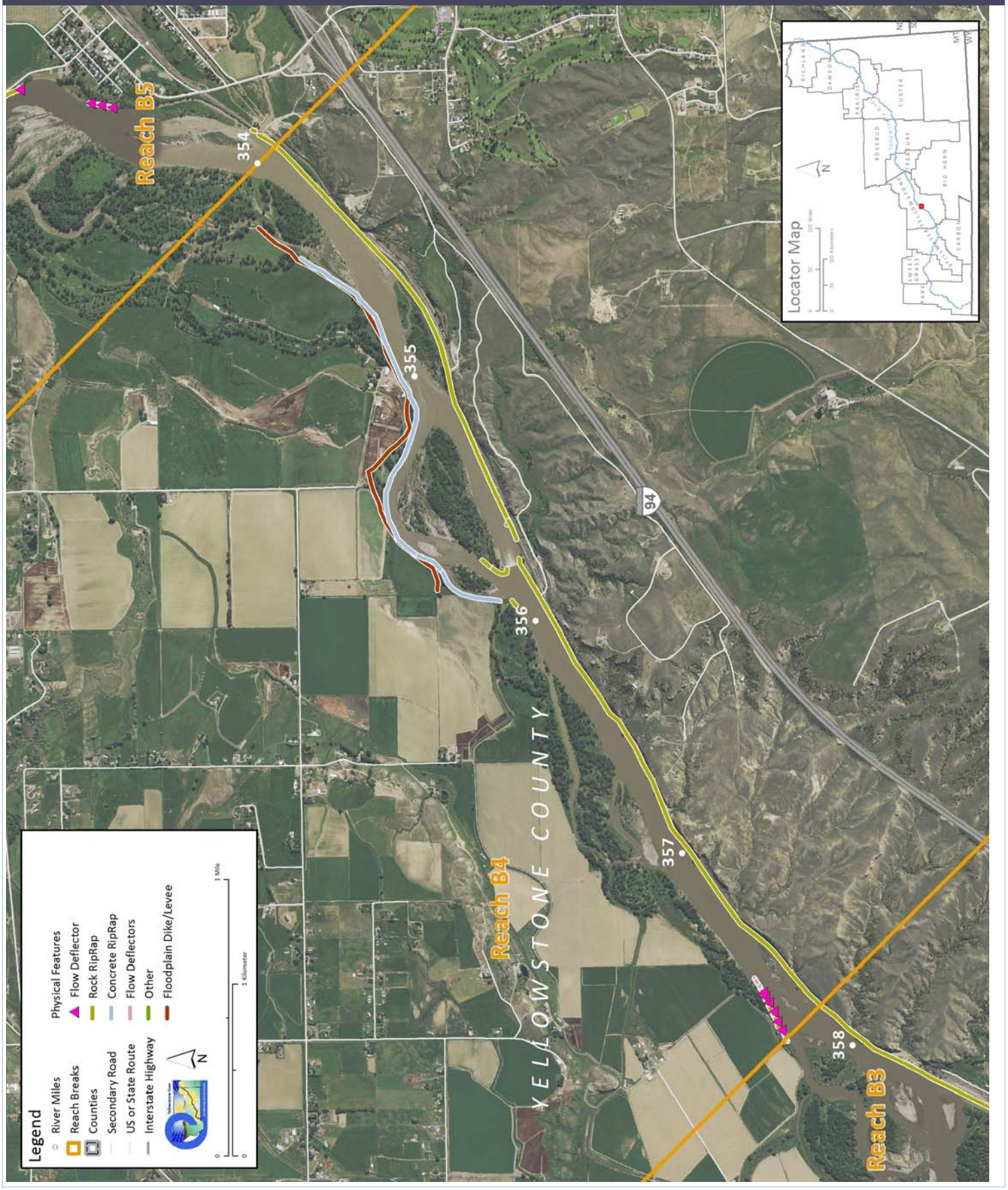
About 2.3 acres of Russian olive have been mapped in Reach B4.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 24,000 cfs to 19,900 cfs, a drop of about 17 percent. The 2-year flood, which strongly influences overall channel form, has dropped from 44,700 cfs to 40,300 cfs, which is a reduction of 10 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 2,940 cfs to 2,010 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 B4 include:
•Flanking of flow deflectors
•Repair of damaged flow deflectors with riprap

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach B4 include:
•Flanked flow deflector removal at RM 357.8
•Nutrient management at corrals associated with animal handling facility at RM 355.
•Fish passage at Huntley Diversion Dam
•Watercraft passage at Huntley Diversion Dam
•Irrigation Diversion structure management at Huntley Diversion Dam

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
1943	Jun 21	61,200	10-25 yr
1996	Jun 12	61,900	10-25 yr
1944	Jun 27	64,800	10-25 yr
1967	Jun 16	66,100	10-25 yr
1975	Jul 7	67,600	10-25 yr
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

	Downstream Gage	Upstream Gage
Gage No	6309000	6214500
Location	Miles City	Billings
Period of Record	1929-2015	1929-2015
Distance To (miles)	170.0	6.5

Discharge

	1.01 Yr	2 Yr	5 Yr	10 Yr	50 Yr	100 Yr	500 Yr	7Q10 Summer	95% Sum. Duration
Unregulated	24,000	44,700	55,100	61,400	74,300	79,400	91,000	2,940	3,846
Regulated	19,900	40,300	51,000	57,500	71,300	76,800	89,400	2,010	2,227
% Change	-17.08%	-9.84%	-7.44%	-6.35%	-4.04%	-3.27%	-1.76%	-31.63%	-42.10%

AERIAL PHOTOGRAPHY

A variety of aerial photographic sources provide the basis for much of the Cumulative Effects Assessment analysis. The table below lists the air photos compiled for the reach and the associated discharge at the most representative USGS gaging station.

	Source	Acquisition Date	Type	Scale	Gage	Discharge
1950	USGS-EROS	14-May-51	B/W	1:28,400	6214500	13200
1976	USCOE	29-Sep-76	B/W	1:24,000	6214500	5630
1995	USGS DOQQ	23-Aug-96	B/W		6214500	4500
2001	NRCS	August 2-8, 2001	CIR	1:24,000	6214500	1700
2004	Merrick	15-May-04	Color	1:15,840	6214500	5960
2005	NAIP	07/14/2005	color	1-meter pixels	6214500	9730
2005	NAIP	07/08/2005	color	1-meter pixels	6214500	11400
2009	NAIP	7/5/2009	Color	1-meter pixels	6214500	23800
2011	USCOE	October 2012	color	1-ft pixel	6214500	3860
2011	NAIP	7/24/2011	Color	1-meter pixels	6214500	22800
2013	NAIP	06/15/2013	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 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	19,525	49.1%	20,730	52.1%	1,205
	Flow Deflectors	338	0.8%	258	0.6%	-80
	Concrete RipRap	8,833	22.2%	8,332	20.9%	-502
	Between Flow Deflectors	976	2.5%	0	0.0%	-976
	Feature Type Totals	**29,672**	**74.6%**	**29,319**	**73.7%**	**-353**
Floodplain Control						
	Transportation Encroachment	4,465	11.2%	4,465	11.2%	0
	Floodplain Dike/Levee	8,976	22.6%	8,976	22.6%	0
	Feature Type Totals	**13,441**	**33.8%**	**13,441**	**33.8%**	**0**
	Reach Totals	**43,113**	**108.3%**	**42,760**	**107.5%**	**-353**

Intent of Bank Protection: 2001

The 2001 bank protection features were assessed for the 'intent' of what they protect.

Feature Type	Irrigated	Non-Irrig.	Ag. Infrastr.	Road	Interstate	Railroad	Urban	Exurban
Concrete RipRap	5,550	0	3,280	0	0	0	0	0
Rock RipRap	3,004	0	462	0	0	23,705	0	0
Totals	**8,554**	**0**	**3,742**	**0**	**0**	**23,705**	**0**	**0**

Bankline/Floodplain Inventory: Time Series

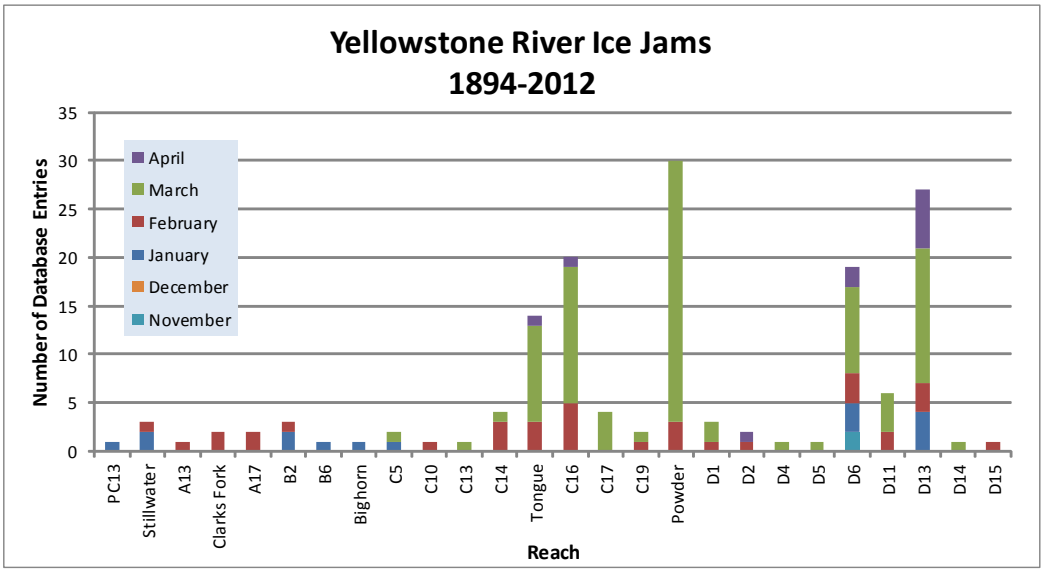
The Human Impacts Timeline assessed physical feature development through time for Yellowstone, Stillwater, and Dawson Counties.

		Sum of Feature Length (ft)					
Feature Class	Feature Type	1950	1976	1995	2001	2004	2005
Irrigation							
	In Channel Diversion	237	474	237	237	237	237
	Floodplain Dike/Levee	13,375	13,375	13,375	13,375	13,375	13,375
	Totals	**13,612**	**13,849**	**13,612**	**13,612**	**13,612**	**13,612**
Other Off Channel							
	Floodplain Dike/Levee	0	4,705	4,705	4,705	4,705	4,705
	Floodplain Dike/Levee	0	4,300	4,300	4,300	4,300	4,300
	Totals	**0**	**9,005**	**9,005**	**9,005**	**9,005**	**9,005**
Stream Stabilization							
	Rock RipRap	18,166	18,166	18,166	18,406	18,406	18,406
	Flow Deflector	0	3,241	3,241	3,241	3,241	3,241
	Concrete RipRap	0	6,452	6,452	6,960	6,960	6,960

Totals	**18,166**	**27,859**	**27,859**	**28,607**	**28,607**	**28,607**
Transportation Encroachment						
Railroad	13,543	13,543	13,543	13,543	13,543	13,543
Other	619	619	619	619	619	619
Totals	**14,162**	**14,162**	**14,162**	**14,162**	**14,162**	**14,162**

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	19,950	9,303	1.47	1950 to 1976:	-2.55%
1976	20,116	8,627	1.43	1976 to 1995:	-3.42%
1995	20,165	7,663	1.38	1995 to 2001:	14.31%
2001	19,897	11,490	1.58	1950 to 2001:	7.58%
Change 1950 - 2001	**-53**	**2,188**	**0.11**		

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.)	0	0.0%		
Agriculture (generally relates to field boundaries)	0	0.0%		
Agriculture (isloated 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	29	2.2%		
Abandoned Railroad	0	0.0%		
Transportation (Interstate and other roads)	0	0.0%		
Total Not Isolated (Ac)	1262		1159	
Total Floodplain Area (Ac)	1291		1290	
Total Isolated (Ac)	**29**	**2.2%**	**132**	**14.1%**

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:	279	0	0	**279**

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
332	663	831	236	28%	266	249	93%

2011 Restricted Migration Area Summary

Note that these data reflect the observed conditions in the 2011 aerial photography (NAIP for Park and Sweet Grass Counties, COE for the rest of the river).

Reason for Restriction	Land Use Protected	RMA Acres	Percent of CMZ
RipRap/Flow Deflectors			
	Irrigated	26	2.3%
RipRap			
	Railroad	63	5.7%
	Irrigated	396	35.8%
	Totals	**484**	**43.8%**

Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ ExUrban	Trans-portation
193.1	0.0	0.0	0.0	10.8

LAND USE

Land uses were mapped from aerial photography Gardiner to the confluence of the Missouri River in North Dakota for four time periods: 1950s, 1976, 2001, and 2011. Mapping was performed at approximately 1:6,000 to ensure consistent mapping across all data sets. Typically, if a feature could not be easily mapped at the target mapping scale, it was not separated out from the adjacent land use.

A four-tiered system was used to allow analysis at a variety of levels. Tier 1 breaks land use into Agricultural and Non-Agricultural uses. Tier two subdivided uses into productive Agricultural Land and Infrastructure for the Agricultural land, and Urban, Exurban and Transportation categories for the Non-Agricultural land. Tier three further breaks down land uses into more refined categories such as Irrigated or Non-Irrigated and Residential, Commercial, or Industrial. Finally, Tier 4 focuses primarily on the productive agricultural lands, identifying the type of irrigation (Pivot, Sprinkler or Flood).

Land Use Timeline - Tiers 2 and 3

		Acres				% of Reach Area			
Feature Class	Feature Type	1950	1976	2001	2011	1950	1976	2001	2011
Agricultural Infrastructure									
	Canal	6	6	6	6	0.2%	0.2%	0.2%	0.2%
	Agricultural Roads	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Other Infrastructure	70	128	157	162	2.1%	3.9%	4.8%	5.0%
	Totals	**76**	**134**	**163**	**168**	**2.3%**	**4.1%**	**5.0%**	**5.1%**
Agricultural Land									
	Non-Irrigated	2,048	1,520	1,338	1,391	62.8%	46.6%	41.0%	42.7%
	Irrigated	728	1,167	1,261	1,161	22.3%	35.8%	38.7%	35.6%
	Totals	**2,775**	**2,686**	**2,599**	**2,552**	**85.1%**	**82.4%**	**79.7%**	**78.3%**
Channel									
	Channel	388	380	423	440	11.9%	11.7%	13.0%	13.5%
	Totals	**388**	**380**	**423**	**440**	**11.9%**	**11.7%**	**13.0%**	**13.5%**
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	5	0.0%	0.0%	0.0%	0.1%
	ExUrban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Residential	0	0	17	36	0.0%	0.0%	0.5%	1.1%
	Totals	**0**	**0**	**17**	**41**	**0.0%**	**0.0%**	**0.5%**	**1.3%**
Transportation									
	Public Road	8	8	8	8	0.2%	0.2%	0.2%	0.2%
	Interstate	0	30	30	30	0.0%	0.9%	0.9%	0.9%
	Railroad	14	22	22	22	0.4%	0.7%	0.7%	0.7%
	Totals	**22**	**60**	**59**	**59**	**0.7%**	**1.8%**	**1.8%**	**1.8%**
Urban									
	Urban Other	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Residential	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Undeveloped	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Industrial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Totals	**0**	**0**	**0**	**0**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Land Use Timeline - Tiers 3 and 4

		Acres				% of Reach Area				Change Between Years (% of Agricultural Land)			
Feature Class	Feature Type	1950	1976	2001	2011	1950	1976	2001	2011	'50-76	'76-01	'01-11	'50-11
Irrigated													
	Sprinkler	0	0	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	728	1,167	1,261	1,161	26.2%	43.4%	48.5%	45.5%	17.2%	5.1%	-3.0%	19.3%
	Totals	**728**	**1,167**	**1,261**	**1,161**	**26.2%**	**43.4%**	**48.5%**	**45.5%**	**17.2%**	**5.1%**	**-3.0%**	**19.3%**

Non-Irrigated

Multi-Use	1,394	1,284	1,333	1,271	50.2%	47.8%	51.3%	49.8%	-2.4%	3.5%	-1.5%	-0.4%
Hay/Pasture	654	235	4	120	23.6%	8.8%	0.2%	4.7%	-14.8%	-8.6%	4.5%	-18.9%
Totals	**2,048**	**1,520**	**1,338**	**1,391**	**73.8%**	**56.6%**	**51.5%**	**54.5%**	**-17.2%**	**-5.1%**	**3.0%**	**-19.3%**

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	7.6	1.2	1.8	2.5	2.4	1.2	4.0	2.9	1.9
Max	29.2	7.6	34.1	111.8	129.6	136.5	26.2	34.4	40.6
Average	17.1	4.9	14.2	35.4	40.3	23.2	17.8	17.7	13.1
Sum	102.5	24.6	85.3	283.4	282.0	208.4	53.3	53.1	117.6

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)	82.4
Channel to Riparian (acres)	68.2
Riparian Encroachment (acres)	**-14.2**

Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

1950s Channel Mapped as 2011 Riparian (Ac)	68.0
1950s Floodplain Mapped as 2011 Channel (Ac)	16.4
Total Recruitment (1950s to 2011)(Ac)	**84.4**

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	17.0	34.3	8.1	0.0	**59.5**
Acres/Valley Mile	4.6	9.2	2.2	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	2.29	1.08%	16.12	0.49	0.70	0.08

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
Rip Rap Bottom	48.1	23.2	5.5%
Rip Rap Margin	96.3	56.3	13.3%
Secondary Channel	0.7	0.6	0.1%
Secondary Channel (Seasonal)	78.7	53.2	12.6%
Channel Crossover	58.6	28.9	6.8%
Point Bar		11.4	2.7%
Side Bar		23.2	5.5%
Mid-channel Bar		18.0	4.2%
Island	80.9	80.9	19.1%
Dry Channel		77.8	18.4%
Dam Influenced	59.4	49.2	11.6%

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 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.