Yellowstone River Reach Narratives — Reach B2

County	Yellowstone	**Upstream River Mile**	368.3
Classification	PCB: Partially confined braided	**Downstream River Mile**	362.2
General Location	Billlings	**Length**	6.10 mi (9.82 km)
General Comments	Billlings; WAI Reach E		

Narrative Summary

Reach B2 is 6.1 miles long and located in Billings. The reach extends from the rimrock bluffs south of town, under the I-90 Bridge, to the refinery area at Lockwood. It is a Partially Confined Braided (PCB) reach type indicating some influence of the bluff line on the river coupled by extensive open gravel bars and low flow channels. Reach B2 is extensively urbanized, with floodplain dikes, industrial and urban/exurban development, pipeline crossings, and bridges throughout the reach. Flow alterations in this reach have been substantial; the mean annual flood has dropped an estimated 17 percent due to human influences, and summer low flows have dropped by 42 percent.

In total there are 21,700 feet of bank armor in Reach B2, which equates to 4.1 miles of bank armor in a 6 mile long reach of river. Concrete riprap is the most prevalent type of armor, with about three miles present in 2011. There is almost a mile of rock riprap and a few flow deflectors. There are also over three miles of floodplain dikes mapped in the reach.

Since 1950, 6,566 feet of side channels have been blocked by dikes. These blocked side channels are in highly urbanized areas upstream of the I-90 Bridge and at the water treatment plant downstream.

The primary land use in the reach is urban/exurban development. A total of 620 acres of the historic 100-year floodplain has become isolated from the river, which is 41 percent of the total 100-year floodplain footprint. Most of the 100-year floodplain isolation is due to the Interstate Highway Embankment. Approximately 21 percent of the Channel Migration Zone has become restricted due to physical features, most of which are riprap installed to protect urban/industrial land uses.

A total of three ice jams have been recorded in Reach B2. One of these jams occurred in February of 1996, and the other two in January of 1997. They all resulted in flooding and the January 3 1997 jam caused some evacuations. The jams were reported as forming upstream of the I-90 Bridge.

There are numerous pipeline crossings in Reach B2. At RM 367 two pipelines cross under the river. One is a crude oil pipeline owned by Beartooth Pipeline that is HDD (Horizontal Directionally Drilled). The other is a petroleum product pipeline owned by Phillips 66 that as of Fall 2012 was trenched, and according to the addendum to the Yellowstone River Pipeline Risk Assessment, had 4 to 10 feet of cover. Further downstream, there are seven pipelines listed in the Pipeline Risk Assessment Report at RM 365. Several of these pipelines are trenched as a bundle, with a reported minimum of two feet of cover.
About 25 acres of Russian olive have been mapped in Reach B2.

Reach B2 was sampled as part of the fisheries study. A total of 31 fish species were sampled in the reach and one of those species was Sauger, which has been identified by the Montana Natural Heritage Program as a Species of Concern (SOC).

Reach B2 was sampled as part of the avian study. The average species richness in Reach B2 was 7.0, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. Two bird species identified by the Montana Natural Heritage Program as Potential Species of Concern (PSOC) were also found, the Ovenbird and the Plumbeous Vireo.

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 23,700 cfs to 19,700 cfs, a drop of about 17 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 2,910 cfs to 2,000 cfs with human development, a reduction of 31 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,836 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 B2 include:
•Extensive armoring with CMZ encroachment

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach B2 include:
•Pipeline crossing management
•Russian olive removal

PHYSICAL FEATURES MAP (2011)

HYDROLOGIC SUMMARY

Hydrologic data available for the Reach Narratives include data from representative gaging stations, modeling from the COE from the Big Horn river upstream, and modeling by the USGS for the Big Horn River to the Missouri River confluence. Gaging stations that best represent the watershed area within any reach are used to describe the flood history within the reach. Hydrology modeling results generated for all reaches provides unregulated and regulated flow values. Seasonal and annual flow duration data generated by the USGS are available for reaches C10 through D13.

Gage Representation (Gage-Based): Billings

Flood History

Year	Date	Flow on Date	Return Interval
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)	178.2	-3.9

Discharge

	1.01 Yr	2 Yr	5 Yr	10 Yr	50 Yr	100 Yr	500 Yr	7Q10 Summer	95% Sum. Duration
Unregulated	23,700	44,200	54,500	60,800	73,500	78,600	90,100	2,910	3,846
Regulated	19,700	39,800	50,400	57,000	70,500	76,000	88,500	2,000	2,227
% Change	-16.88%	-9.95%	-7.52%	-6.25%	-4.08%	-3.31%	-1.78%	-31.27%	-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	5/15/1951 - 5/14/51	B/W	1:28,400	6214500	12000
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	07/12/2005	color	1-meter pixels	6214500	12600
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						
	Steel Retaining Wall	192	0.3%	192	0.3%	0
	Rock RipRap	3,501	5.4%	4,329	6.7%	828
	Flow Deflectors	0	0.0%	67	0.1%	67
	Concrete RipRap	17,283	26.8%	17,283	26.8%	0
	Between Flow Deflectors	0	0.0%	24	0.0%	24
	Feature Type Totals	**20,977**	**32.5%**	**21,895**	**34.0%**	**918**
Other In Channel						
	Bedrock Outcrop	208	0.3%	208	0.3%	0
	Feature Type Totals	**208**	**0.3%**	**208**	**0.3%**	**0**
Floodplain Control						
	Floodplain Dike/Levee	7,037	10.9%	7,037	10.9%	0
	Feature Type Totals	**7,037**	**10.9%**	**7,037**	**10.9%**	**0**
	Reach Totals	**28,223**	**43.8%**	**29,141**	**45.2%**	**918**

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	0	315	2,647	328	656	328	13,002	0
Rock RipRap	689	928	0	0	715	0	1,217	0
Steel Retaining Wall	0	0	0	0	0	0	194	0
Totals	**689**	**1,243**	**2,647**	**328**	**1,371**	**328**	**14,412**	**0**

Bankline/Floodplain Inventory: Time Series

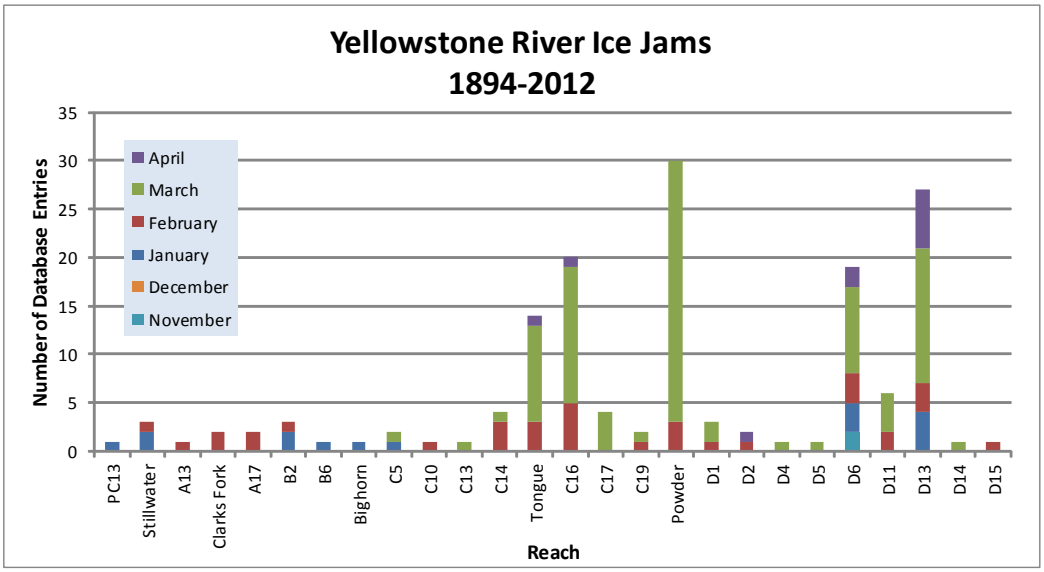
The Human Impacts Timeline assessed physical feature development through time for Yellowstone, Stillwater, and Dawson Counties.

		Sum of Feature Length (ft)					
Feature Class	Feature Type	1950	1976	1995	2001	2004	2005
Irrigation							
	Floodplain Dike/Levee	5,400	5,400	5,400	5,400	5,400	5,400
	Totals	**5,400**	**5,400**	**5,400**	**5,400**	**5,400**	**5,400**
Other							
	Floodplain Dike/Levee	12,435	17,523	17,523	17,523	17,523	17,523
	Totals	**12,435**	**17,523**	**17,523**	**17,523**	**17,523**	**17,523**
Other Off Channel							
	Floodplain Dike/Levee	0	3,468	3,468	3,468	3,468	3,468

	Floodplain Dike/Levee	0	0	757	757	757	757
	Totals	**0**	**3,468**	**4,225**	**4,225**	**4,225**	**4,225**
Stream Stabilization							
	Steel Retaining Wall	275	275	275	275	275	275
	Rock RipRap	1,100	2,973	3,758	3,758	3,758	3,758
	Concrete RipRap	5,062	15,933	18,005	18,005	18,005	18,005
	Totals	**6,437**	**19,182**	**22,039**	**22,039**	**22,039**	**22,039**
Transportation Encroachment							
	Railroad	1,491	1,491	1,491	1,491	1,491	1,491
	Other	3,322	3,960	1,861	1,861	1,861	1,861
	Interstate	0	10,378	10,378	10,378	10,378	10,378
	County Road	6,101	8,904	8,904	8,904	8,904	8,904
	Totals	**10,913**	**24,732**	**22,633**	**22,633**	**22,633**	**22,633**

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
2/6/1996	NA	366	Flooded roadways
1/3/1997	NA	366	Flooding, evacuations
1/10/1997	NA	366	?

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	31,111	29,288	1.94	1950 to 1976:	3.45%
1976	31,620	31,888	2.01	1976 to 1995:	-12.85%
1995	32,440	24,341	1.75	1995 to 2001:	1.21%
2001	32,233	24,867	1.77	1950 to 2001:	-8.75%
Change 1950 - 2001	**1,123**	**-4,421**	**-0.17**		

Length of Side Channels Blocked

Pre-1950s (ft)	0
Post-1950s (ft)	6,566

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.)	50	3.3%		
Railroad	0	0.0%		
Abandoned Railroad	0	0.0%		
Transportation (Interstate and other roads)	570	37.9%		
Total Not Isolated (Ac)	884		852	
Total Floodplain Area (Ac)	1504		910	
Total Isolated (Ac)	**620**	**41.2%**	**58**	**15.4%**

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:	0	0	0	**0**

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
245	490	1,118	251	22%	66	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
RipRap			
	Urban Industrial	218	18.2%
Dike/Levee			
	Exurban Other	38	3.1%
	Totals	**256**	**21.3%**

Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ ExUrban	Trans-portation
0.0	0.0	0.0	276.5	10.3

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	33	17	9	17	0.8%	0.4%	0.2%	0.4%
	Totals	**33**	**17**	**9**	**17**	**0.8%**	**0.4%**	**0.2%**	**0.4%**
Agricultural Land									
	Non-Irrigated	1,988	1,545	1,358	1,066	45.8%	35.6%	31.3%	24.6%
	Irrigated	469	25	5	5	10.8%	0.6%	0.1%	0.1%
	Totals	**2,457**	**1,569**	**1,363**	**1,071**	**56.6%**	**36.2%**	**31.4%**	**24.7%**
Channel									
	Channel	725	702	612	629	16.7%	16.2%	14.1%	14.5%
	Totals	**725**	**702**	**612**	**629**	**16.7%**	**16.2%**	**14.1%**	**14.5%**
ExUrban									
	ExUrban Other	138	0	0	0	3.2%	0.0%	0.0%	0.0%
	ExUrban Undeveloped	5	0	0	0	0.1%	0.0%	0.0%	0.0%
	ExUrban Industrial	30	0	0	0	0.7%	0.0%	0.0%	0.0%
	ExUrban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Residential	145	15	0	0	3.3%	0.3%	0.0%	0.0%
	Totals	**318**	**15**	**0**	**0**	**7.3%**	**0.3%**	**0.0%**	**0.0%**
Transportation									
	Public Road	29	32	32	32	0.7%	0.7%	0.7%	0.7%
	Interstate	0	79	80	80	0.0%	1.8%	1.8%	1.8%
	Railroad	17	17	17	17	0.4%	0.4%	0.4%	0.4%
	Totals	**46**	**128**	**128**	**128**	**1.1%**	**2.9%**	**2.9%**	**2.9%**
Urban									
	Urban Other	13	58	90	98	0.3%	1.3%	2.1%	2.3%
	Urban Residential	117	455	472	713	2.7%	10.5%	10.9%	16.4%
	Urban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Undeveloped	0	111	91	54	0.0%	2.6%	2.1%	1.2%
	Urban Industrial	630	1,285	1,575	1,631	14.5%	29.6%	36.3%	37.6%
	Totals	**760**	**1,910**	**2,228**	**2,495**	**17.5%**	**44.0%**	**51.3%**	**57.5%**

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	5	5	0.0%	0.0%	0.4%	0.5%	0.0%	0.4%	0.1%	0.5%
	Pivot	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Flood	469	25	0	0	19.1%	1.6%	0.0%	0.0%	-17.5%	-1.6%	0.0%	-19.1%
	Totals	**469**	**25**	**5**	**5**	**19.1%**	**1.6%**	**0.4%**	**0.5%**	**-17.5%**	**-1.2%**	**0.1%**	**-18.6%**

Non-Irrigated

Multi-Use	1,157	427	1,138	939	47.1%	27.2%	83.5%	87.6%	-19.8%	56.3%	4.1%	40.5%
Hay/Pasture	832	1,117	219	127	33.8%	71.2%	16.1%	11.9%	37.4%	-55.1%	-4.2%	-22.0%
Totals	**1,988**	**1,545**	**1,358**	**1,066**	**80.9%**	**98.4%**	**99.6%**	**99.5%**	**17.5%**	**1.2%**	**-0.1%**	**18.6%**

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	1.9	0.3	1.1	3.0	0.8	1.9	6.1	8.1	11.8
Max	87.6	41.0	40.7	59.3	90.7	125.5	87.3	58.1	43.3
Average	16.4	9.5	7.2	17.5	13.4	25.8	35.5	31.4	24.7
Sum	180.6	94.7	65.0	210.2	255.2	361.8	248.4	157.1	98.9

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)	129.1
Channel to Riparian (acres)	91.8
Riparian Encroachment (acres)	**-37.2**

Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

1950s Channel Mapped as 2011 Riparian (Ac)	105.2
1950s Floodplain Mapped as 2011 Channel (Ac)	42.7
Total Recruitment (1950s to 2011)(Ac)	**147.9**

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	44.5	19.6	11.6	0.0	**75.7**
Acres/Valley Mile	8.0	3.5	2.1	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	24.62	3.18%	40.06	2.32	5.89	3.52

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	59.0	20.9	3.4%
Rip Rap Bottom	92.6	67.5	11.0%
Rip Rap Margin	19.4	11.8	1.9%
Bluff Pool	104.4	86.8	14.2%
Secondary Channel	10.3	16.5	2.7%
Secondary Channel (Seasonal)	132.4	90.6	14.8%
Channel Crossover	112.2	69.6	11.4%
Point Bar		15.4	2.5%
Side Bar		27.5	4.5%
Mid-channel Bar		27.3	4.5%
Island	81.5	81.5	13.3%
Dry Channel		96.2	15.7%

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 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.