

<b>County</b>	Yellowstone	<b>Upstream River Mile</b>	346.7
<b>Classification</b>	PCB: Partially confined braided	<b>Downstream River Mile</b>	340.6
<b>General Location</b>	Ballantine	<b>Length</b>	6.10 mi (9.82 km)
<b>General Comments</b>	Channel closely follows left valley wall		

## Narrative Summary

Reach B6 is 6.1 miles long and is located Ballantine. The reach is a Partially Confined Braided (PCB) reach type, which indicates some valley wall influence coupled with relatively extensive unvegetated bars and low flow islands. Within Reach B6, the river flows closely along the north valley wall. The Gritty Stone fishing access site is located in the downstream end of the reach.

About 6.3 percent of the bankline in Reach B6 is armored, and the majority of that armor (2,300 feet) is concrete riprap. Since 2001, riprap has expanded by about 430 feet. Reach B6 also hosts almost 1,500 feet of car body riprap, which is fairly unusual in terms of extent on the Yellowstone River. The car bodies were put in place between 1950 and 1995, and their mapped location is at RM 341.7R, although they are difficult to see on the imagery.

Prior to 1950, a side channel that was about 1,350 feet long was blocked by a small dike at RM 343. Even though this side channel was blocked, there has been a net gain of over three miles of side channel since 1950.

Land uses in the reach are primarily agricultural, with about 1,862 acres of flood irrigated land mapped as of 2011. The Channel Migration Zone (CMZ) has been developed for primarily flood irrigation; as of 2011, there were 237 acres of flood irrigated land in the CMZ, and about 9 percent of the total CMZ footprint has become restricted by bank armor and road prisms. The modern 5-year floodplain contains over 200 acres of flood-irrigated ground.

There is one mapped animal handling facility in the reach at RM 345.5R. It is within 800 feet of the active river bank.

The 100-year floodplain has also been restricted; about 210 acres or 11.4 percent of the historic 100-year floodplain area has become isolated from the river by agricultural infrastructure.

Since 1950, there has been almost 250 acres of riparian recruitment in the reach, and most of that was in the 1950s channels that were abandoned.

One ice jam has been recorded in Reach B6. On January 3, 1997, an ice jam occurred at RM 345 that caused severe flooding and resulted in evacuations.

There are 49 acres of mapped Russian olive in the reach, and the mapping indicates that it has expanded on islands and in side channels. Riparian recruitment in the reach has exceeded 500 acres since 1950; about half of that recruitment occurred in areas that were 1950s channel and the other half in areas that were eroded between 1950 and 2001.

Reach B6 was sampled as part of the avian study. The average species richness in this reach was 8.25, 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.

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 26,000 cfs to 21,100 cfs, a drop of about 19 percent. The 2-year flood, which strongly influences overall channel form, has dropped from 48,300 cfs to 43,000 cfs, which is a reduction of 11 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 3,000 cfs to 2,050 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.

Because of the flow alterations, about 25 percent of the 5-year floodplain has become isolated in Reach B6. Much of that 5-year floodplain isolation is within old swales on the south side of the river. The 5-year flood discharge has dropped by 8.25 percent in this reach due to human influences, primarily irrigation.

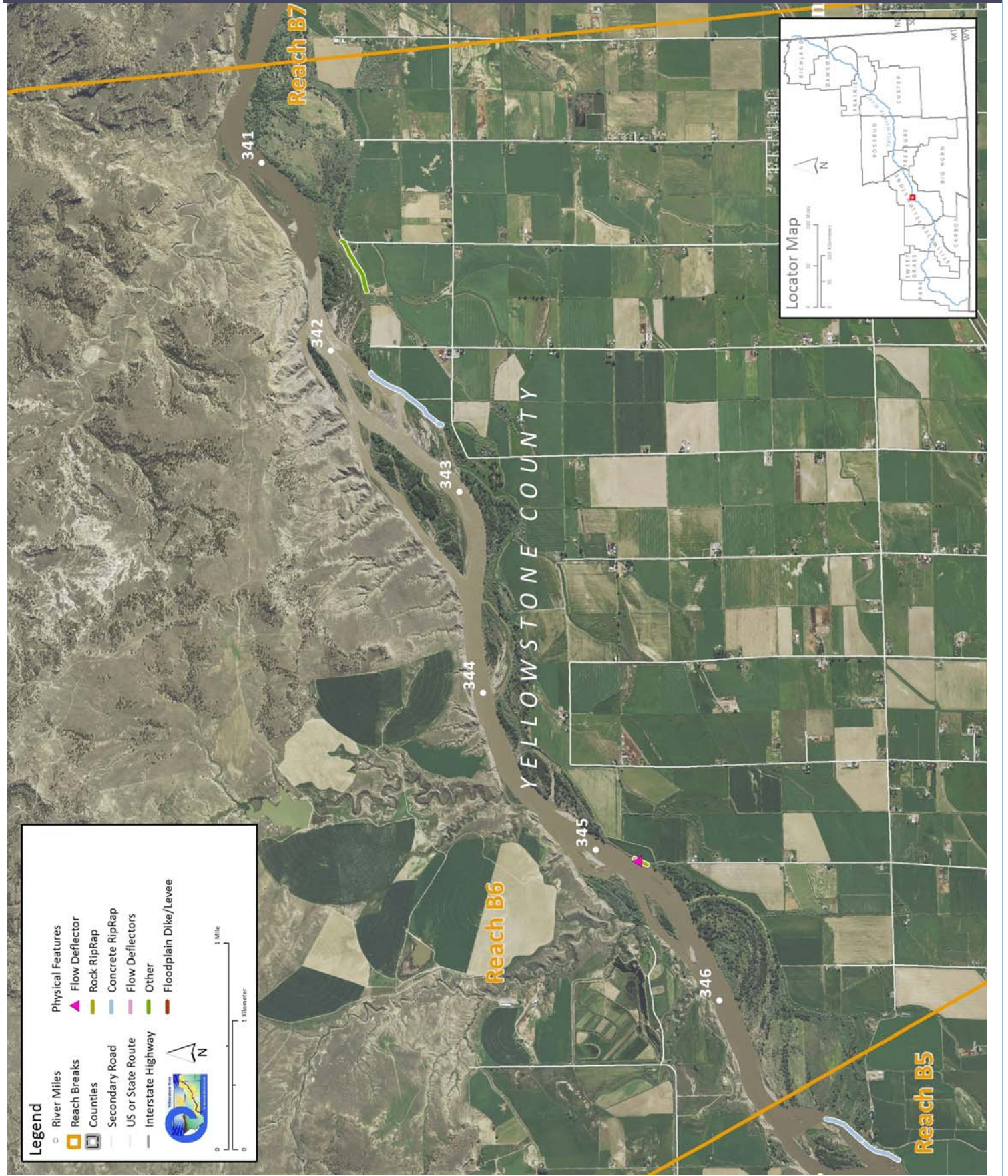
CEA-Related observations in Reach B6 include:

- Gain in anabranching channel length
- Ice jamming
- Side channel blockage at RM 343.

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach B6 include:

- Russian olive removal
- Nutrient management at corrals associated with animal handling facility at RM 534.5R

## PHYSICAL FEATURES MAP (2011)





## HYDROLOGIC SUMMARY

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

### Gage Representation (Gage-Based): Billings

#### Flood History

Year	Date	Flow on Date	Return Interval	Gage No	Downstream Gage	Upstream Gage
1943	Jun 21	61,200	10-25 yr		6309000	6214500
1996	Jun 12	61,900	10-25 yr		Miles City	Billings
1944	Jun 27	64,800	10-25 yr		1929-2015	1929-2015
1967	Jun 16	66,100	10-25 yr		Distance To (miles)	156.6
1975	Jul 7	67,600	10-25 yr			17.7
1974	Jun 19	69,500	25-50 yr			
2011	Jul 2	70,600	25-50 yr			
1918	Jun 15	78,100	50-100 yr			
1997	Jun 12	82,000	>100 yr			

#### Discharge

	1.01 Yr	2 Yr	5 Yr	10 Yr	50 Yr	100 Yr	500 Yr	7Q10 Summer	95% Sum. Duration
<b>Unregulated</b>	26,000	48,300	59,400	66,200	79,900	85,300	97,700	3,000	3,846
<b>Regulated</b>	21,100	43,000	54,500	61,700	76,300	82,200	95,800	2,050	2,227
<b>% Change</b>	-18.85%	-10.97%	-8.25%	-6.80%	-4.51%	-3.63%	-1.94%	-31.67%	-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	15-May-51	B/W	1:28,400	6214500	11500
1976	USCOE	29-Sep-76	B/W	1:24,000	6214500	5630
1995	USGS DOQQ	8/10/96 - 8/24/96	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	07/12/2005	color	1-meter pixels	6214500	12600
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 discrepancies between total feature lengths (e.g. length of rock riprap) in each data set.

### 2001 and 2011 Physical Features Bankline Inventories

Feature Class	Feature Type	2001 Length (ft)	% of Bankline	2011 Length (ft)	% of Bankline	2001-2011 Change
Stream Stabilization						
	Rock RipRap	0	0.0%	304	0.5%	304
	Flow Deflectors	0	0.0%	23	0.0%	23
	Concrete RipRap	2,169	3.3%	2,275	3.5%	106
	Car Bodies	1,465	2.3%	1,465	2.3%	0
	<b>Feature Type Totals</b>	<b>3,634</b>	<b>5.6%</b>	<b>4,067</b>	<b>6.3%</b>	<b>433</b>
	<b>Reach Totals</b>	<b>3,634</b>	<b>5.6%</b>	<b>4,067</b>	<b>6.3%</b>	<b>433</b>

### 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	984	0	482	0	0	0	0	0
Concrete RipRap	2,168	0	0	0	0	0	0	0
<b>Totals</b>	<b>3,152</b>	<b>0</b>	<b>482</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

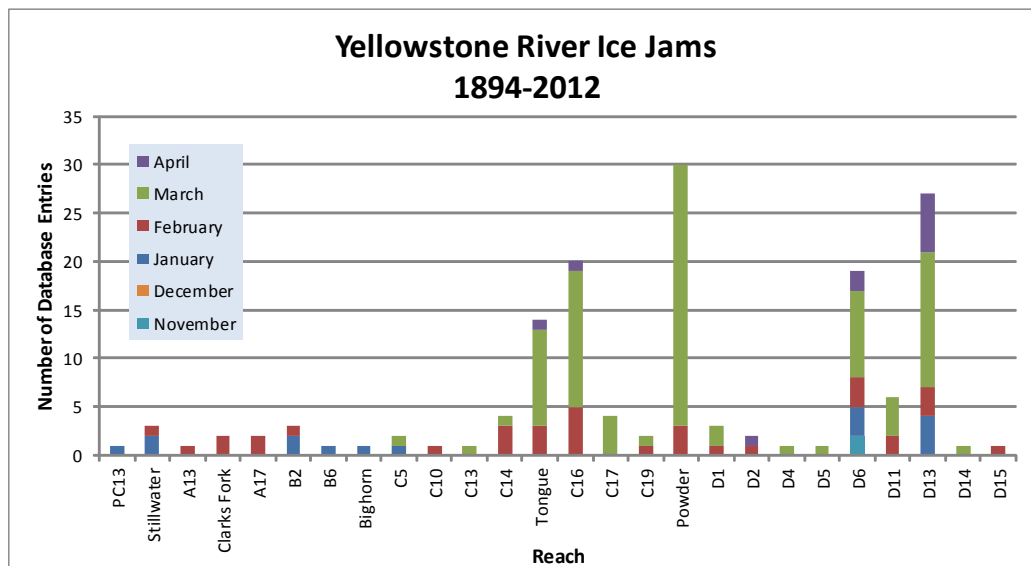
### Bankline/Floodplain Inventory: Time Series

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

Feature Class	Feature Type	Sum of Feature Length (ft)					
		1950	1976	1995	2001	2004	2005
Irrigation							
	Floodplain Dike/Levee	11,978	12,535	12,865	12,865	12,865	12,865
	<b>Totals</b>	<b>11,978</b>	<b>12,535</b>	<b>12,865</b>	<b>12,865</b>	<b>12,865</b>	<b>12,865</b>
Stream Stabilization							
	Concrete RipRap	0	0	2,981	2,981	2,981	2,981
	Car Bodies	0	1,702	1,702	1,702	1,702	1,702
	<b>Totals</b>	<b>0</b>	<b>1,702</b>	<b>4,683</b>	<b>4,683</b>	<b>4,683</b>	<b>4,683</b>
Transportation Encroachment							
	County Road	3,755	3,755	3,755	3,755	3,755	3,755
	<b>Totals</b>	<b>3,755</b>	<b>3,755</b>	<b>3,755</b>	<b>3,755</b>	<b>3,755</b>	<b>3,755</b>

## 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
1/3/1997	NA	345	Severe flooding, evacuations

## 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	31,548	26,855	1.85	1950 to 1976: 14.45%
1976	32,976	36,892	2.12	1976 to 1995: -5.93%
1995	32,692	32,470	1.99	1995 to 2001: 18.16%
2001	32,409	43,922	2.36	1950 to 2001: 27.22%
<b>Change 1950 - 2001</b>	<b>861</b>	<b>17,067</b>	<b>0.50</b>	

Length of Side Channels Blocked	Pre-1950s (ft)	Post-1950s (ft)
	1,352	0

## HYDRAULICS

Available hydraulic information includes county-based HEC-RAS modeling efforts by the Army Corps of Engineers with the exclusion of Park County. Floodplain modeling was performed for four conditions representing a developed and undeveloped floodplain, and unregulated and regulated flows for the 1.5, 2, 5, 10, 20, 50, 100, 200, and 500-year events. Park County has limited FEMA hydraulic modeling and was not included in the analysis.

The results of HEC-RAS modeling for the 5 and 100-year flood events were assessed to compare the extents of inundated area for the pristine (undeveloped floodplain, unregulated flows) and developed (developed floodplain, regulated flows) conditions. The data sets provided for each flow condition were unioned in the GIS to identify areas where the inundated extent differed. These areas of human-caused floodplain isolation due to either flow alterations or physical features such as levees. For the 100-year flood event, isolated areas greater than 5 acres were attributed with the interpreted reason for isolation (railroad, levee, etc.). The resulting values are presented as acres and percent of the pristine floodplain that has been isolated. The pristine floodplain is defined as the total floodplain footprint minus the area of the mapped 2001 bankfull channel (mapped islands were included in the floodplain area).

### Floodplain Isolation

	100-Year		5-Year	
	Isolated Acres	% of Floodplain	Isolated Acres	% of Floodplain
Non-Structural (hydrology, geomorphic, etc.)	0	0.0%		
Agriculture (generally relates to field boundaries)	0	0.0%		
Agriculture (isolated by canal or large ditch)	209	11.4%		
Levee/Riprap (protecting agricultural lands)	0	0.0%		
Levee/Riprap (protecting urban, industrial, etc.)	0	0.0%		
Railroad	0	0.0%		
Abandoned Railroad	0	0.0%		
Transportation (Interstate and other roads)	0	0.0%		
<b>Total Not Isolated (Ac)</b>	<b>1621</b>		<b>1659</b>	
<b>Total Floodplain Area (Ac)</b>	<b>1830</b>		<b>2002</b>	
<b>Total Isolated (Ac)</b>	<b>209</b>	<b>11.4%</b>	<b>344</b>	<b>24.8%</b>

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

	Flood	Sprinkler	Pivot	Total
Irrigated Acres within the 5 Year Flooplain:	304	0	0	<b>304</b>

## 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
425	850	1,464	128	9%	123	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/Flow Deflectors	Irrigated	0	0.0%
RipRap	Irrigated	141	8.8%
<b>Totals</b>		<b>142</b>	<b>8.8%</b>

### Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ExUrban	Transportation
236.8	0.0	0.0	0.0	3.6



## LAND USE

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

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

### Land Use Timeline - Tiers 2 and 3

Feature Class	Feature Type	Acres				% of Reach Area			
		1950	1976	2001	2011	1950	1976	2001	2011
Agricultural Infrastructure									
	Canal	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Agricultural Roads	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Other Infrastructure	52	65	97	137	1.1%	1.4%	2.1%	3.0%
	<b>Totals</b>	<b>52</b>	<b>65</b>	<b>97</b>	<b>137</b>	<b>1.1%</b>	<b>1.4%</b>	<b>2.1%</b>	<b>3.0%</b>
Agricultural Land									
	Non-Irrigated	2,365	2,208	1,811	1,737	51.1%	47.7%	39.1%	37.5%
	Irrigated	1,318	1,458	1,946	1,958	28.5%	31.5%	42.0%	42.3%
	<b>Totals</b>	<b>3,683</b>	<b>3,666</b>	<b>3,757</b>	<b>3,695</b>	<b>79.5%</b>	<b>79.2%</b>	<b>81.1%</b>	<b>79.8%</b>
Channel									
	Channel	879	882	760	778	19.0%	19.1%	16.4%	16.8%
	<b>Totals</b>	<b>879</b>	<b>882</b>	<b>760</b>	<b>778</b>	<b>19.0%</b>	<b>19.1%</b>	<b>16.4%</b>	<b>16.8%</b>
ExUrban									
	ExUrban Other	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Undeveloped	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Industrial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Commercial	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Residential	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	<b>Totals</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>
Transportation									
	Public Road	17	17	17	17	0.4%	0.4%	0.4%	0.4%
	Interstate	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Railroad	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	<b>Totals</b>	<b>17</b>	<b>17</b>	<b>17</b>	<b>17</b>	<b>0.4%</b>	<b>0.4%</b>	<b>0.4%</b>	<b>0.4%</b>
Urban									
	Urban Other	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Urban Residential	0	0	0	4	0.0%	0.0%	0.0%	0.1%
	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%
	<b>Totals</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>

### Land Use Timeline - Tiers 3 and 4

Feature Class	Feature Type	Acres				% of Reach Area				Change Between Years (% of Agricultural Land)			
		1950	1976	2001	2011	1950	1976	2001	2011	'50-76	'76-01	'01-11	'50-11
Irrigated													
	Sprinkler	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pivot	0	0	96	96	0.0%	0.0%	2.6%	2.6%	0.0%	2.6%	0.0%	2.6%
	Flood	1,318	1,458	1,849	1,862	35.8%	39.8%	49.2%	50.4%	4.0%	9.5%	1.2%	14.6%
	<b>Totals</b>	<b>1,318</b>	<b>1,458</b>	<b>1,946</b>	<b>1,958</b>	<b>35.8%</b>	<b>39.8%</b>	<b>51.8%</b>	<b>53.0%</b>	<b>4.0%</b>	<b>12.0%</b>	<b>1.2%</b>	<b>17.2%</b>

Non-Irrigated

Multi-Use	1,683	1,584	1,725	1,675	45.7%	43.2%	45.9%	45.3%	-2.5%	2.7%	-0.6%	-0.4%
Hay/Pasture	682	624	87	61	18.5%	17.0%	2.3%	1.7%	-1.5%	-14.7%	-0.6%	-16.9%
<b>Totals</b>	<b>2,365</b>	<b>2,208</b>	<b>1,811</b>	<b>1,737</b>	<b>64.2%</b>	<b>60.2%</b>	<b>48.2%</b>	<b>47.0%</b>	<b>-4.0%</b>	<b>-12.0%</b>	<b>-1.2%</b>	<b>-17.2%</b>

## RIPARIAN

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

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

### Riparian Mapping

Statistic	Shrub (Acres)			Closed Timber (Acres)			Open Timber (Acres)		
	1950	1976	2001	1950	1976	2001	1950	1976	2001
Min	1.1	1.0	0.5	1.5	0.9	0.4	1.2	0.7	0.7
Max	81.4	33.0	110.7	96.3	139.5	147.3	28.0	98.0	22.3
Average	10.2	7.0	13.4	34.6	24.9	20.5	10.6	20.1	8.9
Sum	194.0	104.9	255.5	380.5	373.4	349.0	84.5	161.0	53.5

### 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) 179.5

Channel to Riparian (acres) 143.0

**Riparian Encroachment (acres) -36.5**

### Riparian Recruitment

Creation of riparian areas between 1950s and 2001.	1950s Channel Mapped as 2011 Riparian (Ac)	156.8
	1950s Floodplain Mapped as 2011 Channel (Ac)	89.2
	<b>Total Recruitment (1950s to 2011)(Ac)</b>	<b>246.0</b>

## 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
<b>Mapped Acres</b>	2.9	71.5	38.0	0.0	<b>112.4</b>
<b>Acres/Valley Mile</b>	0.5	12.7	6.7	0.0	

## RUSSIAN OLIVE

Russian olive is considered an invasive species and its presence in the Yellowstone River corridor is fairly recent. As such, its spread can be used as a general indicator of invasive plants within the corridor. It has the added benefit of being easily identified in multi-spectral aerial photography, making it possible to inventory large areas using remote techniques.

In 2011, Natural Resources Conservation Service (NRCS) in Bozeman, MT conducted an inventory of Russian olive locations in the Yellowstone River watershed. This study utilized the Feature Analyst extension within ArcGIS to interpret multi-spectral 2008 NAIP imagery for the presence of Russian olive. The resulting analysis was converted from raster format to a polygon ESRI shape file for distribution and further analysis within a GIS environment.

This work scope was tasked with integrating the resulting Russian olive inventory into the Yellowstone River Conservation Districts Council (YRDC) Cumulative Effects Assessment (CEA) GIS and associated reach-based database. Additionally, analysis of Russian olive within the corridor was conducted to characterize its distribution in throughout the corridor and its association with other corridor data sets.

	Floodplain Area (Ac)	% of Floodplain	Other Area (Ac)	Inside RMA (Ac)	Inside '50s Channel (Ac)	Inside 50s Island (Ac)
<b>Russian Olive in Reach</b>	48.71	2.83%	15.00	0.55	10.97	11.24

## FISHERIES SUMMARY

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

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

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

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

### Low Flow Fisheries Habitat Mapping

Habitat	2001 (Acres)		
	Bankfull	Low Flow	% of Low Flow
Scour Pool	214.4	115.9	15.3%
Rip Rap Bottom	5.8	5.5	0.7%
Bluff Pool	82.9	57.4	7.6%
Secondary Channel	69.6	21.4	2.8%
Secondary Channel (Seasonal)	137.6	104.6	13.8%
Channel Crossover	107.5	68.4	9.0%
Point Bar		44.5	5.9%
Side Bar		57.1	7.5%
Mid-channel Bar		40.7	5.4%
Island	141.8	144.3	19.0%
Dry Channel		99.8	13.1%

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



**CULTURAL INVENTORY SUMMARY**

The Yellowstone River Cultural Inventory - 2006 documents the variety and intensity of different perspectives and values held by people who share the Yellowstone River. Between May and November of 2006, a total of 313 individuals participated in the study. They represented agricultural, civic, recreational, or residential interest groups. Also, individuals from the Crow and the Northern Cheyenne tribes were included.

There are three particular goals associated with the investigation. The first goal is to document how the people of the Yellowstone River describe the physical character of the river and how they think the physical processes, such as floods and erosion, should be managed. Within this goal, efforts have been made to document participants' views regarding the many different bank stabilization techniques employed by landowners. The second goal is to document the degree to which the riparian zone associated with the river is recognized and valued by the participants. The third goal is to document concerns regarding the management of the river's resources. Special attention is given to the ways in which residents from diverse geographical settings and diverse interest groups view river management and uses. The results illustrate the commonalities of thought and the complexities of concerns expressed by those who share the resources of the Yellowstone River.

**Summary of Cultural Views in Region B**

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