

County	Stillwater	Upstream River Mile	400
Classification	PCA: Partially confined anabranching	Downstream River Mile	392.4
General Location	Park City	Length	7.60 mi (12.23 km)
General Comments	Near Park City, Reach A16 provides an example of a reach that supports numerous irrigation point features that appear to have a minimal effect on the stream corridor		

Narrative Summary

Reach A16 is 7.6 miles long and is located just south of Park City. The reach is a Partially Confined Anabranching reach type, indicating some valley wall influences as well as relatively extensive forested islands. The partial geologic confinement within Reach A16 is created by interbedded sandstone and shale. In addition, both low and high alluvial terraces intermittently form the active river corridor margin.

Approximately 9 percent of the bankline in Reach A16 is armored, and the armor is almost entirely rock riprap, some short sections of concrete armor and flow deflectors. The armor is located almost entirely on the northern corridor margin, against terrace margins. Its use is split evenly between protecting agricultural and exurban residential land uses. On the upstream end of the reach, rock armor protects the Italian Ditch Diversion and Canal, which divert water on the north bank of the river at RM 400. Over four miles of floodplain dikes have been mapped in the reach, most of which follow ditches on the north floodplain.

Although there is no evidence that side channels have been intentionally blocked off in Reach A16, there has still been a net loss of over a mile of side channel since 1950. Similar to most reaches in Region A, the loss of side channels has been accompanied by an overall increase in the total channel footprint; since 1950, the bankfull channel area of Reach A16 has increased by 40 acres.

Land use in Reach A16 is almost entirely agricultural, although there are almost 300 acres of urban/exurban development in the mapping footprint. There are corrals that are part of an animal handling facility within 1,000 feet of an abandoned river swale at RM 395. Over a thousand acres under of ground in Reach A16 are under flood irrigation, and about 11 are in pivot. About 150 acres of developed land are in the Channel Migration Zone, and almost 40 acres of that is in urban/exurban development. About 6 percent of the total CMZ is restricted by bank armor and dikes.

There is one pipeline crossing in Reach A16. It crosses under the river at RM 396.7 and consists of a 24 inch crude oil pipeline that is owned by Kinder Morgan Pipelines. This pipeline was horizontally drilled during its installation.

Reach A16 was sampled as part of the avian study. The average species richness in Reach A16 was 8.5, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for all sites evaluated is 8. An average of one cowbird was observed during the field sampling visits. Reach A16 has lost about one half of its riparian forest considered at low risk of cowbird parasitism since 1950. At that time, there were about 12 acres of forest per valley mile considered to be isolated enough from agricultural infrastructure and urban/exurban development to be considered at low risk. By 2011, about 6.6 acres considered low risk remained.

There are over 250 acres of mapped wetland in the reach, with most of that emergent marshes wand wet meadows. Many of these wetland areas occupy old river swales on the floodplain north of the river, or abandoned channels in the active corridor.

The reach has extensive Russian olive, with almost 30 acres of mapped footprint in the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 16,900 cfs to 15,500 cfs, a drop of about 8 percent. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 2,310 cfs to 1,780 cfs with human development, a reduction of 23 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760 cfs under unregulated conditions to 1,680 cfs under regulated conditions at the Livingston gage, a reduction of 4.6 percent.

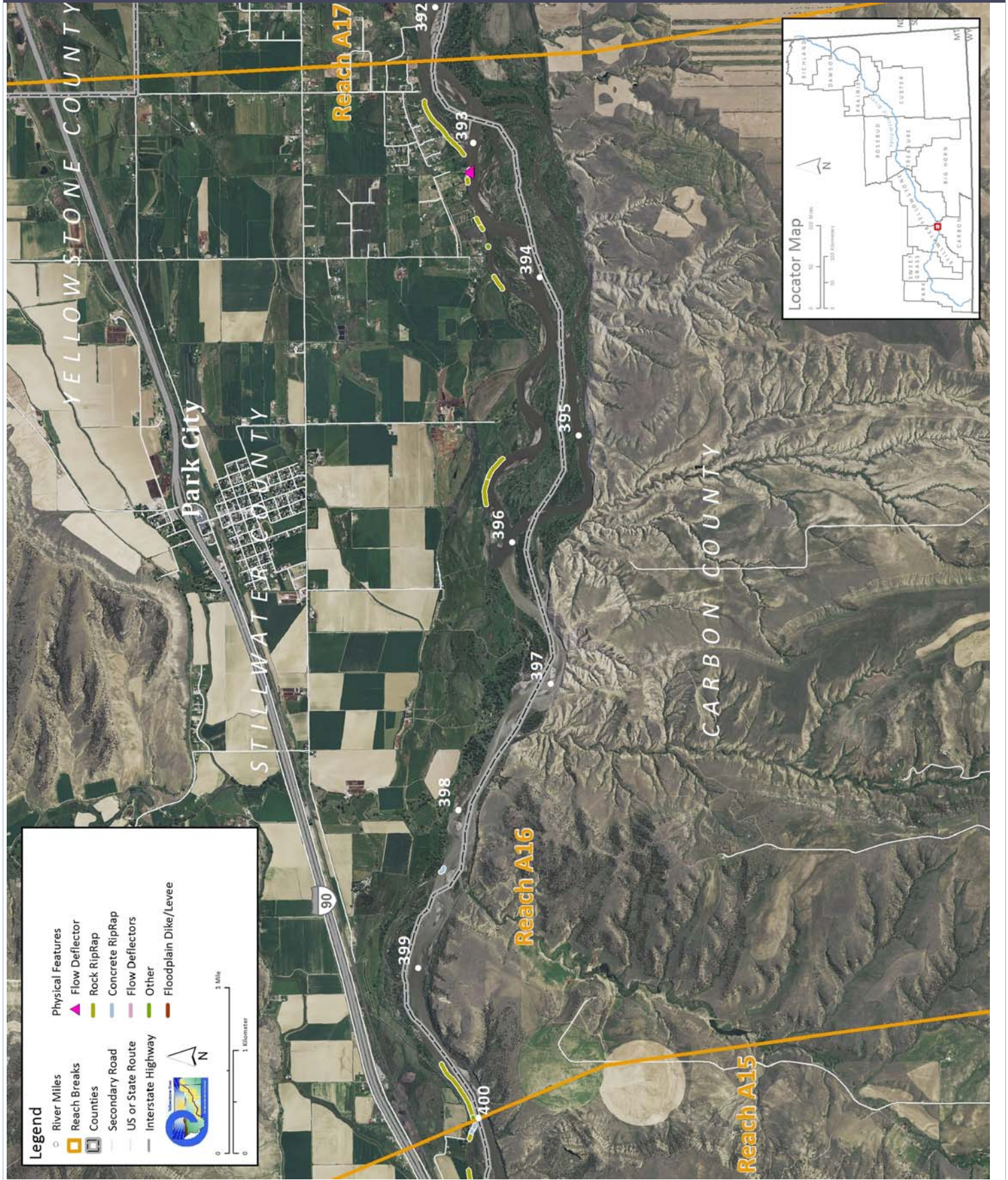
CEA-Related observations in Reach A16 include:

- Passive loss of over a mile of side channel
- Russian olive colonization in abandoned side channels
- Emergent wetland development in abandoned side channels

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach A16 include:

- Diversion structure management at Italian Ditch Diversion RM 400
- Nutrient management at corrals that are part of an animal handling facility at RM 395.
- Russian olive removal (29 acres)
- Wetland management/restoration due to extent of mapped emergent wetland (214 acres emergent, 270 acres total wetland)

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): Livingston

Flood History

Year	Date	Flow on Date	Return Interval	Gage No	Downstream Gage	Upstream Gage
1971	Jun 23	29,200	10-25 yr	6214500	6192500	6192500
1902	Jun 11	30,100	10-25 yr	Billings	Billings	Livingston
1943	Jun 20	30,600	10-25 yr	1929-2015	1929-2015	1929-2015
1974	Jun 17	36,300	50-100 yr	28.0	28.0	106.6
1996	Jun 10	37,100	50-100 yr			
1997	Jun 6	38,000	50-100 yr			
2011	Jun 30	40,600	>100-yr			

Discharge

	1.01 Yr	2 Yr	5 Yr	10 Yr	50 Yr	100 Yr	500 Yr	7Q10 Summer	95% Sum. Duration
Unregulated	16,900	32,200	40,100	44,900	54,600	58,600	67,500	2,310	1,760
Regulated	15,500	30,600	38,600	43,500	53,500	57,600	66,900	1,780	1,680
% Change	-8.28%	-4.97%	-3.74%	-3.12%	-2.01%	-1.71%	-0.89%	-22.94%	-4.55%

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	5/16/51 - 5/17/1951	B/W	1:28,400	6192500	6000
1976	USCOE	28-Sep-76	B/W	1:24,000	6192500	2560
1995	USGS DOQQ	24-Aug-96	B/W		6192500	3540
2001	NRCS	August 2-8, 2001	CIR	1:24,000	6192500	2000
2004	Merrick	14-May-04	Color	1:15,840	6192500	4520
2005	NAIP	07/12/2005	color	1-meter pixels	6192500	5960
2009	NAIP	7/7/2009	Color	1-meter pixels	6192500	11300
2009	NAIP	6/29/2009	Color	1-meter pixels	6192500	13900
2011	USCOE	October 2012	color	1-ft pixel	6192500	2530
2011	NAIP	7/24/2011	Color	1-meter pixels	6192500	13100
2013	NAIP	06/15/2013	color	1-meter pixels	6192500	

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	4,439	5.5%	6,790	8.4%	2,351
	Flow Deflectors	0	0.0%	90	0.1%	90
	Concrete RipRap	167	0.2%	9	0.0%	-158
	Car Bodies	117	0.1%	117	0.1%	0
	Between Flow Deflectors	0	0.0%	38	0.0%	38
	Feature Type Totals	4,723	5.8%	7,043	8.7%	2,321
	Reach Totals	4,723	5.8%	7,043	8.7%	2,321

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	0	0	79	0	0	0	0	36
Concrete RipRap	0	157	0	0	0	0	0	0
Rock RipRap	0	977	1,988	0	0	0	0	2,450
Totals	0	1,135	2,066	0	0	0	0	2,486

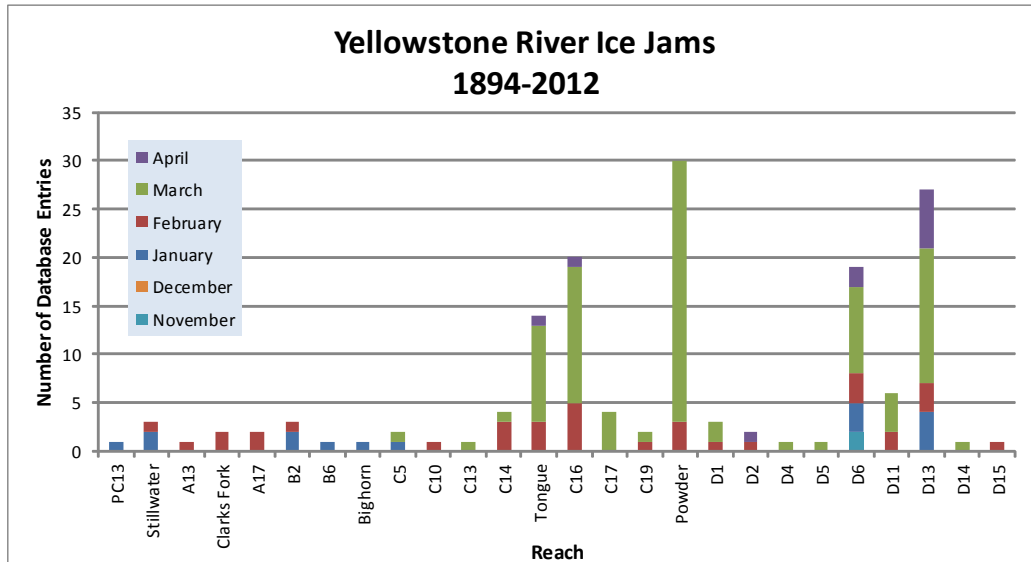
Bankline/Floodplain Inventory: Time Series

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	22,187	22,187	22,187	22,187	22,187	22,187
	Totals	22,187	22,187	22,187	22,187	22,187	22,187
Stream Stabilization							
	Rock RipRap	1,441	1,441	1,976	5,043	5,949	5,949
	Concrete RipRap	0	0	262	262	262	262
	Car Bodies	79	79	112	112	112	112
	Totals	1,521	1,521	2,350	5,418	6,324	6,324
Transportation Encroachment							
	Railroad	4,239	4,239	4,239	4,239	4,239	4,239
	Other	1,669	1,669	1,669	1,669	1,669	1,669
	Totals	5,908	5,908	5,908	5,908	5,908	5,908

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	39,915	59,568	2.49	1950 to 1976:	6.26%
1976	39,509	65,125	2.65	1976 to 1995:	-12.30%
1995	40,855	54,038	2.32	1995 to 2001:	0.11%
2001	40,532	53,715	2.33	1950 to 2001:	-6.71%
Change 1950 - 2001	618	-5,854	-0.17		

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 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)	0	0.0%		
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%		
Total Not Isolated (Ac)	815		1108	
Total Floodplain Area (Ac)	815		1151	
Total Isolated (Ac)	0	0.0%	42	12.5%

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:	5	0	0	5

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
335	671	1,894	61	3%	88	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			
	Irrigated	44	2.2%
	Exurban Residential	15	0.8%
	Canal	46	2.3%
	Totals	104	5.2%

Land Uses within the CMZ (Acres)

Flood Irrigation	Sprinkler Irrigation	Pivot Irrigation	Urban/ExUrban	Transportation
110.1	0.0	0.0	38.9	0.0

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	25	25	25	25	0.5%	0.5%	0.5%	0.5%
	Agricultural Roads	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Other Infrastructure	46	66	118	108	0.9%	1.2%	2.2%	2.0%
	Totals	71	91	142	133	1.3%	1.7%	2.6%	2.5%
Agricultural Land									
	Non-Irrigated	2,421	2,331	2,519	2,427	44.9%	43.2%	46.7%	45.0%
	Irrigated	1,588	1,551	1,156	1,106	29.4%	28.7%	21.4%	20.5%
	Totals	4,009	3,883	3,674	3,533	74.3%	71.9%	68.1%	65.4%
Channel									
	Channel	1,297	1,349	1,252	1,391	24.0%	25.0%	23.2%	25.8%
	Totals	1,297	1,349	1,252	1,391	24.0%	25.0%	23.2%	25.8%
ExUrban									
	ExUrban Other	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	ExUrban Undeveloped	0	0	80	7	0.0%	0.0%	1.5%	0.1%
	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	2	176	261	0.0%	0.0%	3.3%	4.8%
	Totals	0	2	256	268	0.0%	0.0%	4.7%	5.0%
Transportation									
	Public Road	11	11	11	11	0.2%	0.2%	0.2%	0.2%
	Interstate	0	52	52	52	0.0%	1.0%	1.0%	1.0%
	Railroad	11	11	11	11	0.2%	0.2%	0.2%	0.2%
	Totals	21	74	74	74	0.4%	1.4%	1.4%	1.4%
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

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	11	11	0.0%	0.0%	0.3%	0.3%	0.0%	0.3%	0.0%	0.3%
	Flood	1,588	1,551	1,145	1,095	39.6%	40.0%	31.2%	31.0%	0.3%	-8.8%	-0.2%	-8.6%
	Totals	1,588	1,551	1,156	1,106	39.6%	40.0%	31.5%	31.3%	0.3%	-8.5%	-0.2%	-8.3%

Non-Irrigated

Multi-Use	2,349	1,976	1,894	1,798	58.6%	50.9%	51.5%	50.9%	-7.7%	0.7%	-0.7%	-7.7%
Hay/Pasture	72	356	625	629	1.8%	9.2%	17.0%	17.8%	7.4%	7.8%	0.8%	16.0%
Totals	2,421	2,331	2,519	2,427	60.4%	60.0%	68.5%	68.7%	-0.3%	8.5%	0.2%	8.3%

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

Statistic	Shrub (Acres)			Closed Timber (Acres)			Open Timber (Acres)		
	1950	1976	2001	1950	1976	2001	1950	1976	2001
Min	0.7	0.2	0.7	1.4	0.3	0.9	1.8	1.4	1.8
Max	128.0	83.6	72.3	90.3	244.8	245.1	198.1	92.8	38.6
Average	15.2	8.7	10.7	23.2	17.0	29.2	22.4	15.0	26.7
Sum	273.5	182.0	171.6	440.6	610.9	672.2	291.8	149.8	133.4

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) 225.6

Channel to Riparian (acres) 220.7

Riparian Encroachment (acres) -5.0

Riparian Recruitment

Creation of riparian areas between 1950s and 2001.

1950s Channel Mapped as 2011 Riparian (Ac) 222.2

1950s Floodplain Mapped as 2011 Channel (Ac) 121.8

Total Recruitment (1950s to 2011)(Ac) 344.0

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	10.7	214.0	43.3	0.0	268.0
Acres/Valley Mile	1.6	32.0	6.5	0.0	

RUSSIAN OLIVE

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

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

This work scope was tasked with integrating the resulting Russian olive inventory into the Yellowstone River Conservation Districts Council (YRCD) 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	28.74	1.83%	19.92	0.17	10.47	9.07

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	223.2	102.4	8.2%
Rip Rap Bottom	34.8	16.6	1.3%
Bluff Pool	63.2	47.7	3.8%
Terrace Pool	18.5	9.8	0.8%
Secondary Channel	62.0	74.5	6.0%
Secondary Channel (Seasonal)	179.2	100.8	8.0%
Channel Crossover	200.6	121.5	9.7%
Point Bar		60.4	4.8%
Side Bar		51.2	4.1%
Mid-channel Bar		64.5	5.2%
Island	470.6	473.6	37.8%
Dry Channel		129.2	10.3%

AVIAN

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

Bird Species Observed in Reach/Region		Species of Concern	Potential Species of Concern
<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 checked="" type="checkbox"/> <input checked="" type="checkbox"/> American Crow	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Clay-collared Sparrow	<input type="checkbox"/> <input type="checkbox"/> Lark Bunting	<input type="checkbox"/> <input type="checkbox"/> Spotted Sandpiper
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> American Goldfinch	<input type="checkbox"/> <input checked="" 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 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 type="checkbox"/> <input checked="" type="checkbox"/> Swainson's Thrush
<input type="checkbox"/> <input type="checkbox"/> Bald Eagle	<input type="checkbox"/> <input type="checkbox"/> Common Nighthawk	<input type="checkbox"/> <input type="checkbox"/> Mallard	<input type="checkbox"/> <input type="checkbox"/> Sandhill Crane
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Baltimore Oriole	<input type="checkbox"/> <input type="checkbox"/> Common Raven	<input type="checkbox"/> <input checked="" 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 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 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 checked="" type="checkbox"/> <input checked="" type="checkbox"/> Black-billed Magpie	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Downy Woodpecker	<input type="checkbox"/> <input 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 checked="" type="checkbox"/> <input checked="" type="checkbox"/> Eastern Kingbird	<input type="checkbox"/> <input type="checkbox"/> Plumbeous Vireo	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Western Kingbird
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Black-headed Grosbeak	<input type="checkbox"/> <input type="checkbox"/> Eurasian Collared-dove	<input type="checkbox"/> <input 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 checked="" type="checkbox"/> Red-naped Sapsucker	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Western Wood-pewee
<input type="checkbox"/> <input checked="" type="checkbox"/> Bobolink	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Field Sparrow	<input type="checkbox"/> <input type="checkbox"/> Red Crossbill	<input checked="" 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 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 type="checkbox"/> Red-tailed hawk	<input type="checkbox"/> <input type="checkbox"/> Wild Turkey
<input type="checkbox"/> <input type="checkbox"/> Brown Creeper	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Gray Catbird	<input type="checkbox"/> <input type="checkbox"/> Rock Dove	<input type="checkbox"/> <input 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 checked="" type="checkbox"/> <input checked="" type="checkbox"/> Bullock's Oriole	<input type="checkbox"/> <input type="checkbox"/> Great Horned Owl	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Red-eyed Vireo	<input type="checkbox"/> <input type="checkbox"/> Yellow-billed Cuckoo
<input type="checkbox"/> <input type="checkbox"/> Canada Goose	<input checked="" 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 type="checkbox"/> House Finch	<input type="checkbox"/> <input type="checkbox"/> Say's Phoebe	<input type="checkbox"/> <input checked="" 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 A

In the study segment, Laurel to Springdale, three themes emerge as dominant across the four interest groups. One theme focuses on the changing riverbank profile as more and more residential homes are built on the river's edge. The second theme focuses on the river as a powerful and dynamic physical entity. The third is about the changing social profiles of their communities and how those changes influence user practices.