

County	Dawson	Upstream River Mile	67.8
Classification	PCA: Partially confined anabranching	Downstream River Mile	56.3
General Location	Lowermost Dawson County, Richland County	Length	11.50 mi (18.51 km)

Narrative Summary

Reach D10 is located in lowermost Dawson County and extends into upper Richland County. The reach is an 11.5 mile long Partially Confined Anabranching (PCA) reach type, indicating some valley wall influence and numerous forested islands.

In 2011 there were just about 730 feet of rock riprap in the reach armoring 0.6 percent of the total stream bank. Prior to that some armor had been lost; between 2001 and 2011, almost 500 feet of rock riprap and 1,050 feet of concrete riprap were destroyed. Some of the greatest damage was at RM 64.2L, where several hundred feet of flow deflectors were flanked, and now are in the river over 100 feet off of the bank. The remaining bank protection in this area continues to flank. Another is at RM 60, where the flanking of concrete riprap has been followed by over 200 feet of erosion behind the original armor.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D10 has gotten smaller since 1950. The channel contracted by about 404 acres in this reach since 1950, and about 406 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development. The encroachment was at the expense of open gravel bars; between 1950 and 2001, the reach lost 151 acres of mid-channel bar habitat. Floodplain turnover rates have dropped as well; prior to 1976 measured floodplain turnover rates in this reach were 13.9 acres per year, and post-1976 rates were 7.0 acres per year.

Reach D10 has a relatively high concentration of mapped wetlands; the NWI mapping shows a total of 278 acres of mapped wetland, much of which is emergent marsh and wet meadow.

Land use is dominated by agriculture, with 230 acres of pivot irrigation development since 1950. Some of the irrigation development took place in historic riparian areas; a total of 457 acres of riparian lands were converted for agricultural and other land uses since 1950. This equates to 15 percent of the entire 1950 riparian footprint. There are 97 acres of land under pivot irrigation within the Channel Migration Zone (CMZ) of the river, making these areas especially prone to river erosion.

About 38 percent of the historic 5-year floodplain has become isolated, primarily due to flow alterations.

Reach D10 was sampled as part of the avian study. A total of 57 species were identified in the reach, indicating relatively high bird species richness on the Yellowstone River. Four species identified are considered Potential Species of Concern (PSOC) by the Montana Natural Heritage Center: The Black and White Warbler, Dickcissel, Ovenbird, and Plumbeous Vireo. The Red-headed Woodpecker was also identified which is a Species of Concern. Similar to Reach D9 upstream, Reach D10 has seen an increase in the amount of forest area considered at low risk of cowbird parasitism. In 1950, there were 92 acres per valley mile of such forest, and by 2001, that number had increased to 112 acres per valley mile.

There are about 12 acres of mapped Russian olive in the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 2,810 cfs with human development, a reduction of 43 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270 cfs under regulated conditions, a reduction of 53 percent.

CEA-Related observations in Reach D10 include:

- Armor flanking and accelerated erosion behind

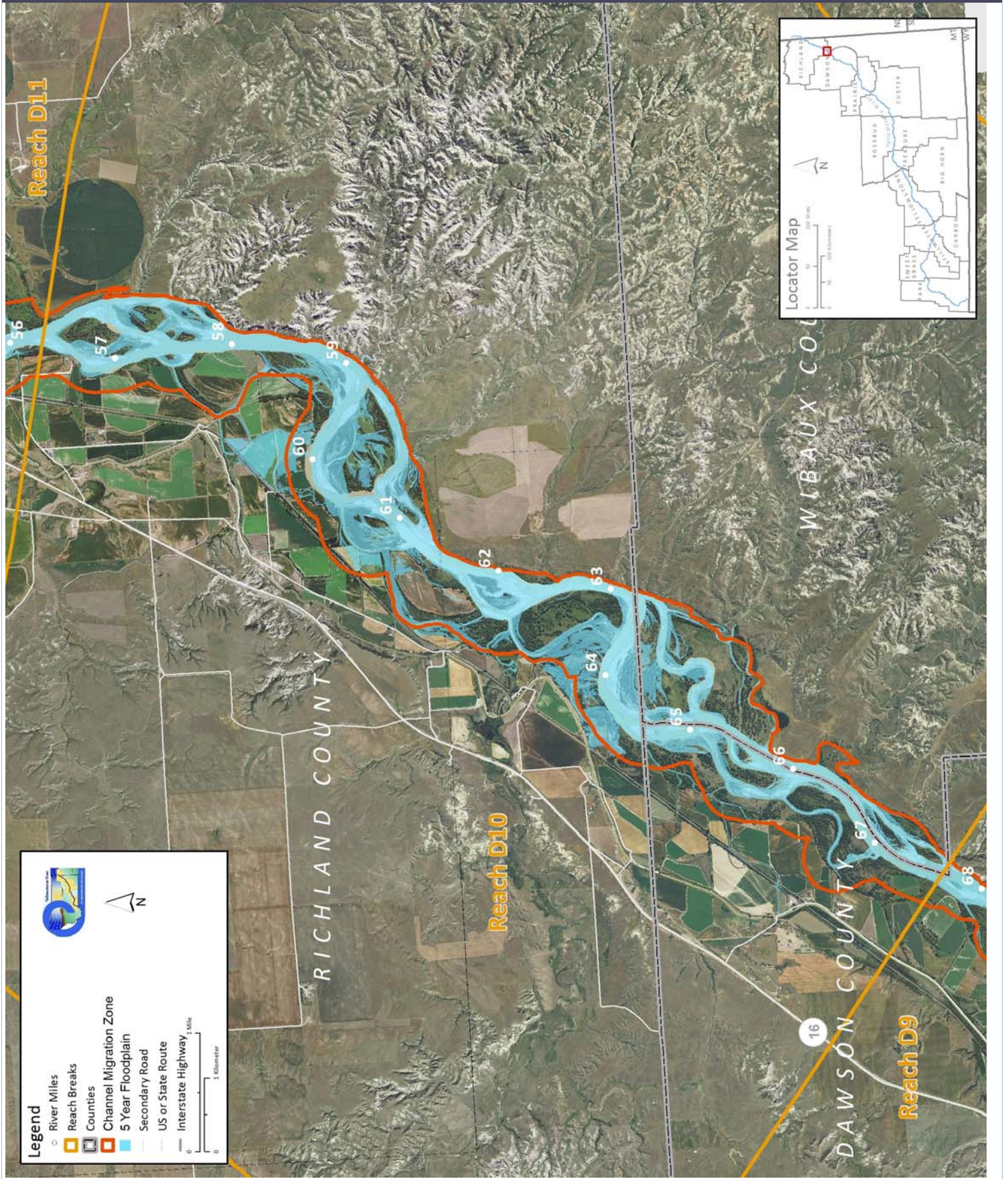
Recommended Practices (May include Yellowstone River Recommended Practices--YRRPs) for Reach D10 include:

- Removal of flanked armor at RM 60 and RM 64.2L
- Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	69,700	54,200	-22.2%			
100 Year (cfs)	144,000	130,000	-9.7%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	1,843.3	1,737.0	1,544.0	1,439.2	-404.1	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock RipRap	728	0.6%	-447			
Concrete Riprap	0	0.0%	-1,051			
Flow Deflectors	0	0.0%	0			
Total	728	0.6%	-1,498			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	0				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.		
Total Acres	361.0	174.9				
Acres/Year	13.9	7.0				
Acres/Year/Valley Mile	1.5	0.8	405.87 acres			
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)	36.4	1.8	-150.8	-112.6		
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	818.1	38%				
100 Year	650.9	13%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	52.1	1%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	4,586.0	5,330.0	Flood (Ac)	722.6	1,275.4	
Ag. Infrastructure (Ac)	44.1	52.6	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	5.7	Pivot (Ac)	0.0	229.5	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	25.7	25.7				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	455.3	2.2	457.5	15.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	21.6	2.3	278.7			
Emergent	136.8	14.7				
Scrub/Shrub	120.4	12.9				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	11.9	0.2%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	92.0	111.0	111.8	19.8		

CHANNEL MIGRATION ZONE MAP



County	Richland	Upstream River Mile	56.3
Classification	PCA: Partially confined anabranching	Downstream River Mile	49.9
General Location	Savage; Elk Island	Length	6.40 mi (10.30 km)

Narrative Summary

Reach D11 is 10.3 miles long, located near Savage and Elk Island. It is a Partially Confined Anabranching reach type (PCA) indicating distinct side channels around vegetated islands with some valley wall influences. The valley wall is comprised of Tertiary-age Fort Union Formation, and a distinct terrace surface borders the active stream corridor. Fort Union Formation rocks are exposed on a right bank bluff on the downstream end of the reach.

There is no mapped bank armor in Reach D11. Prior to 1950, however, about three miles of side channel had been blocked, mostly around Elk Island.

The most striking change in Reach D11 since 1950 is the encroachment of riparian vegetation onto old sand bars. Between 1950 and 2001, the size of the channel has dropped by 313 acres, and there has been 294 acres of riparian encroachment into old channel areas. Much of this encroachment converted open sand bars into forested islands. There has been a loss of over 100 acres of sand bar since 1950. This change has resulted in a conversion of almost 7 miles low flow channels around gravel bars to anabranching side channels around islands.

Reach D11 has had six ice jams-related floods reported since 1943. They all occurred in February or March, and several of them reported flood damages.

Approximately 36 percent of the historic 5-year floodplain has become isolated, largely due to flow alterations.

Land use in the reach is dominated by flood irrigation.

There are about 32 acres of Russian olive mapped in the reach.

Reach D11 was sampled as part of the avian study. A total of 61 bird species were identified in the reach, indicating high bird species richness. Five bird species identified by the Montana Natural Heritage Program as Potential Species of Concern (PSOC) were found, the Black and white Warbler, Chimney Swift, Dickcissel, Ovenbird, and Plumbeous Vireo. The Red-headed woodpecker was also observed, which has been identified as a Species of Concern (SOC). Reach D11 has seen an increase in the amount of forest area considered at low risk of cowbird parasitism. In 1950, there were 216.4 acres per valley mile of such forest, and by 2001, that number had increased to 247.2 acres per valley mile.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,370 cfs to 2,220 cfs with human development, a reduction of 50 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,540 cfs under unregulated conditions to 2,750 cfs under regulated conditions, a reduction of 59 percent. Fall and winter low flows are about 3,500 cfs; these discharges are about 60 percent to 80 percent higher than they were prior to development.

CEA-Related observations in Reach D11 include:

- Reduction in 5-year floodplain footprint with flow alterations
- Increased fall and winter low flows with development
- Reduced summer low flows with development
- Reduced channel forming discharge causing channel contraction
- Extensive riparian encroachment with flow alterations
- Conversion of open sand bars to forested islands

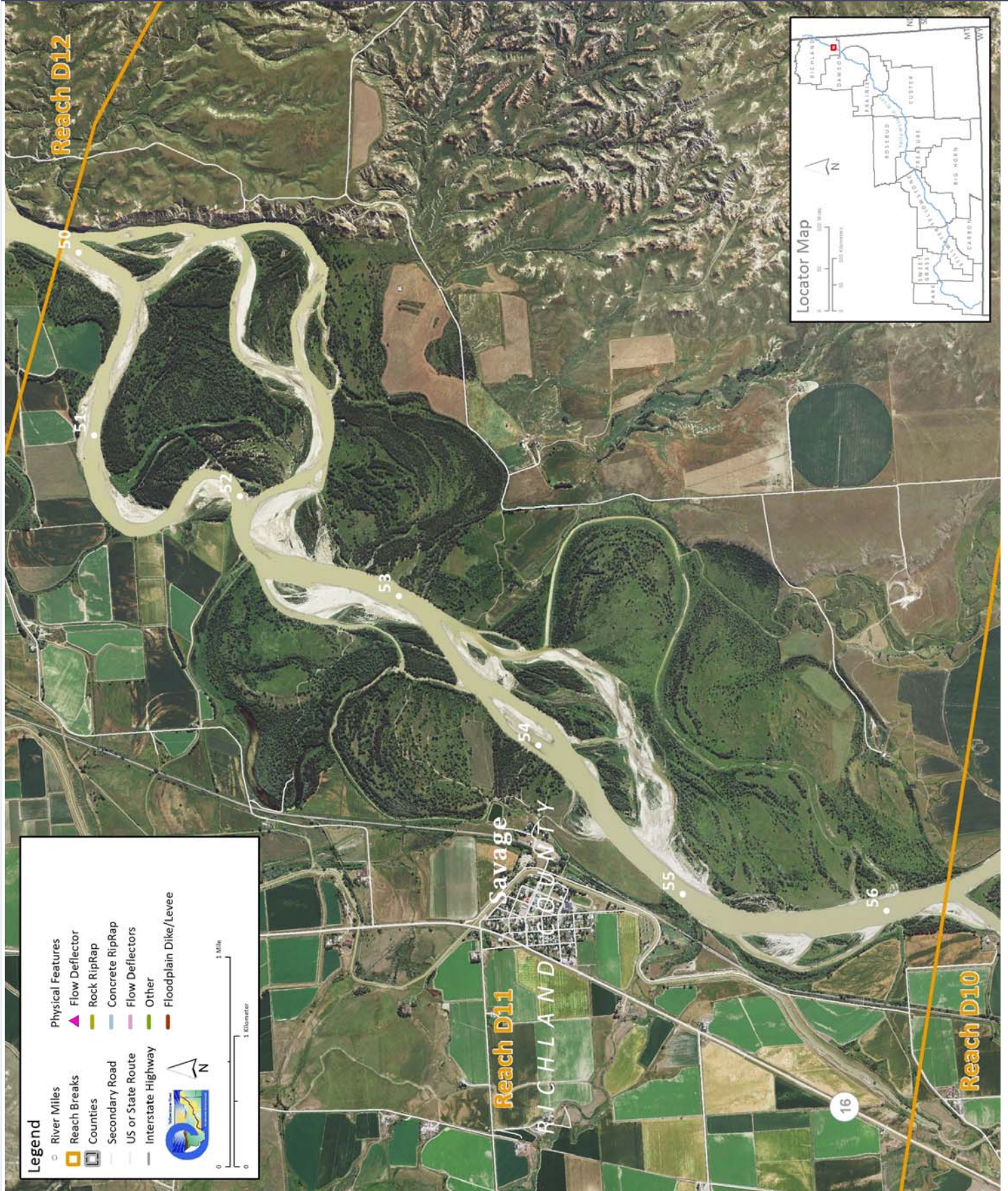
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D11 include:

- Side channel reactivation RM 53L
- Russian olive removal

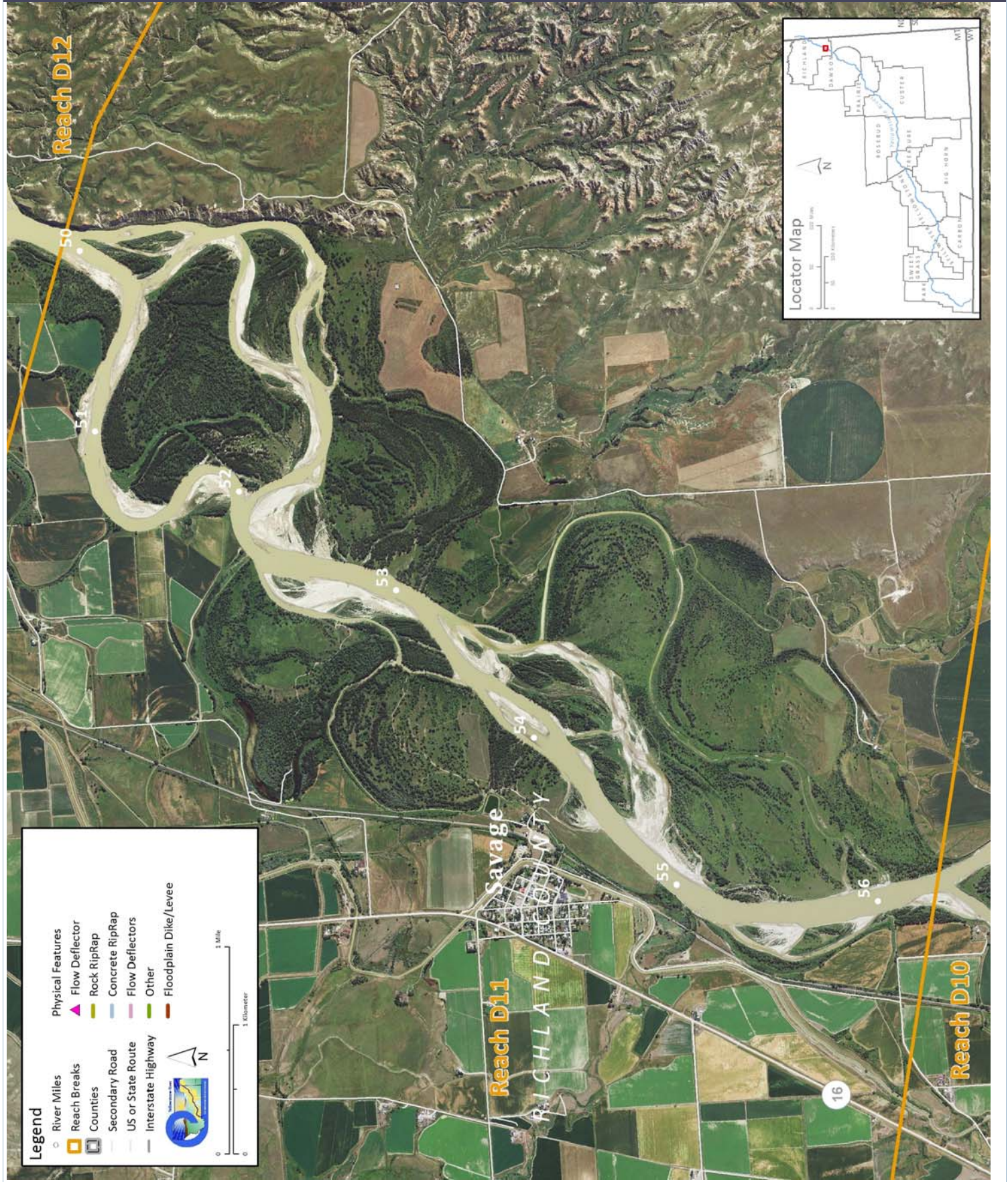
The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	69,800	54,200	-22.3%			
100 Year (cfs)	144,000	131,000	-9.0%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	1,284.2	1,135.9	1,095.2	971.7	-312.5	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock RipRap	0	0.0%	0			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	0	0.0%	0			
Total	0	0.0%	0			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	15,601	0				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)		The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.	
Total Acres	387.4	178.3	294.92 acres			
Acres/Year	14.9	7.1				
Acres/Year/Valley Mile	2.8	1.3				
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)	-6.2	11.8	-108.9	-103.3		
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	861.6	36%				
100 Year	104.0	2%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	62.2	1%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	3,337.6	4,457.3	Flood (Ac)	610.2	658.4	
Ag. Infrastructure (Ac)	39.9	49.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	1.6	0.5	Pivot (Ac)	0.0	11.2	
Urban (Ac)	13.0	35.0				
Transportation (Ac)	31.4	39.1				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	46.2	0.2	46.3	2.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	24.4	4.5	188.2			
Emergent	119.1	22.1				
Scrub/Shrub	44.7	8.3				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	31.8	1.1%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	216.4	252.2	247.2	30.8		

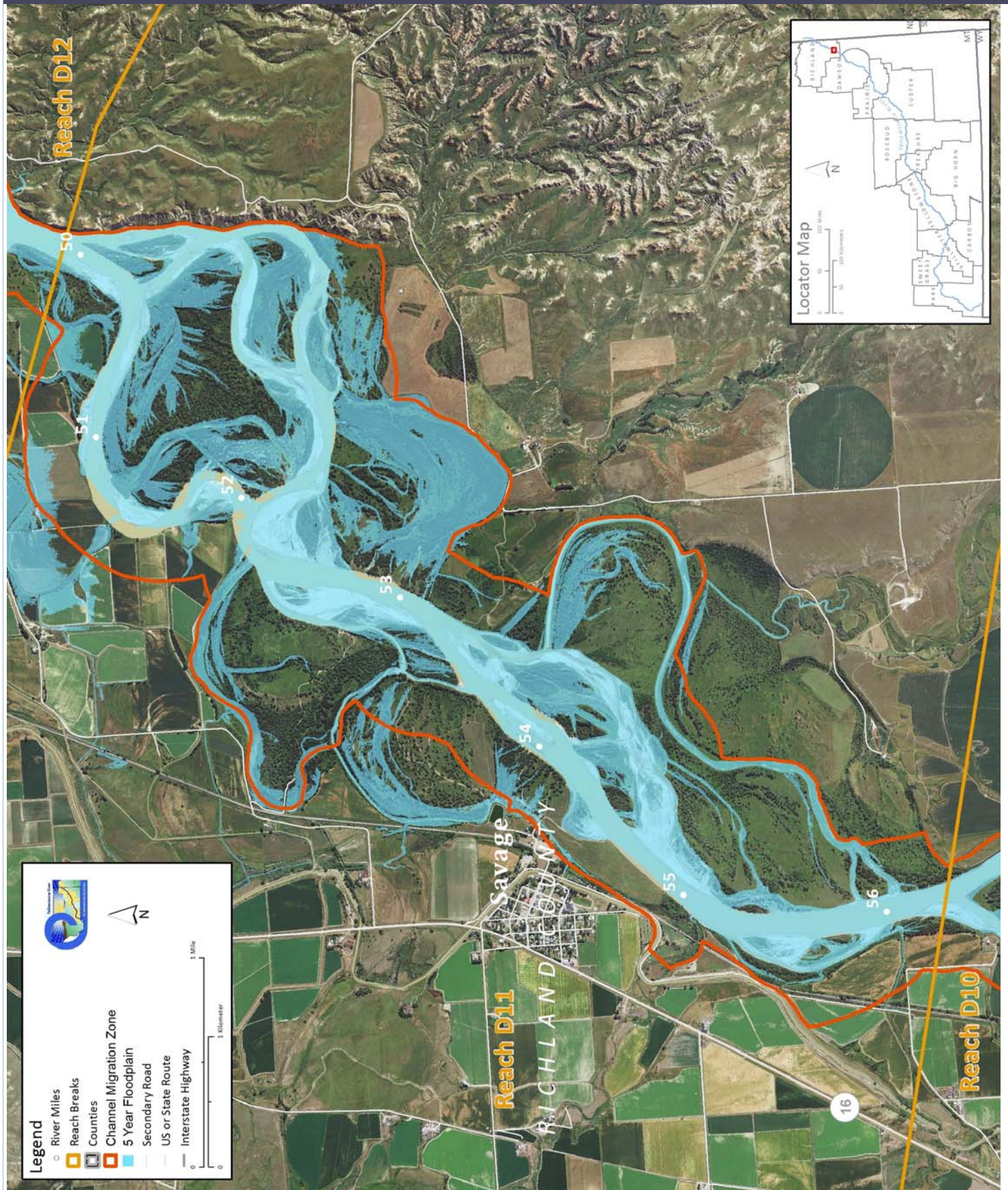
PHYSICAL FEATURES MAP (2011)



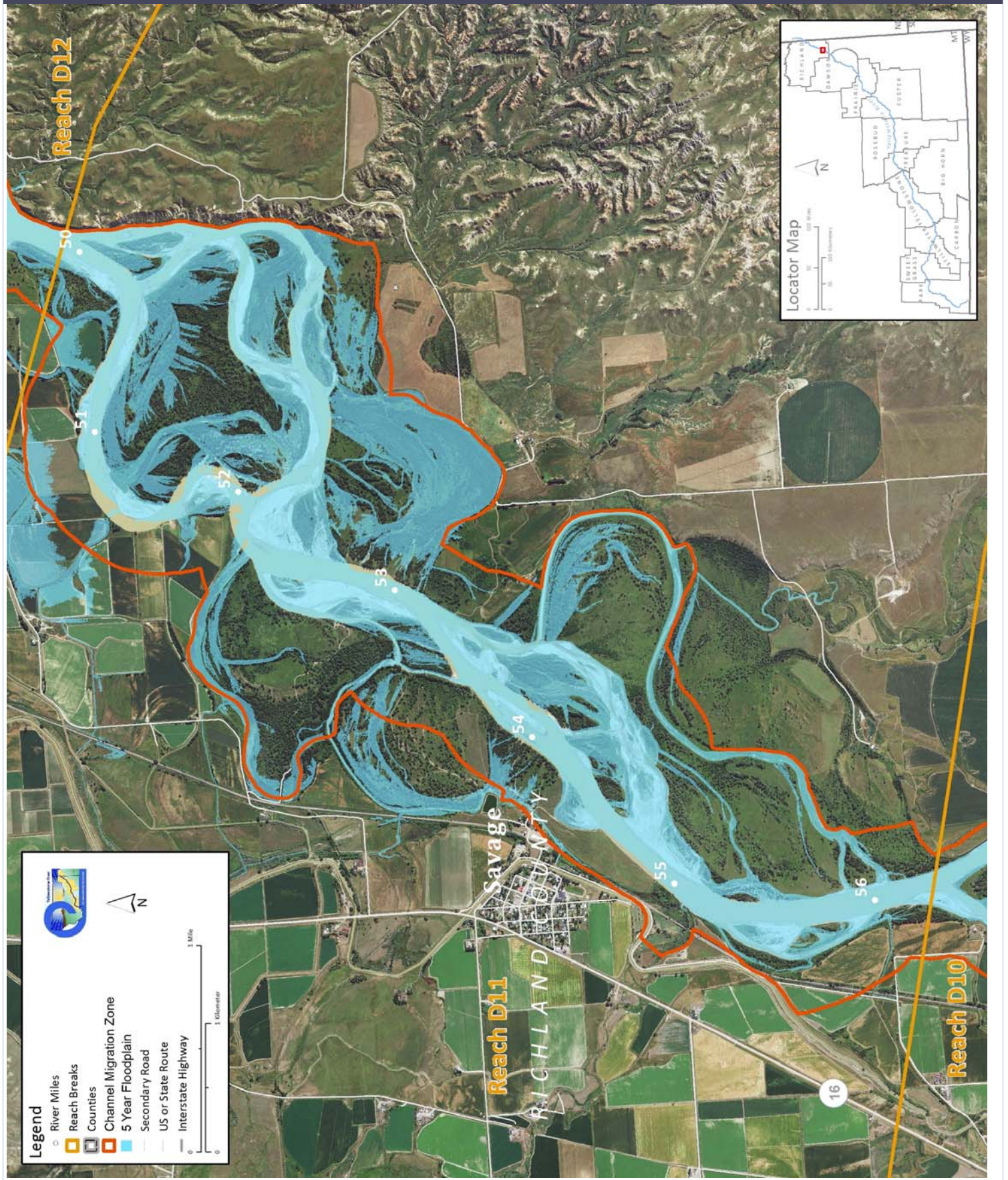
PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



CHANNEL MIGRATION ZONE MAP



County	Richland	Upstream River Mile	49.9
Classification	PCA: Partially confined anabranching	Downstream River Mile	36.3
General Location	Seven Sisters	Length	13.60 mi (21.89 km)

Narrative Summary

Reach D12 is located in Richland County at Seven Sisters. The Seven Sisters Fishing Access Site is located in the lower portion of the reach. The reach is a 13.6 mile long Partially Confined Anabranching reach type, indicating some influence of the valley wall along with extensive forested islands. This reach supports over 20 miles of side channels, and islands that are miles long and over ½ mile wide.

There are almost 7,000 feet of bank armor in the reach, and about one third of that was built since 2001. Most of the armor (3,250 feet) is rock riprap, and there are about 2,000 feet each of concrete riprap and flow deflectors. A total of 5 percent of the bank is armored, which is a relatively low concentration of bank armor for the Yellowstone River. All of the armor is protecting agricultural land, most of it against a flood irrigated field on the left bank in the lower end of the reach at RM 37.

Since 1950, a side channel that is almost three miles long was blocked at RM 45.3L. There have also been some gains in side channel length in the reach, such that the net change in length is a loss of approximately one mile. As of 2001, this reach supported almost 21 miles of anabranching channel.

Land use is dominated by agriculture, with 583 acres of pivot irrigation development since 1950. Physical features such as bank armor, dikes, and levees have isolated 3 percent of the Channel Migration Zone in Reach D12, and as of 2011 there were 224 acres of land in the CMZ under pivot irrigation, and 900 acres under flood.

Reach D12 shows, like most other reaches below the Bighorn River, a shrinking channel with reduced rates of erosion and floodplain turnover. For example, the bankfull channel area in the reach dropped by 480 acres since 1950, and there was almost 600 acres of riparian encroachment into old channel areas. Floodplain turnover rates have dropped from 2.1 acres/valley mile/year from 1950-1976 to 1.3 acres/valley mile/year from 1976-2001. This equates to 330 fewer acres of floodplain turnover since 1976. There has also been a net loss of 159 acres of open bar area as the channel has become smaller and more forested. On the floodplain, riparian acreage has decreased; about 350 acres or 9 percent of the total riparian area was cleared for irrigation since 1950.

There are 75 acres of Russian olive in the reach.

The 100-year floodplain has been isolated in this reach, but compared to other reaches the isolation has been fairly minor. About 300 acres of 100-year floodplain has been isolated by human development, which is 5 percent of the total 100-year floodplain. Although only about 5 percent of the 100-year floodplain has been isolated, the impact of flow alterations on the smaller 5-year floodplain has been much more severe; 42 percent of the historic 5-year floodplain is no longer inundated at that frequency. The isolation of the historic 5-year floodplain, which is due primarily to flow alterations, has been associated with increased development in these areas; currently there are about 300 acres of flood irrigated land and within the historic 5-year floodplain footprint.

There is an animal feeding facility on the right bank at RM 46.8.

Reach D12 was sampled as part of the fisheries study. A total of 37 fish species were sampled in the reach. Three species collected in the reach have been identified by the Montana Natural Heritage Program as Species of Concern (SOC): Pallid Sturgeon, Sauger, and Sturgeon Chub.

Reach D12 was also sampled as part of the avian study. A total of 59 bird species were identified in the reach. All five bird species identified by the Montana Natural Heritage Program as Potential Species of Concern (PSOC) on the Yellowstone River were also found, the Black and White Warbler, the Chimney Swift, the Dickcissel, the Ovenbird, and the Plumbeous Vireo. Similarly, all three bird species identified as Species of Concern (SOC) were identified: the Black-billed Cuckoo, Bobolink, and Red-headed Woodpecker. In contrast to most other reaches, Reach D12 has seen an increase in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 103 acres per valley mile of such forest, and that number increased to 115 acres per valley mile by 2001.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,310 cfs to 2,410 cfs with human development, a reduction of 50 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,470 cfs under unregulated conditions to 2,680 cfs under regulated conditions, a reduction of 59 percent.

CEA-Related observations in Reach D12 include:

- Increase in area at low risk of cowbird parasitism with riparian encroachment

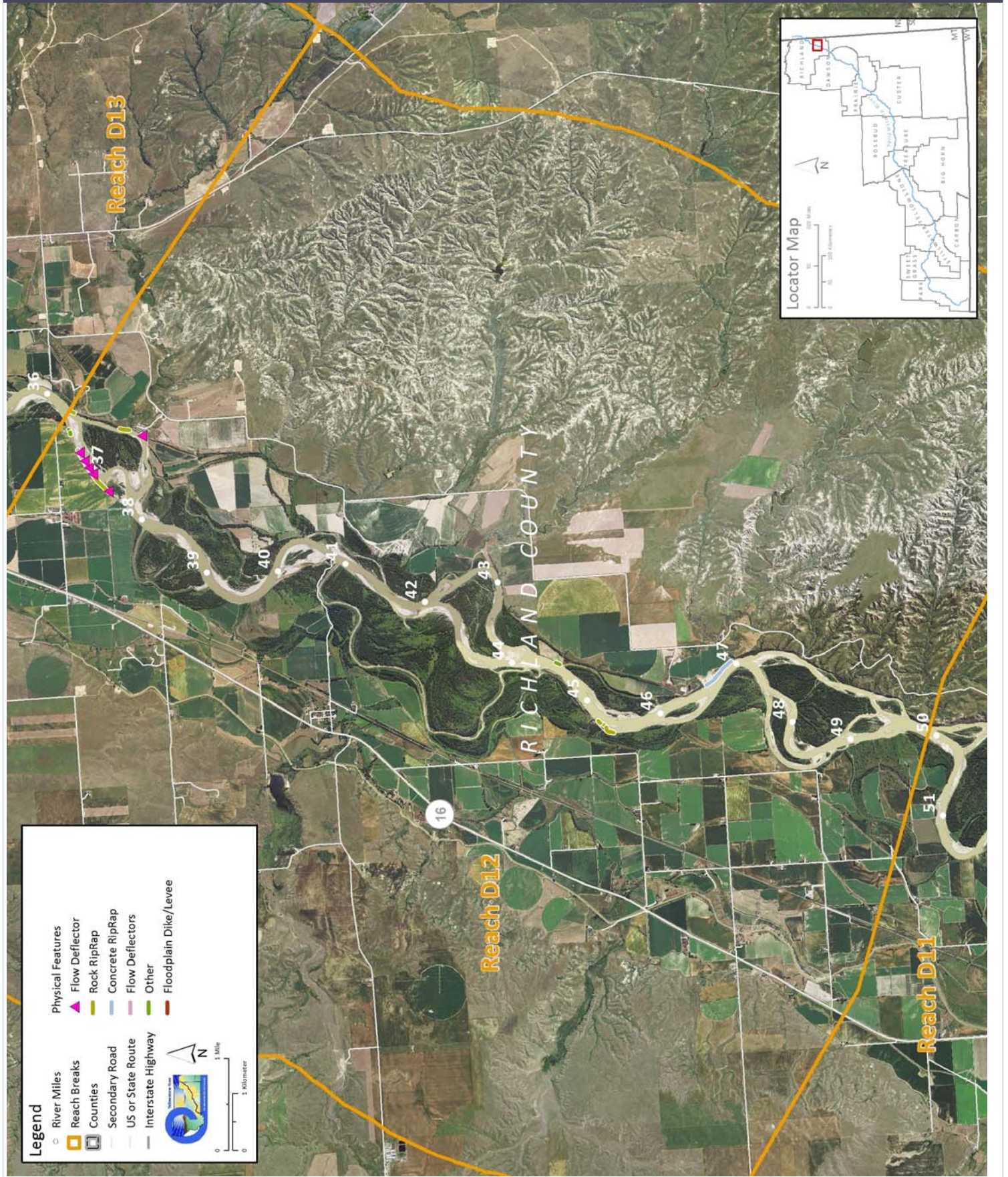
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D12 include:

- Nutrient management at animal handling facility at RM 46.8R
- Side channel reactivation at RM 45.3R
- Russian olive removal

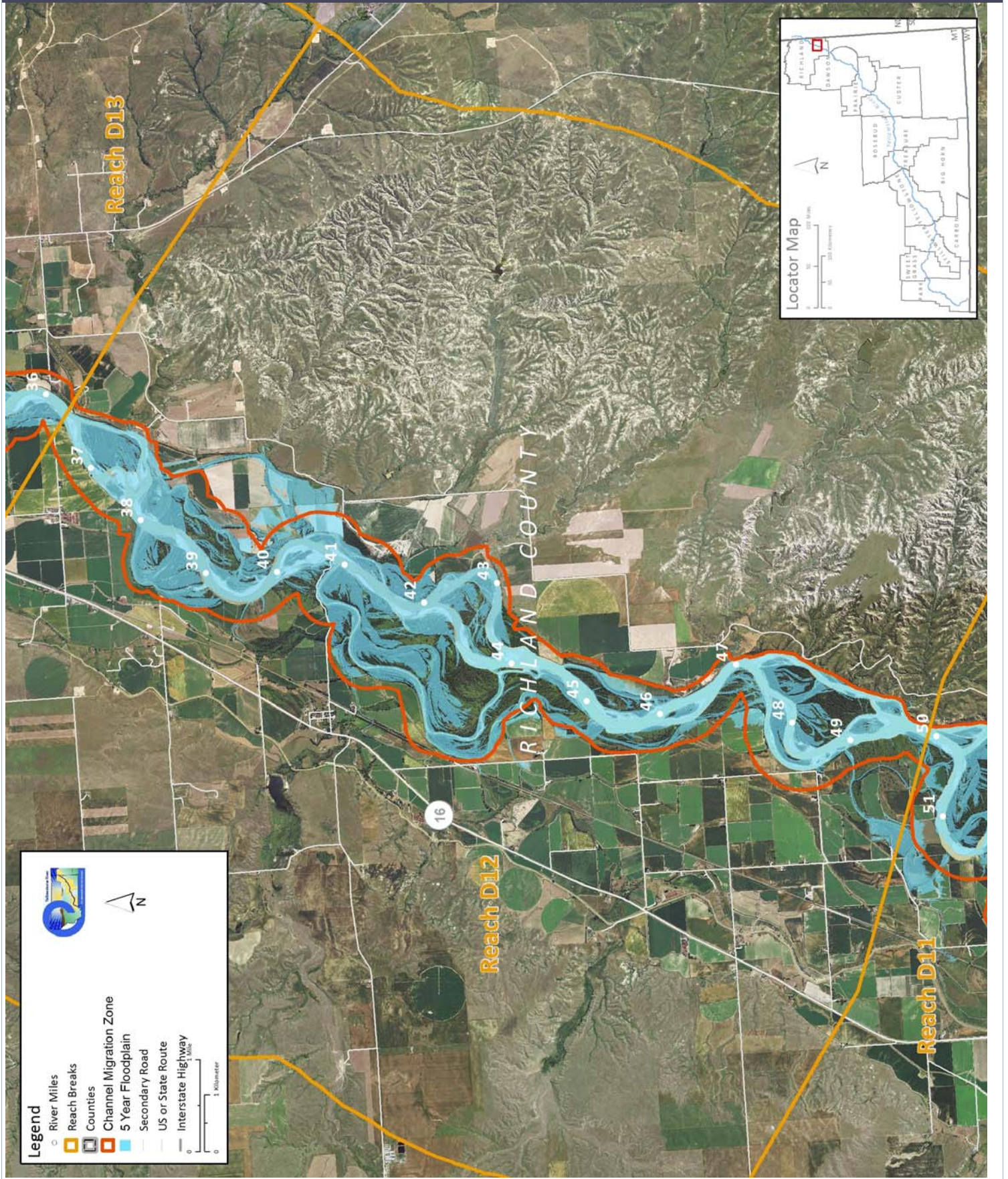
The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	69,800	54,300	-22.2%			
100 Year (cfs)	144,000	132,000	-8.3%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	2,239.4	1,957.5	1,919.3	1,754.7	-484.8	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock RipRap	3,251	2.3%	2,655			
Concrete Riprap	1,945	1.4%	0			
Flow Deflectors	1,801	1.3%	118			
Total	6,997	4.9%	2,773			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	14,624				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)		The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.	
Total Acres	596.0	338.4	597.01 acres			
Acres/Year	22.9	13.5				
Acres/Year/Valley Mile	2.1	1.3				
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)	-205.7	27.4	19.8	-158.5		
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	2,113.3	42%				
100 Year	344.5	5%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	197.9	3%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	5,885.9	6,086.8	Flood (Ac)	2,107.6	2,364.7	
Ag. Infrastructure (Ac)	59.8	154.9	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	1.7	Pivot (Ac)	0.0	582.7	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	43.7	58.6				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	353.9	0.8	354.7	9.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	28.0	2.6	285.0			
Emergent	117.2	10.9				
Scrub/Shrub	139.8	13.0				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	74.8	1.4%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	103.2	104.8	115.5	12.3		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



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

Narrative Summary

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

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

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

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

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

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

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

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

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

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

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

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 134,000 cfs, which 6 percent lower than it was pre-development (143,000 cfs). The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,190 cfs to 2,000 cfs with human development, a reduction of 52 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,340 cfs under unregulated conditions to 2,550 cfs under regulated conditions, a reduction of 60 percent.

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

CEA-Related observations in Reach D13 include:

- Conversion of river pattern from braided to anabranching due to riparian encroachment onto sand bars since 1950.
- Passive side channel abandonment due to hydrologic alterations and potentially downcutting due to CMZ confinement.

- 100-year floodplain isolation due to low agricultural field dikes.
- 100-year floodplain isolation due to transportation infrastructure.
- Channel Migration Zone (CMZ) restrictions that significantly confine the river corridor, potentially causing downcutting. This may be an important Increase in area at low risk of cowbird parasitism with riparian encroachment

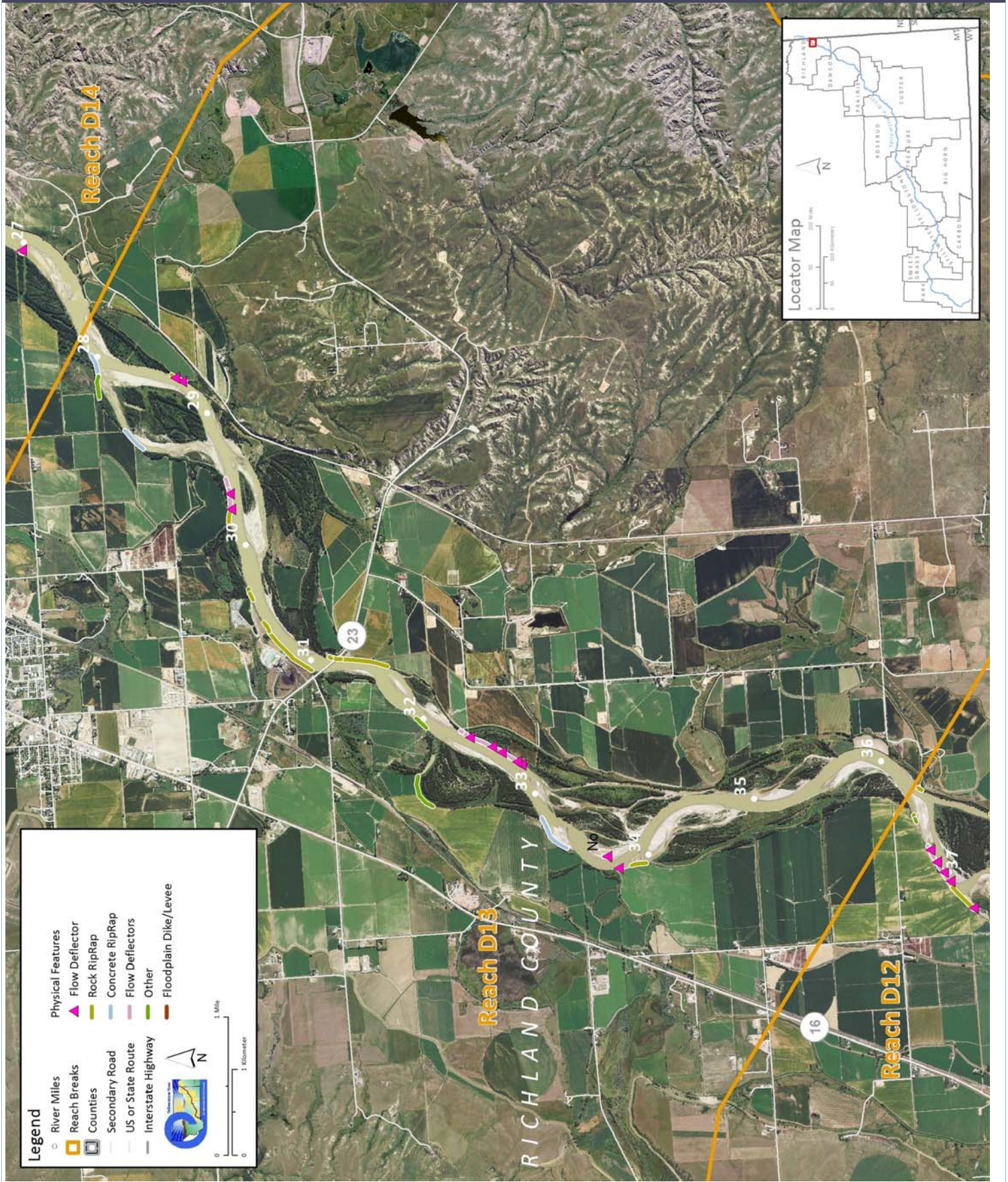
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D13 include:

- Nutrient Management at Animal Handling Facility at RM 29L
- Pipeline Crossing PRACTICE RM 32.1
- Old car body removal RM 32.2L
- Russian olive removal

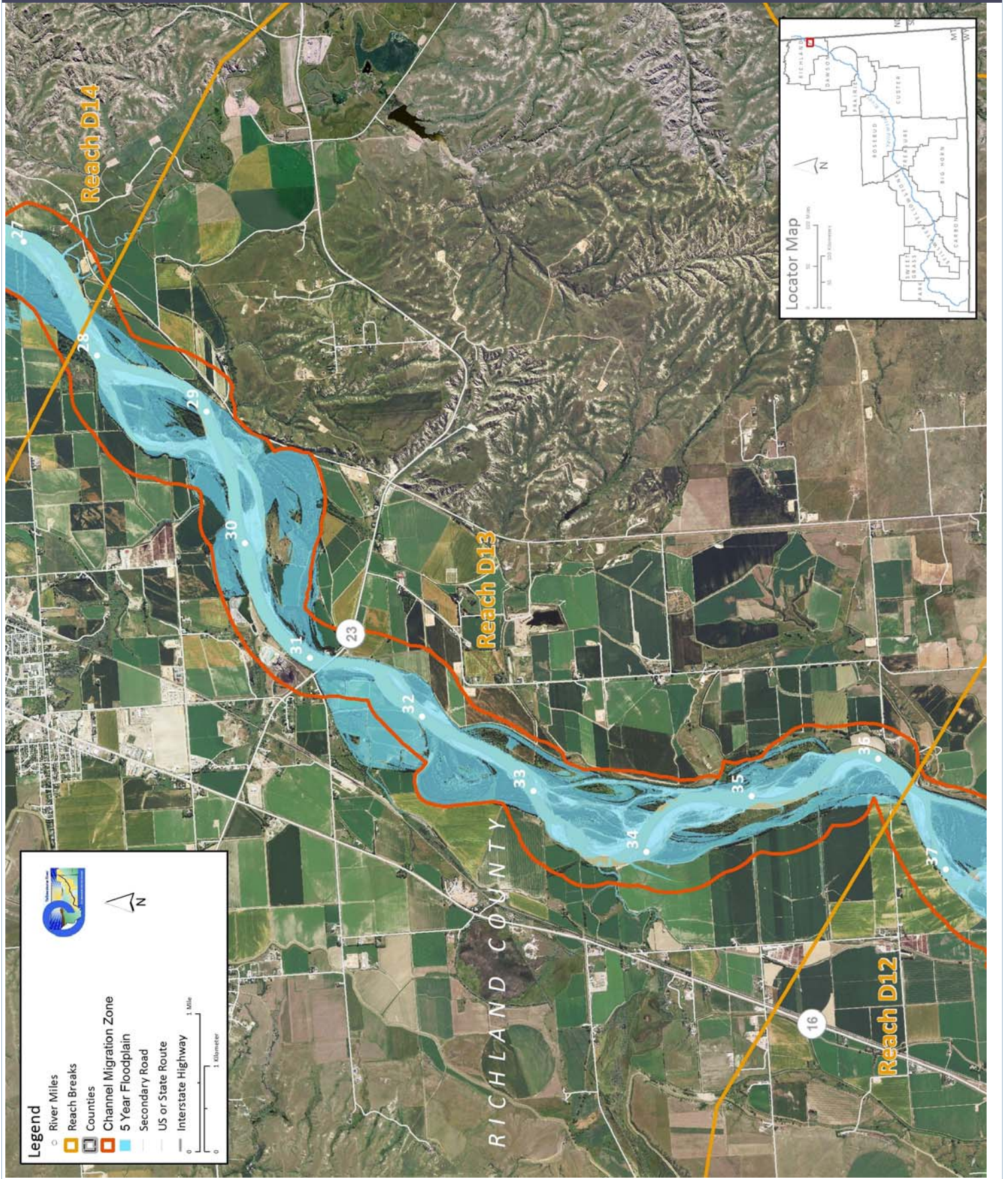
The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	69,900	54,300	-22.3%			
100 Year (cfs)	143,000	134,000	-6.3%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	1,163.3	1,160.8	991.3	942.8	-220.5	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock RipRap	6,386	7.1%	2,410			
Concrete Riprap	3,329	3.7%	0			
Flow Deflectors	4,179	4.6%	143			
Total	13,894	15.4%	2,553			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	0				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)		The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.	
Total Acres	371.6	151.8	291.7 acres			
Acres/Year	14.3	6.1				
Acres/Year/Valley Mile	1.9	0.8				
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)	-58.3	-10.5	23.6	-45.3		
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	466.6	26%				
100 Year	766.0	18%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	639.4	18%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	5,052.4	4,997.8	Flood (Ac)	3,209.5	2,324.4	
Ag. Infrastructure (Ac)	73.2	210.1	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	5.1	216.3	Pivot (Ac)	0.0	893.5	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	53.4	56.8				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	424.0	19.4	443.4	27.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	65.0	8.5	252.0			
Emergent	126.5	16.6				
Scrub/Shrub	60.6	7.9				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	44.7	3.2%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	27.6	23.0	18.1	-9.4		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Richland	Upstream River Mile	27.8
Classification	PCM/I: Partly confined meandering/islands	Downstream River Mile	13.5
General Location	To Fairview	Length	14.30 mi (23.01 km)

Narrative Summary

Reach D14 is located upstream of Fairview. The reach is a 14.3 mile long Partially Confined Meandering with Islands (PCM/I), indicating some valley wall influence, and a meandering main thread with cutoff channels through meander cores forming persistent forested islands.

There is just over a mile of bank armor in the reach, including 3,900 feet of rock riprap and 2,500 feet of flow deflectors. Most of the rock riprap was constructed between 2001 and 2011 (2,300 feet).

Prior to 1950, 3,600 feet of side channel was blocked in the reach at RM 23L.

Similar to many reaches in the Lower Yellowstone Valley, the river channel in Reach D14 has gotten smaller since 1950. The channel contracted by about 309 acres in this reach since 1950, and about 460 acres of riparian vegetation has encroached into old channel areas. This pattern has been consistent in the lower river, and relates primarily to a reduction in flows due to human development. Floodplain turnover rates have dropped from 14.4 acres per year pre-1976 to 6.1 acres per year post-1976. There has also been a major loss of open bar habitat area in the channel; between 1950 and 2001, there was a loss of 510 acres of mid-channel bar area, which can be important habitat to certain species such as least tern.

Land use is predominantly agricultural, with just over a thousand acres of pivot irrigation development since 1950. Development in the reach included conversion of 1,063 acres of 1950s riparian area to other land uses (mostly irrigated agriculture); that represented 36 percent of the entire 1950s riparian footprint. There are 93 acres of pivot irrigated land and 113 acres of urban/exurban development within the Channel Migration Zone (CMZ), making these areas especially susceptible to river erosion. At RM 26L there are three drill pads within the CMZ.

Several dump sites have been mapped on the banks: RM 25R, RM 24.3L, RM 17L, RM 15.8L, and RM 15.8R.

There is one pipeline crossing in Reach D14 at RM 27. It is an 8-inch crude oil pipeline that has been Horizontally Directionally Drilled.

About 41 percent of the historic 5-year floodplain has become isolated, primarily due to flow alterations.

One ice jam was reported in the reach. It was a break-up flood event on March 17, 2011.

There are about 36 acres of mapped Russian olive in the reach.

Reach D14 was sampled as part of the avian study. A total of 30 bird species were identified in the reach. Two bird species identified by the Montana Natural Heritage Program as Potential Species of Concern (PSOC) on the Yellowstone River were found, the Ovenbird and the Plumbeous Vireo. Reach D14 has seen a decrease in the forested area that is at low risk of cowbird parasitism since 1950. At that time, there were 25.6 acres per valley mile of such forest, and that number dropped to 19.6 acres per valley mile by 2001.

CEA-Related observations in Reach D14 include:

- Flow alteration impacts on floodplain access

Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D14 include:

- Solid waste removal at dump sites at RM 25R, RM 24.3L, RM 17L, RM 15.8L, and RM 15.8R.
- Side channel reactivation at RM 23L
- Pipeline crossing Management at RM 27.
- Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	69,900	54,300	-22.3%			
100 Year (cfs)	143,000	134,000	-6.3%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	2,206.2	2,091.0	1,933.5	1,896.8	-309.4	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock RipRap	3,906	2.6%	2,293			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	2,505	1.7%	273			
Total	6,411	4.2%	2,566			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	3,595	0				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)		The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.	
Total Acres	375.2	152.5	459.11 acres			
Acres/Year	14.4	6.1				
Acres/Year/Valley Mile	1.1	0.5				
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)	9.8	94.4	-510.3	-406.1		
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	1,046.3	41%				
100 Year	1,450.6	17%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	160.9	3%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	8,402.4	8,078.6	Flood (Ac)	3,832.7	3,990.2	
Ag. Infrastructure (Ac)	49.0	153.3	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	161.4	Pivot (Ac)	0.0	1,003.3	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	65.0	73.2				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	940.2	123.1	1,063.3	36.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	8.1	0.6	289.5			
Emergent	137.1	10.9				
Scrub/Shrub	144.3	11.5				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	35.7	0.8%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	25.6	38.1	19.6	-5.9		

CHANNEL MIGRATION ZONE MAP

