Reach #5 - Lotic Checklist

Name of Riparian-Wetland Area:	**Missouri River**		
Date:	**7/9/2010** **Revisited 9/8/2010**	Segment/Reach ID:	**Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island)**
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Assessment Procedures:	During February 2-4, 2010, interdisciplinary (ID) Team members met with National Riparian Service Team staff, former BLM National Operations Center surface water specialist, USGS scientist, and University of Montana scientist to gain a common understanding of what is already known and review existing information. Preliminary reach breaks were agreed upon, potential and capability descriptions were discussed, and written descriptions were developed. Predetermined stops were chosen for each reach based upon sites that were representative of larger reaches of river based upon geomorphic and vegetative characteristics, unique or critical areas, grazing allotments, and reach breaks. BLM staff has been monitoring sites on the Upper Missouri since 1990 using the Upper Missouri National Wild and Scenic River (UMNWSR) monitoring form. Depending on site location, sites are monitored on a one, three, or five year cycle. In some instances over 20 years of photographs and documentation exist and this information was heavily used in stop location selection because of the reference material available. Interested parties, grazing permittees, and stakeholders were invited to participate every day of the assessment in July. Each day began with a review of the potential descriptions for the reach. The entire reach was examined by the ID Team by boat with stops at the predetermined locations. At each stop, the inundating discharges, flood frequency curves, and zone locations were reviewed as necessary. Photograph and GPS documentation of the site was completed, and soil pits were dug and documented. Vegetation lists were completed for each zone. At the completion of each stop, the ID Team discussed their individual notes and observations. Once each reach was looked at from top to bottom, the checklist was completed The ID Team stopped at five locations on public land, two on the north side and three along the south side, which the group determined to be representative of the riparian-wetland plant communities occurring within Reach #5. Species diversity information (plant list) was collected at each stop for Zones 1 and 2. Common names for plants will be used throughout this document. For scientific names refer to the plant lists or Appendix A. The following 17 questions were answered using the methodology described in Technical Reference 1737-15.		

Definitions:
Zone 1 - from the scour line (the lower limit of sod-forming or perennial vegetation on depositional banks) to bankfull discharge (the stream discharge generally considered to be the single discharge that is most effective for moving sediment, forming or removing bars, and forming or changing bends and meanders, all of which result in the average morphological characteristics of channels). Bankfull on this reach of the Missouri River roughly coincides with the 2-year return interval discharge, approximately 25,000 cubic feet per second (cfs) (flood frequency analysis based on period of record at Landusky gage post completion of Tiber Dam in 1956). Total period of record is 1934-2010.

Zone 2 - from bankfull to approximately the stage associated with 70,000 cfs, which is about a 10-year return interval pre Tiber Dam or a 20-year return interval post Tiber Dam (flood frequency analysis based on period of record pre and post completion of Tiber Dam in 1956 at Landusky gage (total period of record is 1934-2010)). This intermediate zone is between the frequently wetted area along the river and upland areas found on older, more elevated river terraces. This zone is dominated by plants that are equally likely to occur in wetlands or non-wetlands.

Zone 3 – from approximately the stage associated with 70,000 cfs, which is about a 10-year return interval pre Tiber Dam or a 20-year return interval post Tiber Dam (flood frequency analysis based on period of record pre and post completion of Tiber Dam in 1956 at Landusky gage (total period of record is 1934-2010)) to the uplands. This zone is very infrequently flooded but may contain relic riparian species, such as mature cottonwoods, that were established at lower elevations before the surface was moved higher through sediment accretion.

It is important to note that because the function of the river is dictated largely by attributes and process in Zones 1 and 2, the assessment was focused on conditions observed in these zones.

Wetland Indicator Status Categories:
OBL (Obligate Wetland) - Occurs almost always under natural conditions in wetlands.
FACW (Facultative Wetland) - Usually occur in wetland but occasionally found in non-wetlands.
FAC (Facultative) - Equally likely to occur in wetlands or non-wetlands.
FACU (Facultative Upland) - Usually occur in non-wetlands but occasionally found on wetlands.
UPL (Obligate Upland) - Occur almost always under natural conditions in non-wetlands.

The vegetation section of the PFC checklist focuses on the age class, diversity and amount of *"riparian-wetland"* vegetation present along a reach within Zone 1 and 2. The term "*riparian-wetland"* refers primarily to facultative wetland and obligate wetland plants or those that usually or almost always occur in wetland areas. It is important to note that even though plains cottonwood and green ash are considered facultative plants, meaning they are equally likely to occur in wetland or non-wetland areas, for this assessment they were considered together with other riparian-wetland vegetation and used by the ID Team for completing the PFC checklist. Both plants, and especially plains cottonwood, were found within Zone 1 and 2 and are important in determining the processes and functionality of the Upper Missouri River.

Plant Composition:
Dominant - this term was used to describe plants having a canopy cover greater than 25% or when only a single plant occurred within an assessment area. If the canopy cover of two or more plants made up most of the assessment area, and they were of about equal value, each was noted as a dominant plant.

Vegetation Stability Class Rating:
1 to 3 = Low; 4 to 6 = Medium; 7 to 10 = High
(taken from Appendix H, Monitoring Stream Channels and Riparian Vegetation-Multiple Indicators, Interagency Technical Bulletin, Version 5.0, April 2008)

Soils
Redoximorphic (redox) features – include gray layers and gray mottles, both of which occur when iron compounds are reduced by soil microbes in anaerobic soils. Iron, in its reduced form, is mobile and can be carried in the ground-water solution. When the iron and its brown color are thus removed, the soils show the gray color of their sand particles. The anaerobic, reduced zones can be recognized by their gray, blue, or blue-gray color. The mobilized iron tends to collect in

aerobic zones within the soil where it oxidizes, or combines with additional oxygen, to form splotches of bright red-orange color called mottles. The mottles are most prevalent in the zones of fluctuating water and help mark the seasonal high water table (BLM Technical Reference 17317-19 – Riparian-Wetland Soils).

POTENTIAL: Prior to the Pleistocene, the Missouri River flowed northeast into the Hudson Bay (Wayne et al., 1991). Continental glaciation resulted in the river being pushed southward, thereby draining into the Mississippi River. River Miles 102 to 119 are located in the relatively young postglacial channel, which according to Scott et al. (1997), exhibits low sinuosity and is constrained by a narrow valley. See Figure 1 – Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island).

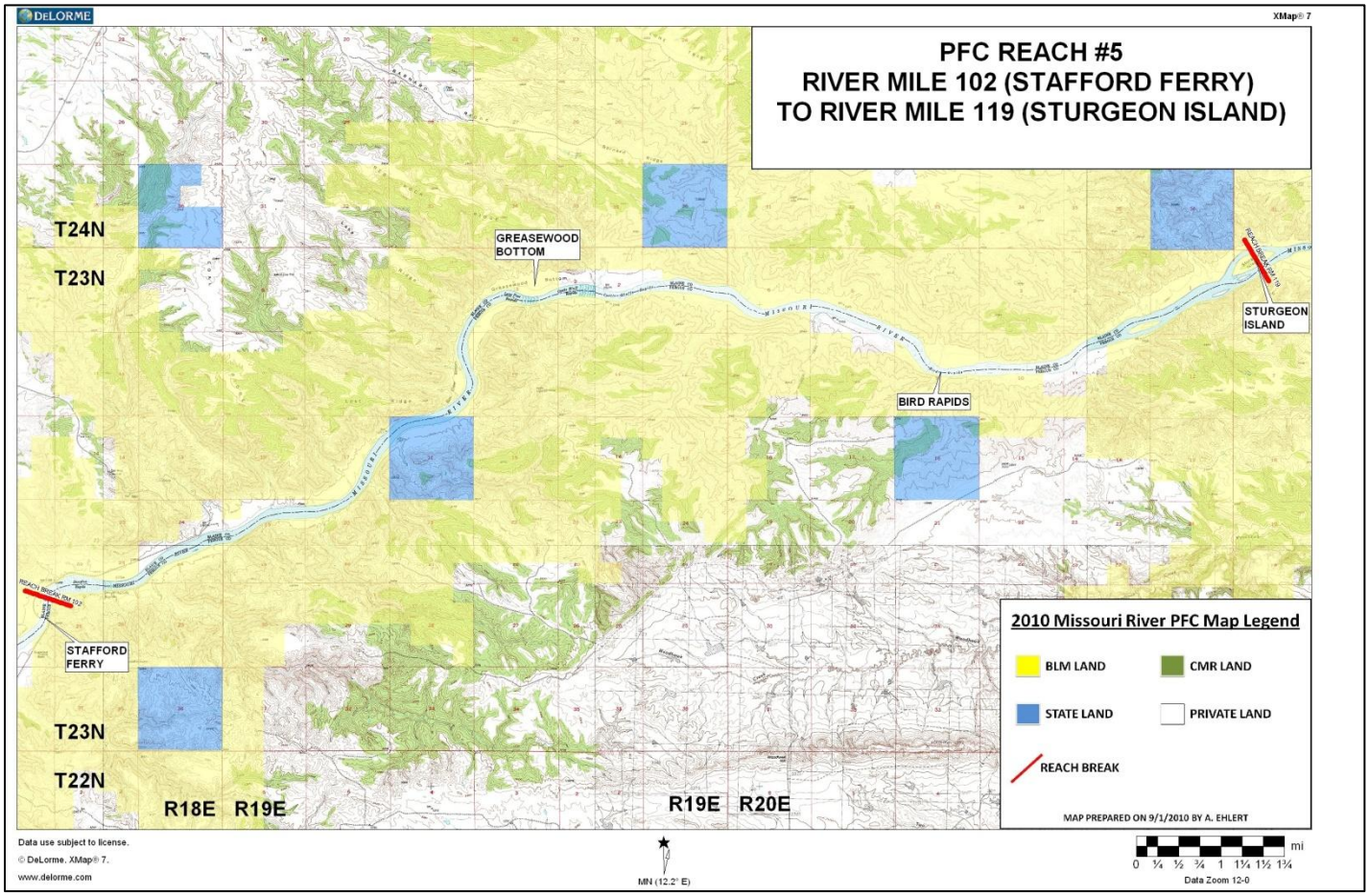


Figure 1 – Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island)

Scott and Auble (2002) describe the postglacial Missouri River channel between Virgelle and Landusky as a series of entrenched meanders, constrained by exposures of sandstone and shale badlands. At potential, the channel would be broadly characterized by a Rosgen F-type channel (Rosgen, 1996). Rosgen F channels are often found on entrenched landforms in highly weathered material (Rosgen, 1996). Furthermore, comparisons of detailed maps from the 1890s from the Missouri River Commission indicate that little channel migration has occurred in the past 100 years (Scott et al., 1997). The channel has also been vertically stable during that period. Scott et al. (1997) plotted stage at peak discharge for the Fort Benton gage prior to and after the construction of Canyon Ferry Dam. There was no downward shift in the stage-discharge relation. The period of record at the Fort Benton gage goes back to 1890 and Canyon Ferry Dam was completed in 1953. The stage-peak discharge relation has also been relatively stable through the period of record at the Virgelle (1935-2010) and Landusky (1934-2010) gages. However, the stage-peak discharge relation at Landusky has been less consistent than Virgelle or Fort Benton with more active scour and fills processes. The Landusky gage is located in a more dynamic valley bottom with fine-grained substrate, so this would be expected. The point is that none of the three stream gages located on the UMNWSR indicate recent downcutting. Even though a process of channel narrowing may have been initiated since the 1800s (Scott and Auble, 2002), narrowing would not have been large enough

to change the classification of the channel.

Rosgen F-type channels can be described as entrenched, meandering, riffle/pool channel on low gradients with high width/depth ratios (Rosgen, 1996). Entrenchment ratios are typically less than 1.4, which means that the ratio of flood-prone width/bankfull width is less than 1.4. Scott and Auble (2002) described the postglacial channel width as only slightly less than the valley width. Channel slopes are generally less than 0.02, and bankfull width/depth ratios are greater than 12. See Figure 2 – Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island) – Aerial View.

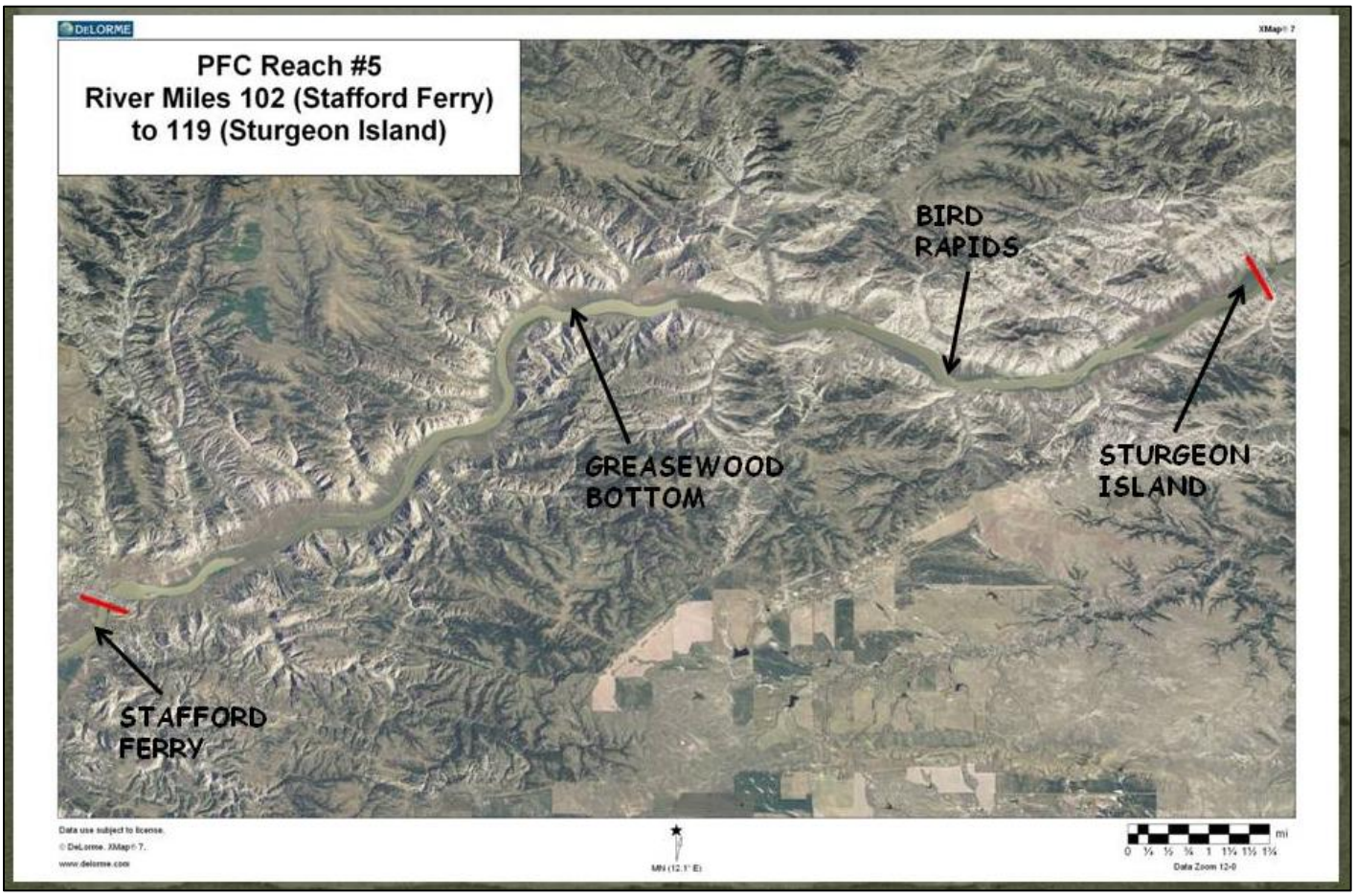


Figure 2 – Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island) – Aerial View

Channel morphology and distribution of riparian vegetation would be strongly influenced by landform and climate through this reach. Bare moist sites suitable for cottonwood recruitment are most often met through flow induced channel change (Auble et al., 2005). Hansen (1989) describes four types of deposits which are suitable for the recruitment of pioneering species such as plains cottonwood and willow (Salix spp.). They include point bars, side bars, mid-channel bars, and delta bars. Reach #5 was broken out from other reaches specifically because of the absence of such features. A small unconstrained zone occurs near McGarry Bar and is associated with a tributary junction; another is located on the north side of the river and is associated with a mass-wasting slump that fell into the river, but the remainder of the reach is highly constrained. Because meandering is nearly nonexistent through this reach, flood deposition is the controlling process for the establishment of woody vegetation. This results in vegetation community patterns of small numbers of linear, even–aged stands and establishment surface of mature trees well above channel-bed elevation (Scott et al., 1997). This reach and Reach #3 are even more constrained than associated constrained reaches of the Upper Missouri River (Reach #4 and Reach #6). Trees within Reach #5 are limited to individual or widely spaced individuals as opposed to even, widely-spaced stands.

Because of the climate of north central Montana, which includes very cold temperatures, snow, and rapid warm up from

"Chinook" winds, mechanical ice drives occur. The influence on riparian vegetation is substantial as vegetation between the 2- and 9- year return-interval flood stage is subjected to intense physical disturbance (Scott and Auble, 2002). Depending on the flow and ice regime of prior years, seedling, sapling, and pole-size cottonwood trees may be found across a range of elevations. However, Scott and Auble (2002) found that all trees had established 1.75 meters above the lower limit of perennial vegetation.

Although ice drives strongly influence vegetative patterns through this constrained reach, one unconstrained zone within the larger constrained zone does occur. Unconstrained zones can be found near tributary junctions, channel islands, and overflow channels (Scott and Auble, 2002). In these unconstrained parts, recruitment of trees is less dependent on the large flood pulses because with the lateral movement and sediment aggradation, established trees are removed from the zone where they receive more frequent physical disturbance (Scott and Auble, 2002). An unconstrained zone near McGarry Bar occurs within this reach. See Figure 3 - Unconstrained Zone Near McGarry Bar.

Figure 3 - Unconstrained Zone Near McGarry Bar

As sediment aggrades and depositional features mature, the potential exists for more mesic riparian species. According to Hansen (1989), as the alluvial material matures there is a corresponding change in soil parameters, which provides a more suitable environment for tree species such as green ash and boxelder. Hansen (1989) describes a successional path of pioneer species such as plains cottonwood and sandbar willow followed by an understory of green ash, boxelder, chokecherry, and red-osier dogwood. Rivers which are free to move back and forth across their floodplain result in stands of vegetation in various stages of succession (Hansen, 1989). However, physical sites capable of creating these conditions would be limited within this laterally constrained reach, and the linear stands of cottonwood may establish too high and be too open for the arid climate of the Missouri Breaks, thereby supporting drier ecological site types. The presence of cottonwood trees may not indicate that the moisture availability and physical site characteristics requirements are met for shallower rooted understory species. Understory species may tend to establish as small microsites in locations that receive both fine sediments and overland flow from the uplands. This can create small sites with clay lenses that perch water tables, which may be more conducive to the establishment of understory sites (personal communication, M. Scott (USGS) and M. Merigliano (University of Montana)). A cooperative study with the University of Montana started in 2010, looking at site conditions for late-seral, riparian woody plants on the Upper Missouri, and will provide further information.

Most streambank miles through the reach would be dominated by herbaceous vegetation. Species would include a variety of Carex, Juncus, Scirpus, and Eleocharis species. The fore mentioned species would be located within the Zone 1, would be frequently inundated and subject to ice, and be within close proximity of summer low water levels. These species tend to be located between the 2-year flood stage and the low water level (personal observation). During periods of low flow, they are very effective at capturing sediment. However, they can be vulnerable to high shear stress, buried by sediment, or completely removed by high flow or ice depending on conditions that year.

Historical accounts also contribute to the description of potential within this reach including the 1890s map by the Missouri River Commission and accounts from the Lewis and Clark expedition from 1804 to 1806. When Lewis and Clark camped at McGarry Bar, they wrote "camped on the south near two dead cottonwoods, the only timber for fuel which we could discover in the neighborhood." From Bird Rapids to McGarry Bar, which is all within Reach #5 Lewis and Clark describe "once in the course of several miles there will be a few acres of tolerably level land in which two or three impoverished cottonwood trees will be seen."

LIMITING FACTORS: Two significant dams (Canyon Ferry Dam on the Missouri and Tiber Dam on the Marias) regulate flows on the Upper Missouri River through the Wild and Scenic reach. Although the frequency of flood pulses and the timing of a snow-melt dominated hydrograph has not changed, the magnitude of large peak flows has been reduced from 40% to 50% as a result of regulation (Bovee and Scott, 2001). Examination of post dam recruitment patterns of cottonwood by Scott and Auble (2002) identified that all stands originating in the post dam period occurred within unconstrained channel reaches. Reduction in the magnitude of peak flows has resulted in establishment of stems at lower elevations that are subject to more frequent disturbance. If patterns continue, cottonwood recruitment would be limited to unconstrained reaches. In Reach #5, this effect will be most noticeable due to the lack of unconstrained reaches. The figure below shows typical existing landform, channel, and vegetative characteristics of River Miles 102 to 119. See Figure 4 - Typical Existing Conditions on Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island).

Figure 4 - Typical Existing Conditions on Reach #5 - River Mile 102 (Stafford Ferry) to 119 (Sturgeon Island)

The possibility does exist that the capability of this reach in terms of flow regime may move closer to potential. Bureau of Land Management (BLM), Bureau of Reclamation (BOR), U.S. Army Corps of Engineers (USACE), and other groups and organizations have been investigating the potential for augmenting flow releases from reservoirs to mimic natural flow regimes. Social and economic constraints will not allow for a completely natural flow regime, but efforts to increase peak flows would change the capability of this system and river reach closer to potential.

A key factor affecting potential is the decrease in the magnitude of fluvial disturbances on the Upper Missouri River associated with both climatic shift and dams. A shift from wetter conditions in the mid- to late 1800s, combined with the effect of flow regulation, has resulted in a process of channel narrowing (Scott and Auble, 2002). This affect has resulted in establishment of cottonwood trees as existing back channels have filled in. Currently, this increase in trees has mitigated the effects of the loss of trees from higher surfaces and current amounts of cottonwood forest are similar to amounts in 1890 (personal communication, G. Auble (USGS) and M. Scott (USGS)). However, this is a one-time response as the channel would not be capable of narrowing indefinitely.

Vegetation potential on the Upper Missouri River is also influenced by non-native plants and invasive weed species.

Evidence exists that direct competition between native plants and areas dominated by exotic plants (non-native and invasive weeds) can result in the disappearance of native species. Kudray (2004) found reduced species richness was most strongly correlated with greater exotic herbaceous cover and also had a negative correlation with native woody species richness.

Five invasive weed species were documented by Kudray (2004) within the Upper Missouri River including: leafy spurge, Canada thistle, spotted knapweed, diffuse knapweed, and houndstongue. If control methods are found for the above listed weeds, particularly leafy spurge and knapweed, the capability could change. However, even with aggressive control strategies, it is highly unlikely that these weeds would be removed from the Missouri River ecosystem.

The history of the establishment and spread of invasive weed species along the Missouri River within the Monument is very similar to other western rivers, although probably more recent. Vegetation inventories completed in 1975 and 1976, which included the river corridor, major tributaries and adjacent upland areas, did not document any infestations of invasive weed species on public land (George Hirschenberger, retired BLM, personal communication). However, by 1983 the BLM had identified areas between Coal Banks Landing and the Fred Robinson Bridge where invasive weed species, mainly leafy spurge, were becoming established along the river corridor. These areas were widely dispersed and small in size and density. In that year BLM personnel chemically treated an estimated 20 acres of leafy spurge and Canada thistle on public land (John Fahlgren, retired BLM, personal communication). By 2001, compiling information collected from surveys conducted over several years, the size of infested acres on public land had grown to 615 acres. The number of new invasive weed species had also grown considerably, from two in 1983 to over 10 in 2001. Again in 2010 the BLM completed a survey for invasive weed species along the entire river corridor from Fort Benton to the boundary of the Charles M. Russell Wildlife Refuge. As Table 1 below indicates, the acres infested on public land (Zones 1 - 3) more than doubled, increasing from 615 acres in 2001 to 1,363 acres in 2010.

Table 1 - Invasive Weed Species of Concern Found Along the Missouri River

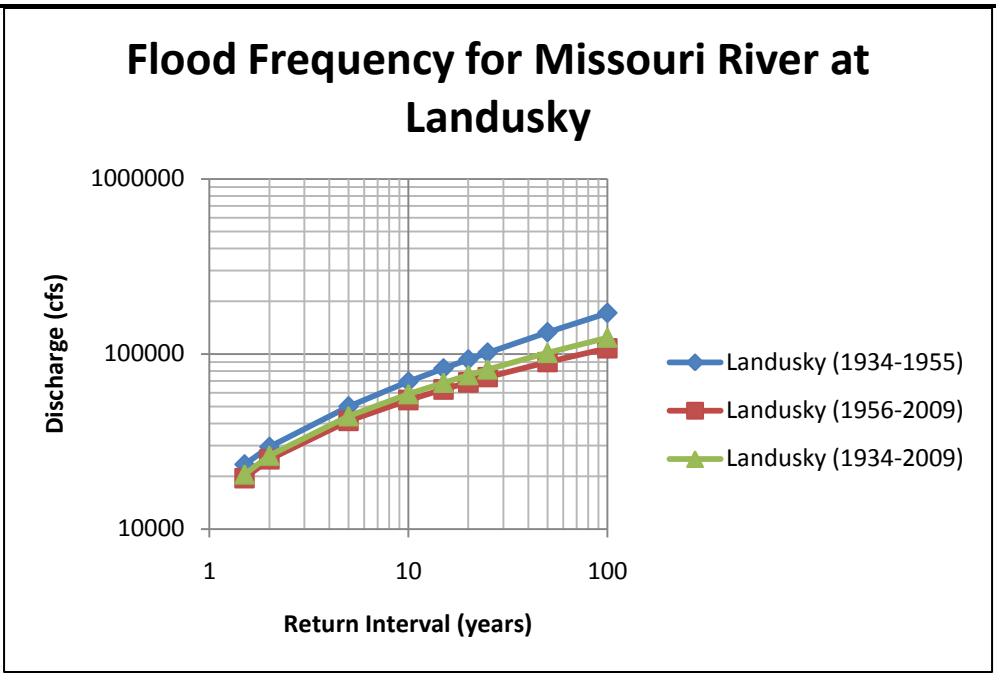
Common Name	2001 BLM Infested Acres	2010 BLM Infested Acres	Difference
Russian Knapweed	370	322	-48
Common Burdock	Not Mapped	2	
Hoary Cress	2	Trace Amount	-2
Spotted Knapweed	19	46	27
Canada Thistle***	14	280	266
Field Bindweed***	Trace Amount	9	9
Poison Hemlock***	Trace Amount	11	11
Houndstongue***	Trace Amount	40	40
Russian Olive	Not Mapped	62	
Leafy Spurge	198	586	388
Perennial Pepperweed	12	5	-7
Dalmatian Toadflax	Trace Amount	Trace Amount	0
Salt Cedar	Trace Amount	Trace Amount	0
Total Acres	**615**	**1363**	**748**
***** *Species were not completely documented in earlier surveys*			

In evaluating the health and functionality of riparian ecosystems, the kind, amount and density of vegetation plays an important role. Healthy native plant communities capture sediment aiding in floodplain development and provide a deep-binding root mass protecting banks against ice damage and water erosion. These areas are also very prone to establishment of invasive weeds and non-native plants. Invasive weeds prefer highly disturbed sites such as river banks, roadsides and camping areas. Once established, invasive weeds often out-compete and displace native vegetation creating a single species plant community often resulting in increased soil erosion, an altered nutrient cycle, and reduced biological diversity (Sheley et al., 1999).

Non-native grass species are common and abundant, especially in Zone 2 (personal observation). These include smooth brome, Kentucky bluegrass, quackgrass, crested wheatgrass, and annual bromes. Smooth brome is aggressive, competitive and can exclude all other species (Kudray, 2004). Smooth brome occurred in 69 percent of Kudray's plots. Control methods and the capability of the BLM to economically control non-native grasses are limited.

Kudray (2004) indicated that Russian olive was the only well established non-native woody species occurring along the river. Following his study seven small infestations of salt cedar have been discovered; one at Hole in the Wall and at six sites between the PN Bridge and the CMR boundary. Salt cedar is an evergreen shrub or small tree that can quickly invade disturbed areas, rapidly spread, form dense thickets and outcompete and replace native species. The plants were removed and no other plants have been discovered during follow-up visits to the sites. Russian olive can have significant affects on riparian forests. According to Lesica and Miles (2001), Russian olive can displace native trees and shrubs and form monotypic stands, especially where the riparian zone is less dynamic. There is the possibility of Russian olive becoming the dominant or co-dominant tree on the Upper Missouri (personal communication, G. Auble (USGS)). Along the upper half of the Missouri River, which is mostly private land, it may be socially and economically impractical to control invasions of Russian olive. However, along the lower half of the Missouri River, which is largely public land, the opportunity to control Russian olive and limit its spread and establishment is still a viable option.

Yes	No	N/A	HYDROLOGICAL
X			1) Floodplain above bankfull is inundated in "relatively frequent" events **Rationale for Answer** The river channel attributes and function are within a relative range of historic conditions both vertically and morphologically. A reach scale channel narrowing process has decreased the width of the active channel, which without a corresponding decrease in channel elevation would result in greater flood prone area. During the period of record for the Virgelle and Landusky gages (1934 and 1935 respectively through 2010), the stage-peak discharge relations have been relatively stable, thereby indicating that the river has not downcut. Although a stable stage-discharge relation accompanied by channel narrowing would indicate a deeper channel, it may not be an indicator of vertical instability as much as the channel reaching a new equilibrium. The take home message is that flows of certain magnitudes inundate similar elevations as historically. Relative to the potential channel morphology of a Rosgen F-channel type, no physical channel or flood plain characteristics prohibit access to the floodplain. Evidence of floodplain inundation was also present with rack lines of debris and soils exhibiting frequently inundated and redox conditions. Canyon Ferry Dam and Tiber Dam do regulate flows through this reach; however, the effect on "relatively frequent" events such as 2- to 5-year return intervals is less than the shift in flooding frequency of much larger events, which may be important for ecological processes such as cottonwood recruitment.



Flood Frequency Curves for the Landusky Gage

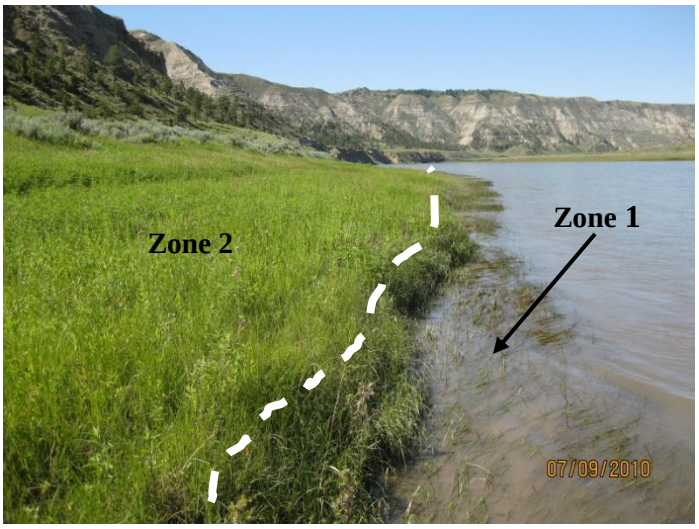
Because of the channel morphology of a Rosgen F channel (box shaped), limited floodprone areas exist. However, two small areas, McGarry Bar and Round Bottom , were inundated frequently although these depositional sites make up very small percentages of the reach. Depositional sites and floodplain development are limited because of the lower sinuosity and transport nature of this reach.

Redoximorphic (redox) features, indicating that the soils undergo periodic saturation, are prevalent in both Zones 1 and 2 except on the steep erosive bends of the river. Redox features were observed from the soil surface to within 20 inches of the soil surface. The depth to these features increases with distance from the edge of the channel. The redox features observed were reduced soil matrices in Zone 1 and redox concentrations and depletions in both Zones 1 and 2.

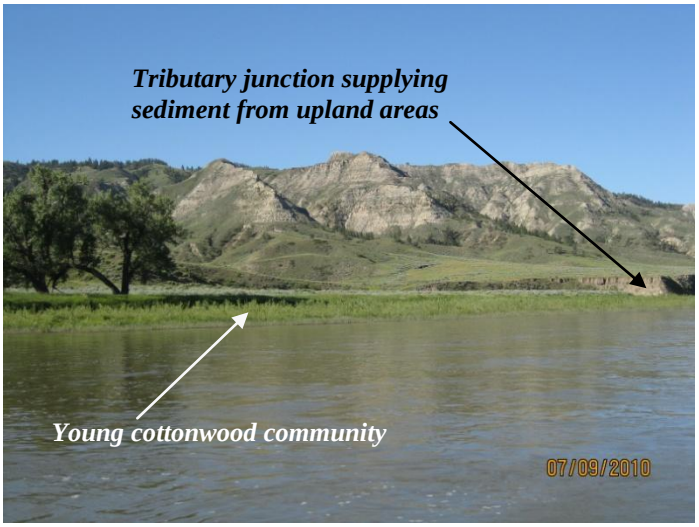
		X	2) Where beaver dams are present are they active and stable **Rationale for Answer** Although beavers are present on the Missouri River, beavers on the Missouri do not build dams that affect channel morphology, floodplain hydrology, or alter water-table elevations.
X			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region) **Rationale for Answer** Examination of the 1890 Missouri River Commission map, 1950's, 1980's and 2006 imagery has shown a decrease in channel width in all reaches of the UMNWSR. However, the ensuing change in width/depth ratios would not have changed the classification of the river channel. Furthermore, there have been no significant vertical shifts in the stage-peak discharge relationship at the Virgelle and Landusky gages, which would indicate vertical changes in the river. However, the stage-peak discharge relationship at Landusky has been less consistent than Virgelle with more active scour and fills processes. The Landusky gage is located in a more dynamic valley bottom with fine-grained substrate, so this would be expected. The point is that

			none of the stream gages located on the UMNWSR indicates recent downcutting. The river channel attributes and function are within a relative range of historic conditions both vertically and morphologically.
X			4) Riparian-wetland area is widening or has achieved potential extent **Rationale for Answer** A process of channel narrowing occurring over the last century has resulted in riparian species, such as cottonwood, becoming established on sites that were previously within the active channel. Keep in mind that the channel will not be capable of narrowing indefinitely, and this may be a one-time response as the channel approaches a new equilibrium. As riparian-wetland vegetation establishes on zones that were at one time frequently flooded, subsequent sediment deposition moves them higher and drier, thereby decreasing the flooding frequency of these sites. Although there has been a net decrease in river channel, the amount of riparian-wetland area may be similar to past extents. Only two locations within the reach (one at McGarry Bar and one on the north side of the river associated with a mass-wasting slump) exhibited a large amount of increase in riparian-wetland area as fresh depositional surfaces were colonized with riparian-wetland vegetation. In most of the reach, the zone of riparian-wetland vegetation is very small and located within Zone 1. However, although this is a small amount of area, the vegetation in Zone 1 is capturing sediment and being colonized by riparian-wetland plant species and the soils exhibit saturated conditions. Several of the stops exhibited conditions where the amount of area was not growing, but riparian-wetland species were recruiting into new areas, such as moving higher in elevation in Zone 2, which would indicate riparian-wetland area growth. In Zone 3, the soils are infrequently saturated. This may be because sediment accretion has moved the floodplain higher relative to the river, the flooding frequency of the magnitude flow necessary to saturate that elevation has decreased, or both. Previous monitoring at the depositional zone on the north side of the river indicated that it was once an island. The back channel has now accreted and this area was colonized with riparian-wetland vegetation.
X			5) Upland watershed is not contributing to riparian-wetland degradation **Rationale for Answer** Existing channel morphology and channel forming process did not indicate a large change in the amount of water or sediment supplied by the watershed. No evidence existed of excessive deposition or scour/erosion from sediment "hungry" waters due to dam released waters. Substrate-particle sizes range from cobble and gravel in high shear-stress zones to very fine in low shear-stress areas such as depositional zones. This indicates that the reach is capable of processing the water and sediment provided by the watershed. Conversely, homogeneity of the particle-size distributions would indicate that the stream is no longer capable of moving its sediment load or that a change in stream energy has occurred and recent stream discharges are capable of moving a greater percentage of substrate materials. Reach #5 is primarily a transport reach. As such, it is processing sediment supplied by the watershed and depositional zones are few. Depositional areas were primarily located where side tributaries were large enough to supply enough materials to overcome the river's capability to move it, or from mass-wasting from the hillslopes. The river had the sediment transport competence and capacity to move most materials supplied by smaller tributaries. This condition

			is as expected based upon the potential sinuosity and gradient for the channel.

Yes	No	N/A	VEGETATION
X			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery) **Rationale for Answer** Herbaceous riparian-wetland plant communities were common throughout the reach within Zone 1. These communities consisted of plants that reproduce and spread primarily by rhizomes (underground shoots) and included reed canarygrass, alkali cordgrass, rough horsetail, three-square, hardstem and alkali bulrush, woolly sedge and common spikesedge. Within Zone 1, dense communities of these rhizomatous herbaceous plants were common, indicating they are well established and expanding and thus exhibiting multiple "age-classes."  ***Typical herbaceous riparian plant community occurring within Reach #5 (South Stop #2). In this picture nearly all of Zone 1 is submerged during high flow.*** Throughout the complete reach, shrubs, primarily sandbar and yellow willow, were present in Zone 1 and 2 but only in trace amounts. Again, as noted in other reaches, sandbar and yellow willow are established at low positions along the bank subjecting them to physical damage from ice drives and high flows. Where there were large and more level depositional areas, sandbar willow occurred in greater densities. At one site where a small lateral bar (North Stop #1) is building, the surface was covered by a tall, dense, multi-aged sandbar willow community. Also called coyote willow, sandbar willow can form dense stands by spreading underground roots (rhizomes) and re-sprouts easily if the stems are damaged or removed (Hoag et al., 2008). Its ability to spread and form dense stands is one measure of a diverse age class. Otherwise, the occurrence and amount of shrubs were infrequent with only trace amounts of sandbar and yellow willow.

			 ***Dense sandbar willow community at North Stop #1.*** Within Zone 1 and 2, the dominant tree species included plains cottonwood and peachleaf willow. Seedlings and saplings were the two age classes present but only in trace amounts. Again, many of the willows and cottonwoods observed were damaged by beaver and ice and were resprouting from plants that could actually be very old.
X			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*) **Rationale for Answer** The most widespread plant communities occurring in Zone 1 is a diverse composition of herbaceous riparian-wetland vegetation. Common spikesedge, an aggressive rhizomatous species, was frequently observed along the scour line. Reed canarygrass, a tall rhizomatous grass species, usually appeared at or near bankfull (Zone 1) at three of the five locations and was the community dominant at one site. Other riparian-wetland plants occurring within Zone 1 included alkali cordgrass, rough horsetail, hardstem, alkali and three-square bulrush and woolly sedge. The latter two were the community dominants at two of the locations. Willow shrub communities were uncommon throughout the reach. However, where site conditions existed that are favorable for willow establishment, protected from ice drives, on coarse soils and adequate flooding and seasonal moisture, sandbar willow was well established and growing in great densities. One example of this was found at the North Stop #1 site, a lateral bar which is capturing sediment and building, where the entire surface is covered with a dense stand of sandbar willow. The McGarry Bar site (South Stop #1), although unique and not representative of the riparian plant communities typically found throughout Reach #5, contained a diverse woody plant community of plains cottonwood and sandbar willow. This site has a much wider floodplain, having formed a delta bar below a tributary junction, receiving sediment not only from the river but also from adjacent upland areas.

			 ***Lateral bar developing at North Stop #1 with dense stand of sandbar willow covering entire surface.***  ***Woody plant community developing in front of and above McGarry Bar site.***
X			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics **Rationale for Answer** Redoximorphic (redox) features indicating that the soils undergo periodic saturation were prevalent in both Zones 1 and 2 except on the steep erosive bends of the river. Redox features were observed from a depth of 0 to 20 cm below the soil surface. The depth to these features increases as the distance from the edge of the channel increases. The redox features observed were reduced soil matrices in Zone 1 and redox concentrations and depletions in both Zones 1 and 2. Zone 1 is dominated by plants and plant communities consisting of obligate (OBL) and facultative wetland (FACW) plants. Plants noted included alkali cordgrass, reed canarygrass, common spikesedge, hardstem bulrush, three-square bulrush, alkali bulrush, rough horsetail, woolly sedge and other sedge species, sandbar, yellow and peachleaf willow and plains cottonwood. It was obvious that the majority of riparian-wetland plants are growing below bankfull. The majority of riparian-wetland plants are growing below bankfull in Zone 1. Zone 2 is not flooded often enough or long enough to support a moisture regime favorable for riparian-wetland plant species.

X			9) Stream bank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high stream flow events (*community types present*) **Rationale for Answer** Zone 1 contained herbaceous riparian community types that are strongly rhizomatous with medium to high stability ratings. There were no abnormal signs of bank damage (eroding/sloughing), exposed banks, sparsely vegetated or bare areas. The herbaceous plants were spaced closely together and many areas were capturing sediment. The herbaceous riparian species noted along the reach with medium to high stability class ratings include reed canarygrass, alkali cordgrass, hardstem, alkali and three-square bulrush, common spikesedge, rough horsetail and woolly sedge. These plants are mid- to late successional species that have established, survived and increased under adverse growing conditions created by scouring from ice and water. While herbaceous riparian areas were the dominant community type, woody plants, though only in trace amounts along the bank, also help stabilize banks and catch sediment. Woody plants generally have larger, stronger and deeper roots that add strength to banks to a greater depth than herbaceous plants. In combination, willows, grasses and grass-like plants (sedges, rushes, spikerush) are excellent bank stabilizers. Because their rooting characteristics are different and they become intertwined, they complement one another and add strength to water and ice scoured areas along the river bank.
X			10) Riparian-wetland plants exhibit high vigor **Rationale for Answer** Depending on the duration of annual high flows, streambanks can be submerged for a considerable portion of the growing season. In 2010, most of Zone 1 was inundated until late July. Riparian-wetland species were observed to be emerging through deposited sediment and standing water indicating that plants are well established and possess enough stored energy in roots to initiate and maintain growth during prolonged periods of flooding. Sandbar willow communities showed signs of healthy vigor as indicated by height, leaf width and color and the ability of plants to push and continue growth through thick layers of deposition. Throughout the reach, plains cottonwood and peachleaf willow plants exhibited signs of stress from repeated removal of stems by beaver and damage from ice. On some sites cottonwood and peachleaf willow exhibited a multi-stemmed or clumped growth form, where re-sprouting from the base of the plant has occurred. This was very obvious at the McGarry Bar site (South Stop #1). Woody plants have established on depositional surfaces created by a tributary junction. Nearly every cottonwood tree at this site was damaged by ice and beaver and re-sprouting from the base. Cottonwood resprouts were vigorous with this year's shoots 15 to 18 inches long.

			 ***Cottonwood trees that have been sheared off by beaver were re-sprouting with 15 to 18 inches of new growth this year.***
X			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*) **Rationale for Answer** The plants, plant groupings and community types observed in Zone 1 were well developed and the depositional surfaces well vegetated with riparian-wetland plants that have medium to high stability ratings. The amount of bare areas observed was not excessive and were the result of recent, naturally occurring sediment deposits and scouring from water and ice. There were no abnormal signs of bank damage (eroding/sloughing), exposed banks, sparsely vegetated or bare areas. The herbaceous plants were spaced closely together and many areas were capturing and depositing sediment.  ***Streambanks are well vegetated to protect against scouring by water and to trap sediment.***

			 ***Streambanks are well vegetated to protect against scouring by water and to trap sediment.***
		X	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery) **Rationale for Answer** Large woody material is present within the reach; however, it is not required for function. During the steamboat era, a significant amount of woody material was pulled from the Missouri River to aid in navigation. Nevertheless, not only did the river fail to degrade (downcut) as a result of this activity, but it also narrowed during the past century. Although woody material is not a driver for function on the Upper Missouri, it can play an important role in small areas for floodplain development, energy dissipation, and aquatic habitat.

Yes	No	N/A	EROSION DEPOSITION
X			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy **Rationale for Answer** The channel morphology and floodplain areas are as expected relative to potential; the river is very constrained in this reach with very few meanders, oxbows, overflow channels, floodplains, and islands. However, because of the F channel type (box shape) and low sinuosity; one would not expect many of these features. The depositional areas on BLM lands were well vegetated with riparian vegetation. The increased roughness of these areas results in energy loss in the channel due to friction loss. Depositional zones were where expected (mid-channel bars and tributary junctions). Although they make up a very small percentage of the reach, new depositional zones were vegetated with pioneer species such as cottonwood and sandbar willow, which provide a functional role. These species are generally the first to establish on depositional zones of coarser material. Because these species are currently established on low elevation surfaces that are subject to frequent disturbance from floods and ice, they may never become mature individuals. However, due to their stiffer stems relative to herbaceous plants, they are able to trap woody material and organic matter, and subsequently fine-grained sediments, which lead to more conducive environments for sedge/rush communities and maturation of the floodplain. The

			increase in organic material also leads to increased water holding capacity of the floodplain.
		X	14) Point bars are revegetating with riparian-wetland vegetation **Rationale for Answer** The reach has very low sinuosity. Although there are entrenched meanders, there are no point bars. Depositional areas do exist at tributary junctions. These sites are vegetating with riparian-wetland species.
X			15) Lateral stream movement is associated with natural sinuosity **Rationale for Answer** Examination of the 1890 Missouri River Commission map, 1950's, 1980's and 2006 imagery has shown a decrease in channel width in all reaches of the UMNWSR. However, the ensuing change in width/depth ratios would not have changed the classification of the river channel. Furthermore, there have been no significant vertical shifts in the stage-peak discharge relation at the Virgelle or Landusky gages, which would indicate vertical changes in the river. However, the stage-peak discharge relation at Landusky has been less consistent than Virgelle with more active scour and fills processes. The Landusky gage is located in a more dynamic valley bottom with fine-grained substrate, so this would be expected. Although there are entrenched meanders within the reach, very little lateral channel movement is occurring.
X			16) System is vertically stable (*not down cutting*) **Rationale for Answer** A reach scale channel narrowing process has decreased the width of the active channel, which without a corresponding decrease in channel elevation would result in greater flood prone area. During the period of record (1934 and 1935 respectively through 2010), the stage-peak discharge relation at the Landusky and Virgelle gages has been relatively stable, thereby indicating that the river has not downcut. Although a stable stage-discharge relation accompanied by channel narrowing would indicate a deeper channel, it may not be an indicator of vertical instability as much as the channel reaching a new equilibrium. The take home message is that flows of certain magnitudes inundate similar elevations as historically.
X			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition) **Rationale for Answer** Existing channel morphology and channel forming process did not indicate a large change in the amount of water or sediment supplied by the watershed. No evidence existed of excessive sediment deposition or scour/erosion from sediment "hungry" waters due to dam released waters. Substrate particle sizes ranged from cobble and gravel in high shear-stress zones to very fine in low shear-stress areas such as depositional zones. This indicates that the reach is capable of processing the water and sediment provided by the watershed. Conversely, homogeneity of the particle size distributions would indicate that the stream is no longer capable of moving its sediment load or that a change in stream energy has occurred and recent stream discharges are capable of moving a greater percentage of substrate materials.

			Reach #5 is primarily a transport reach. As such, it is processing sediment supplied by the watershed and depositional zones are few. Depositional areas were primarily located where side tributaries were large enough to supply enough materials to overcome the river's capability to move it, or where mass-wasting from hill slopes entered the river. The river had the sediment transport competence and capacity to move most materials supplied by smaller tributaries. This condition is as expected based upon the potential sinuosity and gradient for the channel.

Remarks (Reach #5):

General Comments

From Coal Banks to Grand Island, approximately 2% of cottonwood trees are less than 10 years old, 7% are 10 to 25, 31% are 25 to 50, 34% are 50 to 114, and 24% are greater than 114 years old (unpublished USGS data, in review and subject to revision). Spatial and temporal variability in the recruitment of trees means that there is no reasonable expectation of constant total area or stable age distributions (unpublished USGS data, in review and subject to revision). The process of channel narrowing that has been occurring since the late 1800s has resulted in establishment of cottonwood trees as existing back channels have filled in. This increase in trees has mitigated the effects of the loss of trees from higher surfaces, and current amounts of cottonwood forest are similar to amounts in 1890 (unpublished USGS data, in review and subject to revision). However, without a change in flow regimes on the UMNWSR, the amount of cottonwood forest will decrease, and this effect will be most noticeable in the confined parts of the river.

Soils Summary

Zone 1 is within the active channel that is saturated/flooded with a two-year return interval flow. Soils within this zone undergo continuous or periodic saturation. This zone is most often in a reduced state resulting from the soils being saturated and virtually free of elemental oxygen (anaerobic). The soils matrix is reduced and low chroma colors (gleyed/gray) are observed. When the water table drops and the soils dry out, prominent redoximorphic (redox) features such as iron concentrations and depletions, are found to the surface of the soil profile.

Overall for the reach, fines are kept in suspension in this zone due to the higher stream energy, so gravel and cobble settle out. A series of depositional events have stratified soil textures in the upper 20 inches, ranging from loamy sand to sandy clay loam (approximately 12 to 25 percent clay) with many gravels and cobbles. Sand, gravel and cobble predominate below 20 inches.

Zone 2 is on the floodplain above Zone 1 and is within the 10-year (pre dams) and 20- to 30-year (post dams) floodplain, which is periodically saturated during less frequent flood events. As the river and water-table levels rise and fall, the soil alternates between reduced and oxidized states. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated (USDA-NRCS 2010).

Evidence of this fluctuation is indicated by the presence of redox features within the upper 20 inches of the soil profile, which commonly include rust colored iron concentrations in the matrix, along roots and pores, and gray colored iron depletions throughout the soil matrix. The soil matrix is not reduced. The depth to redox features increases as the distance from the active channel increases. Redox features are not always present on some outside meanders because they are eroding faster than the features can form.

As the river rises during flooding events and reaches the floodplain (above bankfull) stream energy is dissipated resulting in finer textured material settling out of suspension in depositional zones. Soil textures are stratified resulting from depositional events and predominately range from sandy loam to silty clay loam (approximately 15 to 30 percent clay).

Zone 3 is located on terraces above Zone 2. This zone is not frequently flooded; therefore, indicators (redox features) of recent soil wetting are not observed.

Although this zone is not frequently flooded by summer stages, it is frequently scoured by ice resulting from spring thaw ice jams resulting in areas of bare soil. Rock fragments ranging in size from gravel to stones can be deposited by ice at higher elevations than river summer flows are capable of depositing.

Soil textures in this zone range from loamy sand to clay dependent on what type of material was deposited during past flood events and/or the parent material found on the adjacent uplands.

Vegetation

Throughout the reach there was repeated evidence of beaver mortality on young cottonwood trees. In many locations this has created trees with a clumped or multiple stem growth form.

Invasive weeds (leafy spurge, Russian knapweed, perennial pepperweed), non-native and invasive plants were present at all six stops and were more abundant in Zone 2.

Confined or constrained reaches, such as this one, exhibit a typical "box" channel, have very limited floodprone areas and consequently a limited amount of sites for riparian-wetland vegetation. Some of the sites most favorable to the establishment of riparian-wetland areas are those with a wider floodplain and flatter depositional surface occurring at the junction of tributary coulees.

Zone 2 within this reach was narrow and appeared to have a steeper gradient. The steeper areas above Zone 1 were transitioning from riparian-wetland plants to upland plants.

Because of the steeper gradient characteristic in Zone 2, there was evidence of ice gouging and small debris piles of sediment, gravel and rocks.

McGarry Bar (South Stop #1) and lower end of Round Bottom (North Stop #1) are the only two examples of widening riparian zones. Otherwise, the potential appears to be limited to a narrow depositional area ranging from three to six feet wide.

Wildlife Information

All stops along this reach showed use of habitat by wildlife. Bald eagles and other raptors are utilizing large cottonwoods for nesting structure near the river. There are abundant migratory bird species throughout the reach, with highest density in mature woodland sites with good understory, which are not located near public use sites (campsites). There is heavy use of cottonwood and some willow by beaver, with light browsing use by deer on several woody species. (See explanation of how determined in following paragraph.) Recreational impacts to wildlife from campsites in important wildlife habitat occur as traffic causes soil compaction, spreads invasive non-native plants, and causes disturbance to nesting, resting or feeding by wildlife species.

Use of woody species by big game was determined by clean shearing off of leaders, the absence of grazing, or even presence of livestock at most locations visited. Cattle leave abundant signs, including tracks, droppings, and mechanical damage to woody species when they have grazed an area. Livestock grazing on woody species tend to tear ends off stems and mechanically damage additional stems leaving a ragged appearance. Deer generally browse on smaller diameter leaders with clean cuts and small amounts of bark tearing. While one clean bite does not guarantee it was not livestock use, observation of multiple stems on same and adjacent woody species, tracks and animal droppings in area will usually confirm class of animal utilizing browse. The difficulty is in "quantifying" livestock vs. wildlife use in areas where both have been feeding.

Grazing Allotments

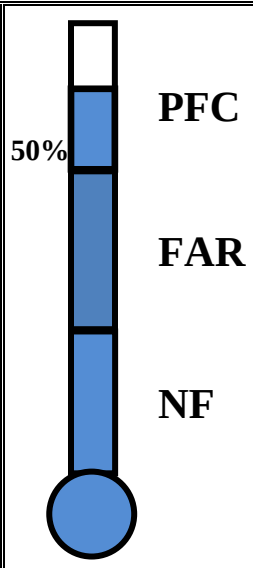
North Side - Lost Ridge #06208; Greasewood Bottom #06282; Williamson Bottom #06283; Sturgeon Island #06284

South Side - Mattuschek #20045; Woodhawk #20031

SUMMARY DETERMINATION: Reach #5 was rated by the ID Team well above proper functioning condition.

In summary, key attributes and processes responsible for the rating of Proper Functioning Condition were adequate riparian-wetland species diversity, age class, vigor, cover of riparian-wetland plants with medium to high stability ratings on the streambanks, stable streambanks, and channel attributes and functions within the range of conditions appropriate for this reach.

Invasive weeds and non-native grasses were identified as the basis for not attaining a higher ecological status. Because invasive weeds and non-native plants compete with and often displace native riparian-wetland plants, they may reach a level where they affect the functional condition of the Missouri River through changes in vegetation composition, structure and streambank stability.

Functional Rating		**Are factors contributing to unacceptable conditions outside the control of the manager?**
_X_ Proper Functioning Condition ___ Functional - At Risk ___ Nonfunctional ___ Unknown **Trend for Functional - At Risk:** ___ Upward ___ Downward ___ Not Apparent		Yes ___ No _X_ **If yes, what are those factors?** ___ Flow regulations ___ Mining activities ___ Upstream channel conditions ___ Channelization ___ Road encroachment ___ Oil field water discharge ___ Augmented flows ___ Other (specify)

(Revised 1998) (5/2008)

Appendix A – Plant List for Reaches #1-#6

Common Name	***Scientific Name***	**AKA Name(s)**
alfalfa	*Medicago sativa*	
alkali bulrush	*Scirpus maritimus*	Saltmarsh Bulrush
alkali cordgrass	*Spartina gracilis*	
Baltic rush	*Juncus balticus*	
black medic	*Medicago lupulina*	
boxelder	*Acer negundo*	
Canada thistle	*Cirsium arvense*	
cheatgrass	*Bromus tectorum*	downy brome
chokecherry	*Prunus virginiana*	
common burdock	*Arctium*	
common cattail	*Typha latifolia*	broadleaf cattail, cattail
common mullein	*Verbascum thapsus*	
common reed	*Phragmites australis*	
common spikesedge	*Eleocharis palustris*	common spikerush
creeping meadow foxtail	*Alopecurus arundinaceus*	
crested wheatgrass	*Agropyron cristatum*	
diffuse knapweed	*Centaurea diffusa*	
field bindweed	*Convolvulus arvensis*	creeping jenny, morning glory
green ash	*Fraxinus pennsylvanica*	
golden currant	*Ribes aureum*	
hardstem bulrush	*Scirpus acutus*	
houndstongue	*Cynoglossum officinale*	
Japanese brome	*Bromus japonicas*	
Kentucky bluegrass	*Poa pratensis*	
leafy spurge	*Euphorbia esula*	
narrow-leaf cottonwood	*Populus angustifolia*	
needle spikerush	*Eleocharis acicularis*	
peachleaf willow	*Salix amygdaloides*	
perennial pepperweed	*Lepidium latifolium*	
plains cottonwood	*Populus deltoides*	great plains cottonwood
poison hemlock	*Conium maculatum*	
quackgrass	*Agropyron repens*	
red-osier dogwood	*Cornus stolonifera*	
red top	*Agrostis gigantean (alba)*	
reed canarygrass	*Phalaris arundinacea*	
rough horsetail	*Equisetum hyemale*	scouringrush horsetail
Russian knapweed	*Centaurea maculosa*	
Russian olive	*Elaeagnus angustifolia*	
Sandbar willow	*Salix exigua*	coyote willow
showy milkweed	*Asclepias speciosa*	
small-fruit bulrush	*Scirpus microcarpus*	
smooth brome	*Bromus inermis*	

Common Name	***Scientific Name***	**AKA Name(s)**
spotted knapweed	*Centaurea repens*	
three-square bulrush	*Scirpus pungens*	
water birch	*Betula occidentalis*	
western snowberry	*Symphoricarpos occidentalis*	
White stem gooseberry	*Ribes inerme*	
white sweetclover	*Melilotus alba*	
woolly sedge	*Carex lanuginosa (pellita)*	
yellow willow	*Salix lutea*	
Yellow sweetclover	*Melilotus officinalis*	

Appendix B – References for Reaches #1-#6

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