Impacts of the Missouri River Flood of 2011 will be felt for a long time. The flood was far reaching in extent and great in magnitude. Although the peak flows were tempered by the mainstem dams, it was still the highest flow on record since the construction of the dams authorized by the Pick-Sloan Plan. Impacts of these flows in the “free flowing” and channelized sections of the river are extensive. This article will discuss some of the changes that are evident and some that will be revealed over the next few years.

It is important to realize that the 2011 flood altered the Missouri River, its channel, and its ecosystem greatly. The river will respond to these changes over the next few years as it moves back toward a state of equilibrium. Some impacts will take months or even years to become apparent. Other impacts have already been observed in the aftermath of the high flows. Some of the impacts to the river and its ecosystem will be detrimental, others will be beneficial. It is important that these impacts are observed, measured, and documented by the scientific community. Proper post-flood assessment will yield information that can be very useful in managing the river over the next several decades.
This article will mainly talk about changes in the free flowing segments of the Missouri River below Fort Randall and Gavins Point Dams. However, significant changes of a different sort have occurred in the channelized section of river beginning below Ponca State Park. The channelized river responds differently to a flood than the unchannelized section. This is mainly due to the narrow, confined nature of the channelized section. The wider nature of the unchannelized river is better equipped to dissipate the energy of the flood without inundating larger areas of floodplain. Figure 1 shows an example of the differences in width between the unchannelized and channelized river sections. Figure 2 shows the theoretical impact of this difference based on U.S. Army Corps of Engineers estimated inundation maps for the flood of 2011.

**Changes to the channel**

One of the most obvious areas where there has been change is in the channel itself. The river bed is composed of unconsolidated sand, silt, and clay. These sediments are moved around a lot in a normal flow year. Flood conditions like 2011 drastically rearranged the bed sediments. In the free flowing sections from Fort Randall Dam to about Niobrara, NE and from Gavins Point Dam to Ponca, NE, the river bed has been significantly altered in many areas. Large deposits of sand have been left behind by the high waters. Some of these deposits are now sandbars that are 8 to 10 feet above normal water levels. To understand why these sandbars are so large, consider how the river creates them. A flowing river with unconsolidated bed sediments, such as the Missouri River, will move the sediments into the shape of dunes on the river bed. Many of these dunes build up to within two or three feet of the river level. The Missouri River is continuously carrying out this process and is the reason why most of it is so shallow. Before flows were controlled by the dams, the Missouri River routinely built sandbars during its annual rises. That process has been greatly reduced since the dams were put in place. During the flood, river levels were close to 10 feet above normal. The sand dunes on the river bed built up to within a few feet of the flood level the river was at. When the water levels dropped with the decrease in discharges from the dams, they left behind sandbars that protruded great distances out of the water. These sandbars will still persist until slowly eroded away by wind, water, and ice over the years. Figure 3 shows the difference in typical pre-flood and post-flood sandbars. Figure 4 is a comparison of the channel before and after the flood, highlighting the drastic increase in post-flood channel deposits.

The source of large sand deposits created in the channel and in some overbank areas had to come from somewhere, and it wasn’t from behind the dams. The source of these deposits was mostly from the riverbed, and to a lesser extent from bank erosion. Evidence has already been shown that areas of the free flowing channel have been scoured and are significantly deeper than...
before the flood. Bed degradation values of ten feet or more have been detected in some areas. Other areas have seen bed degradation to a lesser degree. Features have been observed protruding along the river banks at flows of about 20,000 cubic feet per second (cfs) that in past years would have still been submerged. This is a result of the bed degradation and will likely have an impact on docks, boat ramps, and other objects that were built to a specific river level. Also, as the river cuts deeper into its channel, it reduces its connection with the floodplain, negatively affecting the riparian ecosystem.

The main channel (thalweg) has been moved significantly in several areas. In some cases it has moved from the Nebraska side of the river to the South Dakota side and vice-versa. The main channel location impacts river navigation as well as energy distribution in the river. Not only will navigation by boats and other vessels be impacted, but points of erosion and deposition will likely change as well. Fast moving water areas and slow moving water areas have also likely changed. This can have an effect on fisheries and wildlife patterns.

In the channelized reach of the river, deposition has greatly affected the surrounding landscape. This is particularly evident in some of the agricultural fields surrounding the river. In some cases sand and silt were deposited over productive topsoil, making it difficult to recover for crop production. Areas where flowing water moved out of the main channel and into surrounding agricultural fields had an even greater negative impact on agriculture. In many of these areas, the moving water eroded away the topsoil and cut channels into the underlying sandy sediments (which were probably former river beds from decades or centuries ago). Figure 5 shows typical results from this type of impact.

**Wetlands and Backwaters**

Bed degradation in the river channel below Gavins Point Dam has resulted in a loss of natural wetlands and other backwaters along the river. When the riverbed downcuts, it lowers the surrounding water table and wetlands and backwaters dry up. The flood has impacted two of the restored backwaters near Yankton and Ponca State Park. Originally designed and constructed to be connected to the river on their downstream end, both of these backwaters have been eroded on the upstream end by the flood to the extent that they are now connected to the river on both ends. This results in a flow-through backwater and significantly changes the dynamic of the backwater. The most significant change is the threat of erosion that comes with the flow through channel. Time will tell what the impact will be, with the worst case being complete loss of the backwaters to erosion.

Wetland areas along the river have also been altered. Sand and silt deposits left by the flood have covered these wetland areas, in essence changing their ability to function as a wetland. Other wetlands escaped without significant deposition, but were inundated by flood waters which may have transported contaminants into the environment. These potential water quality impacts will need to be evaluated during the post-flood assessments.

**Riparian Forest Impacts**

One of the most ecologically important trees along the river is the cottonwood. These trees have adapted to shallow water tables and short periods of inundation, but the unusually long inundation period created by this flood was enough to damage the root systems of some trees. Such root damage may make trees more susceptible to blow down by strong winds, as has been observed.
at various locations along the river. In addition, some trees have been topped as the flood has undercut the riverbank, while others have been lost due to an apparent increase in beaver activity. Loss of these trees may represent a negative impact on the forest, but an ecologically positive impact on the aquatic environment, as snags increase the variety of habitats for aquatic insects and fish. Some areas of forest along the river have already experienced significant cottonwood tree loss. Other areas that may have been impacted won’t show the damage immediately, but tree loss could occur over the next few years. At this point it is unknown how extensive the cottonwood tree damage will be.

Significant benefits may also come to the forests as a result of the flood. Eastern red cedar and Russian olive trees are undesirable species that have colonized the floodplain during the regulated flows of the last sixty years. These trees are sensitive to inundation and the flood may have reduced some occurrences of them while rejuvenating native floodplain forest plant species. For instance, it is possible that the flood generated new cottonwood areas on sandbars and floodplain deposits. The extent of new cottonwood generation is unknown at this time, but will need to be documented over the next few years.

**Invasive Plant Species**

Purple loosestrife is an invasive plant species that can take over riparian habitats and create a monoculture (figure 6). It has the ability to regenerate rapidly and its seed is distributed by flowing water. Significant efforts are in place by various government agencies to control the purple loosestrife population on the river. The flood has created a potential challenge for these agencies. Knowledge about the location of purple loosestrife colonies is no longer accurate. The flood has destroyed many of the existing areas where the plant was established. Unfortunately, the flood waters will have redistributed the seed and plant fragments from colonies that existed prior to the flood. The result will be many new colonies appearing over the next few years in areas that are unknown at this time. Close monitoring will have to occur along the river to identify these colonies before they become too established. Efforts will need to be carried out to eradicate the colonies before they grow out of control. This will be an expensive and time-consuming effort for all organizations involved.

**Summary**

The flood of 2011 has and will have significant impacts on the Missouri River channel and its riparian ecosystem. We have become used to the river behaving in a similar manner for several decades. The flood has likely significantly altered the river system, with impacts that may be both positive and negative for the ecosystem. This provides both a challenge and an opportunity to learn more about how the river and its ecosystem function and respond in the years to come.

![Figure 5: Field erosion after flooding. Note collapsed center pivot into eroded area and absence of topsoil.](image)

![Figure 6: Purple loosestrife colony.](image)