19. Watershed Health and Riparian Areas

The information provided in this report focuses on efforts the Forest watershed program has undertaken in order to actively improve conditions on the Forest. The watershed desired condition is that forest waters provide adequate natural flow and connectivity to allow stable populations of aquatic biota. The Forest watershed program has implemented Forest Plan direction by focusing on the removal of barriers to aquatic organism passage (AOP), impoundment dam removal and road decommissioning throughout the Forest.

Key Points

- Forest Plan direction strives to maintain and improve watershed conditions by providing natural flow and connectivity to allow stable populations of aquatic biota.
- Forest watershed program has implemented forest plan direction by focusing on the removal of barriers to aquatic organism passage, impoundment dam removal and road decommissioning.
- Climate change will likely result in dryer growing conditions and more extreme flow events.
- Work being done by the Forest watershed program will make the Forest more resilient to the impacts of climate change.
- No changes in Forest Plan are recommended. Continued implementation of the Plan will result in improved water resources.

Monitoring Question

To what extent is Forest management affecting water quality, quantity, flow timing and the physical features of aquatic, riparian, or wetland ecosystems?

Results

Aquatic Organism Passage (AOP)

The AOP barriers occur where Forest infrastructure such as roads, trails and dams intersect streams. For more than a decade, the Forest has been actively identifying opportunities to remove such barriers. This process involves identification and inventory of sites, multiple assessments of those sites to determine site condition, prioritization of sites that have been determined to be a barrier, design and implementation of a project to remove the barrier, and post-project monitoring to determine if the barrier was successfully removed.

A list of potential AOP issue sites was generated using an assessment process detailed in the watershed report (available upon request) in the project file. The AOP issue list for 2010 was eventually reduced to 96 AOP sites categorized by high, medium and low importance. High importance sites (total of 15) were targeted and work begun to improve aquatic organism passage, safety, infrastructure, erosion issues, watershed health, watershed connectivity, etc.

Table 19-1. Sites completed to improve AOP on the forest.

Fiscal Year	Sites Completed	Cost ($)
2005	8	10,560
2006		
2007	4	82,608
2008	3	32,300
2009		
2010	11	504,137
2011	1	430,000

Future AOP site opportunities aim to improve watershed and aquatic biota health across the forest. These are sites that have been identified as unsatisfactory and vary in amount of completed assessments on them thus far. At this point 25 additional sites have been identified as needing work in future years. An estimated cost to address these sites is $2 million. These sites vary in terms of size and cost as well as the impact on aquatic habitat.

Waterfowl Impoundments

The Forest contains over fifty wildlife impoundment dams that were originally constructed to provide open water wetland habitat for waterfowl. These dams were built on streams flowing out of existing wetland habitats. Over the years, resources available for operations and maintenance of these structures have decreased. This has resulted in many of these dams being in poor condition. Some have failed, and others are showing signs of failure. When failures occur, a large slug of sediment is transported downstream, impacting water quality and stream morphology and habitat. Therefore, the Forest has been actively removing these dams where feasible.

Waterfowl impoundment dams restrict water flow and flood wetlands to produce open water wetland habitat. Impoundments are barriers that reduce watershed connectivity and alter natural stream characteristics. Removal of impoundments is done to restore natural wetland habitat, stream flow dynamics and connectivity, creating healthier watersheds and habitat for aquatic biota.

Approximately 56 impoundments are currently inventoried and monitored across the forest. There is currently an active initiative to remove, or at least maintain these structures to improve watershed health.

Some impoundments, typically those found on major roads, are replaced with adequately sized culverts. Other impoundments are completely removed to allow natural reestablishment of vegetation, wetland, and stream conditions.

Removal/Remediation Activity

Impoundments have been removed on the forest in the past five years. Additional impoundments will be removed in the future as budget and time permits. Impoundment removal typically consists of:

- Drawing down reservoirs by removing stoplogs, debris, etc.

- Removal of water level control structure.
- Removal of impoundment dam (usually earthen fill material), unless major road is present, in which case an adequately sized crossing is installed to allow AOP.
- Remediation of reservoir area.
- Monitoring remediation actions.

Table 19-2. Impoundment removals thus far.

Fiscal Year	Impoundments Removed	Cost ($)
2006	2	27,510
2007		
2008	1	23,520
2009	2	21,400
2010	9	355,274
2011	2	30,002

There are eight additional dams that have been identified for removal in the next several years. The average cost of a dam removal project is around $30,000.

Road Decommissioning

Road decommissioning is a way to improve watershed conditions and meet FP direction. Roads impact watersheds by compacting soils, increasing runoff and routing sediment to water bodies. The Forest Plan set a 200 mile target for road decommissioning and the watershed program on the Forest has worked to implement this direction.

Road decommissioning is an effective way of increasing watershed health. Road intersections with wetlands and streams serve as point sources of sediment loading. Sediment loading decreases natural stream function and is detrimental to aquatic biota. Closing and/or removing roads is done to reduce these effects. Overall, reduction in road density within a watershed is desired as part of the Forest Plan.

Road decommissioning can be as simple as signing a road closed, installing gates, slashing entrances or installing barriers, or extensive as removing road fill from wetland areas. Most road decommissioning done in wetland areas involves removal of road fill to allow natural hydrologic flow. This improves AOP, nutrient flow, reduces sediment loading and improves overall watershed health.

To date, over 140 miles of road have been decommissioned, some have been converted to trails, but most have been removed from the system. This effort will continue in future years.

Implications

The information presented above shows that the Forest is actively implementing Forest Plan direction to remove passage barriers to aquatic organisms, restore natural flows and protect habitat. Nearly 30 stream crossings and over 15 dams have been worked on in the past six years. Also, over 100 miles of roads have been decommissioned. The impact of this work on the landscape is significant. Each project not only improves conditions at the site but also in the

surrounding area. Some stream crossings improve habitat on several miles of stream while some dam removals impact tens of acres of wetland habitat.

New Issues

Climate Change

The effect of climate change on hydrology and watershed conditions on the Forest depends on the timing and intensity of precipitation and changes in seasonal temperature patterns. Presentations given at the Climate Change Workshop (February 15, 2011) summarized the climate change scenarios and predicted how conditions, coupled with current climate trends, may affect Forest resources.

Workshop presenters used the research done by the International Panel on Climate Change to illustrate how climate has changed in North America and how locally collected meteorological data demonstrates similar trends here on the CNF. The following statements summarize their findings.

- Annual precipitation is increasing
- Large precipitation events are more frequent
- Longer growing season (more frost-free days); an increase in 40 to 50 days over the last century.
- Increase in water temperature of lakes
- Increase in streamflow; e.g. Mississippi River flow at Grand Rapids, MN has increased by 20% since 1980.

Wuebbles et al (2009) studied climate change with regards to the Upper Mississippi River Basin and made the following statements about current patterns.

- “Heavy downpours are now twice as frequent as they were a century ago.”
- “The largest increase [in temperature] has been measured in winter, extending the length of the frost-free or growing season by more than one week.”
- “There has been a significant reduction in mean snow cover area in the Northern Hemisphere, and over the last few decades spring snow melt has been moving to earlier in the year.”

Climate Modeling has produced results that have caused scientists to draw the following conclusions.

Precipitation

- Projected change in North American precipitation by 2080-2099 (Global Change Research Program, 2009) is for a wetter fall, winter, and spring, and a dryer summer.
- Dryer growing season conditions.
- Evapotranspiration is projected to increase due to increases in average summer temperature.
- Models suggest that summer and fall soil moisture could decrease by up to 30%

- Soil moisture is projected to increase during winter and spring by up to 80% due to increases in precipitation.
- "Upper Mississippi River basin, will likely see an overall increase in winter and spring precipitation in the coming decades, with little change to a slight decrease in summer and fall."
- "Additionally, projections indicate that intense precipitation events will increase in frequency, leading to higher runoff and increased risk of flooding."

Temperature

- "Warmer temperatures will increase evaporation and transpiration, leading to lower summertime soil moisture levels."

Hydrology

- "The hydrology of the northern parts of the basin are likely to be more strongly affected by warmer air temperatures and changes in cold season processes".
- "Flashiness, or the likelihood of flooding, is also likely to increase by the end of the century, particularly in the spring, as indicated by the TQmean and R-B Index analyses."
  TQmean – The fraction of time that daily streamflow exceeds mean streamflow for each year (Konrad and Booth, 2005), which reflects redistributions in streamflow from base flow (slow response) to storm flow (fast response)
  R-B Index – The Richards-Baker Flashiness Index which has been used to evaluate the magnitude of daily streamflow variations (i.e. flashiness) was calculated by dividing the sum of the absolute values of day-to-day changes in daily discharge volumes by total discharge volumes for each year or season (Baker et al., 2004).

Management Considerations

- "An increase in the magnitude of relative regular flooding events will need to be accounted for in the design and construction of new flood control structures, bridges and other infrastructure affected by high-water." (Pan 2009)
- "Climate models predict that annual precipitation in the Midwest will continue to increase, with extreme precipitation events increasing more rapidly than total rainfall. "
- "Flooding on major rivers in the Midwest will worsen because runoff will increase faster than extreme rainfall, as excessive rain falls on near saturated soils." (Cherkauer and Sinha 2010.)
- Climate modeling for the Lake Michigan region resulted in predictions of:
  - More precipitation "in the form of convective storm events, which yield more runoff and less soil moisture recharge"
  - "total runoff was projected to increase in the winter and spring, with an increase in the number of days with high-flows and a decrease in the number of days with low-flows".
  - "By autumn this pattern (described above) had been reversed, due to lower precipitation in the summer and autumn".

How are predicted conditions likely to affect the hydrology and aquatic resources of the Forest?

1. Typically, spring is when the CNF has the greatest runoff and highest water levels. This is due to the following factors:

- In early spring soils are frozen, thereby decreasing infiltration and increasing runoff
- Vegetation is still dormant, resulting in lower rates of transpiration.
- Winter snowpack may melt more rapidly.
- Cool spring temperatures keep evaporation rates low.

So, an increase in the earliest spring rains, those occurring when the soil is frozen or saturated, has the greatest potential to cause flooding. Those that occur later in spring or early summer should have less effect on runoff due to increased infiltration, and higher evapotranspiration.

2. Despite more frequent intense rain events during the summer, drought conditions are likely due to warmer temperatures.

- Water in excess of a plant's needs will not be used and, unless the soil has a high storage capacity, will be lost to runoff.
- Warmer temperatures lead to greater evapotranspiration between rainfall events.
- So, while more precipitation will occur, the long-term supply of water available to plants is at risk of decreasing.
- This results in stream water levels increasing rapidly with each rain event but then falling to below normal levels in between events. A stream hydrograph would represent this as having higher peaks and lower troughs under this scenario.

3. Intense rain events may wreak havoc on stream structure and road related infrastructure.

- Destabilization of stream banks from high energy water pulses would increase the rate of sedimentation, changes stream morphology, and potentially lead to poorer water and habitat quality.
- Depending on culvert size, stream crossings may restrict water flow during high rainfall events and contribute to increased stream velocities and scouring below the crossing.
- Sedimentation resulting from erosion of natural road surfaces may increase in adjacent streams, lakes, and wetlands.

How can the CNF accommodate the predicted change in forest hydrology due to heavier but less frequent rains and increased spring (and fall) runoff?

1. Increase spring runoff storage capacity by:
    - Restoring drained wetlands and those having been filled
    - Increasing water residence time within stream channel by restoring natural stream meander (in the case of channelized streams e.g. Leech Lake and Mississippi rivers)
2. "Right-size" culverts at stream crossings by factoring in predicted runoff values.
3. Remove or re-engineer roads that contribute to excessive sedimentation.
4. Increase the amount of large diameter woody features in streams to absorb excess energy during peak flows. Strategically place wood to stabilize and protect stream banks and improve stream morphology.

Recommendations

No specific recommendations are presented at this time. The work being done by the Forest is adequately and proactively protecting and improving watershed conditions and aquatic habitat. Management direction in the Forest Plan is considered sufficient to maintain water resources on the Forest. Continued implementation of Plan direction will ensure high quality water resources for the foreseeable future.

References

Wuebbles D. J. & Hayhoe K. 2004. Climate change projections for the United States Midwest. Mitigation and Adaptation Strategies for Global Change 9: 335–63.

Wuebbles, D. J., K. Hayhoe & K. Cherkauer, 2009. Climate change and the Upper Mississippi River Basin. In Criss, R. E. & T. M. Kusky (eds), Finding the Balance Between Floods, Flood Protection, and River Navigation. Proceedings of a Conference held 11 November 2008 in the Harlene and Marvin Wool Ballroom, Busch Student Center, St. Louis University, MO: 47–54.

Pan Zaito, 2009. Climate change, precipitation, and streamflow in the central United States. In Criss, R. E. & T. M. Kusky (eds), Finding the Balance Between Floods, Flood Protection, and River Navigation. Proceedings of a Conference held 11 November 2008 in the Harlene and Marvin Wool Ballroom, Busch Student Center, St. Louis University, MO: 55–60.

Cherkauer, K. A., Sinha, T., 2010. Hydrologic impacts of projected future climate change in the Lake Michigan region. J. Great Lakes Res. 36 (Supplement 2), 33–50.