Upper Mississippi River Pool 8 Drawdown Results

Water Level Management Task Force

A summary of the research and monitoring results from the 2001 and 2002 experimental drawdowns of Pool 8.

Cover photograph by Robert J. Hurt

Upper Mississippi River
Pool 8 Drawdown Results

A Summary of the research and monitoring results

from the 2001 and 2002 experimental drawdowns of Pool 8.

Water Level Management Task Force

August 2007

Executive Summary

Water level management on the Mississippi River has evolved over time and has been based on scientific analysis as well as lessons learned through a series of demonstration projects under the guidance of the Water Level Management Task Force (WLMTF), a technical advisory group to the River Resources Forum (RRF). The River Resources Forum is an advisory body to the U.S. Army Corps of Engineers-St. Paul District, and was formed to offer recommendations and coordination of river-related issues.

The WLMTF includes representatives from federal and state agencies, and others, including:

- U.S Army Corps of Engineers- St. Paul District,
- U.S. Fish and Wildlife Service,
- U.S. Geological Survey,
- U. S. Coast Guard,
- Iowa Department of Natural Resources (DNR),
- Minnesota DNR and Department of Transportation (DOT),
- Wisconsin DNR and DOT,
- representatives from the commercial navigation industry,
- non-governmental organizations (NGOs),
- citizen groups.

In 1995 the WLMTF began to evaluate the potential for water level management in the northern reaches of the Upper Mississippi River with funding and technical support from the U.S. Army Corps of Engineers-St. Paul District. After successfully conducting several small-scale drawdowns, a demonstration large scale drawdown of a navigation pool was planned. After a lengthy selection process, Pool 8 was chosen for the first pilot drawdown. The drawdown was initially scheduled for the summer of 2000; however it was postponed due to projections of summer river discharges not conducive to implementing the drawdown. A demonstration drawdown of Pool 8, located near LaCrosse, Wis., was conducted in the summer of 2001 and then repeated in the summer of 2002. This was the first pool-scale drawdown conducted by the Water Level Management Task Force. A brief summary of the results follows.

Vegetation Monitoring

More than 50 species of moist soil, perennial emergent and aquatic species of plants were found on the exposed areas. Many of these species are a valuable source of food and cover for wildlife. A shift was observed from a plant community dominated by annuals the first year of the drawdown to one dominated by perennials the second year. Following the drawdowns, a substantial expansion of aquatic plant communities in the lower third of the pool was recorded, as well as a comparable reduction in open water habitat. The perennial plants grown on the sand and mudflats during the drawdowns have persisted for five years in some areas.

Fish

Overall, there were no negative short-term trends or differences in fish catch rates that could be attributed to the drawdown. An increase was observed in catch rates for the forage fish group surrounding the drawdown period which may warrant further investigation during a future drawdown. No fish kills were observed in the backwaters.

Freshwater Mussels

While a large scale monitoring of the effect of the drawdowns on freshwater mussels was not conducted, a pre-drawdown survey conducted in 1999 indicated that limited numbers of mussels were in the drawdown zone. An informal survey was conducted during a volunteer mussel rescue effort in July 2001. The survey indicated more mussels than expected on exposed sites, possibly due to the effects of the extended flood in spring 2001. The Pool 8 experience showed the need for more comprehensive monitoring of the effects on mussels in future drawdowns.

Shorebirds

In 2002, the number of shorebirds observed during weekly monitoring surveys in Pool 8 nearly doubled from the 2001 season. The 2001 data suggests that the water level reduction in Pool 8 created vital feeding habitat for migrating shorebirds as indicated by the number of shorebirds and the increased number of different species observed.

Waterfowl

There was a positive response by waterfowl to the improved habitat which resulted from the drawdowns, most noticeably by tundra swans. Diving duck use days also increased steadily in the years following the drawdowns. However, any trends in waterfowl use on a pool or refuge basis and the cause of these trends need to be evaluated with some caution.

Commercial Navigation

Pool 8 is generally described as a pool that is difficult to navigate under normal pool operation. During the drawdowns, navigating the pool by the commercial navigation industry seemed a bit more difficult according to tow pilot comments; however, the pool was still navigable.

Recreational Boating

Recreational boating activity did not appear to be significantly affected by the drawdowns. The drawdowns appear to have had little effect on the distribution of either active or beached watercraft on Pool 8 or on the adjacent Pools 7 and 9.

The report also addresses monitoring and effects on sediment consolidation and transport, nitrogen cycling, water quality, contaminants and cultural resources.

Table of Contents

List of Tables

List of Figures

WATER LEVEL MANAGEMENT ON THE UPPER MISSISSIPPI RIVER

Lower Pool 8 –Coon Slough, 1890
Henry Bosse

Introduction

The Upper Mississippi River has been modified for navigation and other purposes for over 100 years. Navigation improvements culminated in the construction of the Nine-Foot Channel Navigation Project in the 1930s which resulted in a series of locks and dams on the Upper Mississippi River. Since construction of the locks and dams, a series of shallow impoundments or navigation pools provide relatively stable water levels during non flood periods to maintain the Nine-Foot Navigation Channel.

Over the years, the amount of allowable fluctuation at the locks and dams was periodically reduced, primarily to reduce navigation channel dredging requirements and because people generally preferred more stable, higher water levels. The allowable fluctuation at Lock and Dam 8 in 1937 was 3.5 feet. It was reduced to 2 feet in 1945, to 1.5 feet in 1964, and the current 1 foot in 1972. The minimum water surface elevation at the primary control point in La Crosse has always remained at 631.0 (4.7 on the La Crosse gage.)

From an ecological standpoint, the maintenance of relatively stable and high water levels has resulted in sediment and nutrient accumulations in the backwaters and lower portion of the pools; erosion of the islands in the lower portion of the pools; reduced habitat diversity and quality; loss of aquatic vegetation; reduced water clarity and less species diversity in the ecosystem (Figure1.)

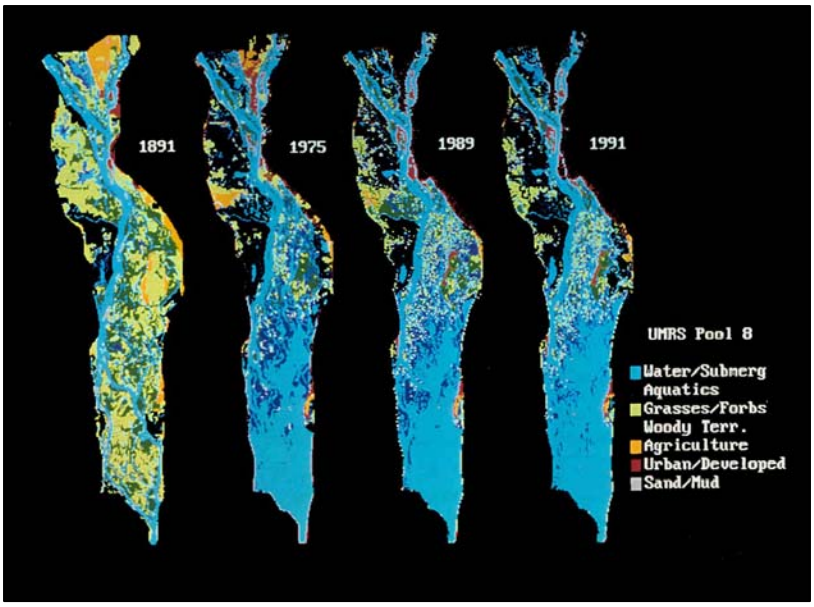

Figure 1. Loss of habitat in lower Pool 8 as a result of impoundment.

Although river managers have been rebuilding islands, as well as restoring channels and deepwater habitat with funds from the federal Environmental Management Program, emergent plant beds have only partially recovered because emergent aquatic plants depend on a seasonal fluctuation in water levels for their long term survival and the generation of new plants. Water level management offered a way to help restore the natural seasonal fluctuation in water levels.

The Drawdown Project

2001 Demonstration Drawdown

The drawdown was scheduled for June 15 through September 15, 2001 with a target of an 18-inch reduction at the dam, and a maximum six-inch reduction at the La Crosse gage (Figure 2.) Due to a late spring flood, the pool elevation at Lock and Dam 8 did not reach normal pool levels until June 30 and the target level of the drawdown was not achieved until July 6. The drawdown was maintained near the target level at L&D 8 for 40 days, until August 14, or about half of the recommended 90-day period. An estimated 1,954 acres of river bottom were exposed.

As river flow rates dropped, the minimum pool elevation at the La Crosse gage could no longer be maintained and pool levels at the dam had to be increased to maintain the water levels at the La Crosse gage. From August 16 to September 15, the pool level at L&D 8 was only about three-tenths of a foot below normal. However, due to the slope of the pool, reduced water levels persisted throughout the mid-portion of the pool through September 15.

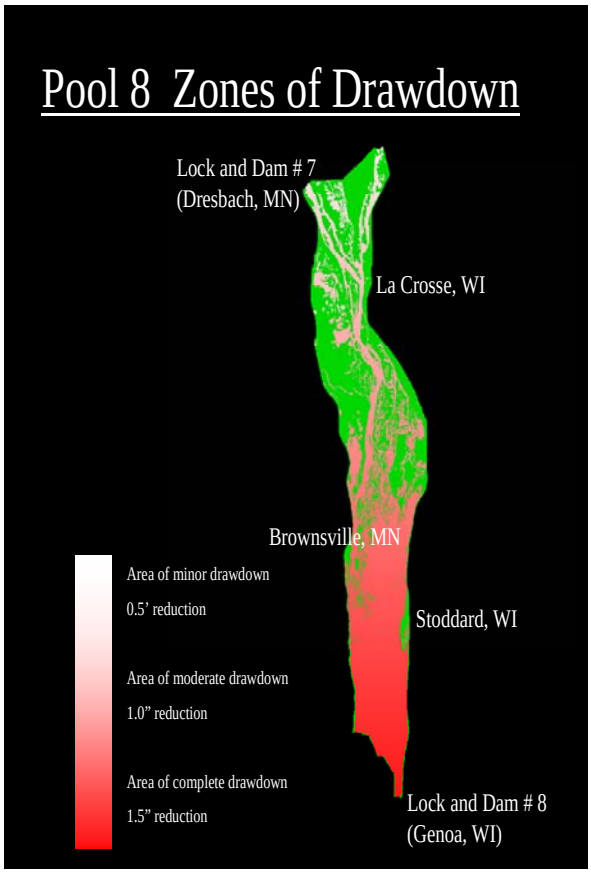

Figure 2. Estimated zones of impact due to drawdown of 1.5 foot water level reduction at the dam.

A second year drawdown was recommended by river biologists and managers and supported by the public in order to ensure that perennial emergent aquatic plants established in 2001 would persist.

2002 Drawdown

The second year drawdown of Pool 8 began as planned on June 17 and the target reduction of 18 inches was reached on July 3. Flows in the Mississippi River were high for much of the summer, which enabled the U.S. Army Corps of Engineers to maintain the maximum target drawdown level of 18 inches at the lower end of the pool while minimizing the impact upstream. The mid pool area around Lawrence Lake and Goose Island experienced only a limited effect from the drawdown. Maximum extent of the drawdown in 2002 was similar to that of 2001. However, because river discharge rates were generally higher in 2002, area exposed at any given time during 2002 was generally less than that of 2001. The drawdown was in effect in the lower portion of Pool 8 for the prescribed time frame of 85-90 days. Refilling of the pool began on September 16, reaching full pool level by September 24.

The Drawdown Monitoring Plan

In 1999, partner agencies organized to cooperatively provide expertise and resources for a monitoring effort to evaluate the environmental, physical and social impacts of the drawdown. Components to be monitored included:

- Habitat restoration goals, primarily the regeneration of emergent plant growth,
- maintenance of the navigation channel,
- the physical environment, including photo documentation,
- fish and wildlife,
- recreation and commercial uses.

Pool 8 is a trend pool for the Long Term Resource Monitoring Program (LTRMP); consequently sampling data from more than 10 years were available for water quality, vegetation and fisheries. Components not covered by the LTRMP were divided among the other agencies for sampling.

MONITORING RESULTS

MAINTENANCE OF THE NAVIGATION CHANNEL

Sediment Transport System including Dredging, Hydrodynamics, Bathymetry, and Tributary Degradation

Jon S. Hendrickson, Marvin Hrdlicka - U. S. Army Corps of Engineers-St. Paul, District

Main Channel -Pool 8, near Turtle Island. WI DNR

Discharge measurements were collected during the drawdown and compared to discharge conditions without a drawdown. The ISDOT (Integrated Surface Difference Over Time) method was used to measure bedload transport. This method was developed by personnel from the Engineering Research and Development Center (Abraham and Pratt, 2002), and was used for the first time in Pool 8. Hydrographic surveys were collected in Pool 8 during the drawdowns and were compared to pre-drawdown surveys collected during 1998 and 1999 to assess bathymetry changes. Cross sections were obtained on Coon Creek and the Root River before and after the drawdown in 2001 to assess changes due to the drawdown. The objectives of these surveys were to obtain measurements of changes in hydrodynamics, sediment transport, and bottom configuration in the Mississippi River main channel and on tributaries that enter Pool 8.

Hydrodynamic and sediment transport related hypothesis that were analyzed included:

1. Due to decreased cross sectional area and greater effects of boundary roughness during a drawdown, the flow through secondary channels will be decreased so that a greater percent of the total river discharge is conveyed in the main channel.
2. The onset of drawdown will mobilize bed sediments and result in greater rates of sediment transport in the main channel in Pool 8, possibly causing degradation of the main channel in the reaches where dredging is usually done.
3. Tributary degradation could occur due to the lowered water levels in Pool 8, introducing additional sediment to the main channel in Pool 8.

4. The high main channel dredging volumes that are needed prior to a drawdown so that commercial navigation can continue will result in reduced dredging volumes in future years.

The navigation channel reach selected for this study extends from river mile 686 to 691 located near Brownsville, Minn. This is a highly divided reach with many secondary channels. The main channel discharge decreases from 74 percent to 25 percent of the total river discharge from the upstream to the downstream end of the reach, due to flow through the secondary channels to backwater areas. Because of the decrease in main channel discharge, a large amount of dredging is needed annually in this reach..

Dredging Summary 2001 to 2003

The large quantity of dredging that was done in 2001 in advance of the drawdown resulted in reduced dredging in the following 2 years (Table 1.) The average dredging for the three years was 83,500 cubic yards which is 11 percent higher than the long term value of 75,000 cubic yards based on long term trend analysis. District wide dredging for the years 2001 to 2003 averaged 883,000 cubic yards, which is close to the projected long term value of 900,000 cubic yards.

Table 1. Dredging amounts in Pool 8 for the years 2001 to 2003.

Year	**Dredging** (thousands of cubic yards)
2001	208.9
2002	3.7
2003	38.0
	Average = 83.5

Dredging volumes from 2004 to 2006 were 94,700, 45,900, and 16,500 cubic yards of sand respectively. It appears that the advance dredging reduced dredging volumes until 2003, but not beyond. The lower dredging volumes in 2005/06 are probably related to lower flow conditions on the Mississippi and Root Rivers. The average dredging volume between 2001 and 2006 was 67,900 cubic yards.

Similar results would be expected to occur in other pools where large quantities of dredging are required prior to the drawdown. However caution is urged. The discharge on the Root River was well below average in both 2002 and 2003. The Root River supplies over 50 percent of the bed material that result in dredging in Pool 8 so it is likely that the amount of sand entering the pool was below average in 2002 and 2003. Discharge on the Mississippi River was above average in 2002 and below average in 2003 which probably resulted in a fairly typical bed material supply from Pool 7 for the two years.

Hydrodynamic Monitoring

Discharge measurements were collected during the drawdown and compared to discharge conditions without a drawdown to examine changes in the flow of water in the river. Data collected indicated the percentage of water conveyed in the main channel –in the study reach increased from 60 to 73 percent of the total river discharge, which was due to decreased flow in secondary channels. These factors caused the average main channel velocity to increase from 1.83 to 2.35 fps.

Additional flow measurements were collected in the main channel and secondary channels throughout Pool 8 and compared to the data collected in previous years during normal water levels. These

measurements indicated that secondary channels with entrances located further upstream in Pool 8 (e.g. the sloughs flowing past Goose Island) were not affected significantly by the drawdown, while discharge was reduced in secondary channels further down in the pool. The flow through Crosby Slough was almost cut in half from 8.3- to 4.8-percent of the total river flow, while the flow in Wigwam Slough was not affected. Crosby Slough is located further downstream in Pool 8 and flows through a shallow delta into a backwater area, while Wigwam Slough is located further upstream in Pool 8 and is relatively deep along its length. It is also possible that drawdown conditions increased the effectiveness of the closing dam at the entrance to Crosby Slough thereby affecting flow conditions in the slough.

Sediment Transport

Sediment transport is strongly influenced by river flow and channel velocity. Maximum channel velocities typically occur at the bankfull discharge condition (about the 1.5-year flood.) The flow rate at bankful conditions is about 85,000 cubic feet per second (cfs) at Lock and Dam 8. If flows during the drawdown were between 50,000 cfs and 80,000 cfs it was speculated that the combination of flow and drawdown could result in velocities high enough to significantly increase sediment transport.

In 2001, flows were less than 50,000 cfs for 75 of the 84 days during which the pool was drawn down. A discharge of 60,000 cfs was exceeded for 7 days at the start of the drawdown; however the pool wasn't completely drawn down at this point. In 2002, flows were in the lower portion of the drawdown range (less than 50,000 cfs) for 52 of the 101 days during which the pool was drawn down. A discharge of 60,000 cfs was exceeded for 29 days at several different times during the drawdown, and the pool was drawn down 1.5-foot for all but 6 of these 29 days.

Measurements of sand wave movement using the Integrated Surface Difference over Time Method (Abraham et al. 2003) indicated an increase in sediment transport during the drawdown in 2001. The potential for increased sediment transport was much greater during the 2002 drawdown because of the higher flows.

Bathymetry Changes in the Main Channel

Hydrographic surveys were conducted in Pool 8 during the drawdowns for comparison to pre-drawdown surveys completed during 1998 and 1999 to determine whether any changes in the bottom contours in the main channel were induced by the drawdown. The results were used to determine if greater sediment transport rates in the main channel would cause main channel degradation in the reaches where dredging is usually done.

A comparison of the surveys between river miles 686 and 691 indicated relatively small amounts of deposition and erosion between 2001 and 2003. On an annual basis this reach normally aggrades to the point where main channel dredging is needed. It could be that the high dredging volumes during 2001 combined with increased sediment transport kept the channel from accumulating sediment, leading to a reduction in dredging in 2002 and 2003.

Tributary Degradation

Due to the lowered water levels in Pool 8, a high flow event on a tributary creek or river during the drawdown could potentially have caused down-cutting of the tributary introducing additional sediment to the main channel in pool 8. Cross sections were obtained on Coon Creek, located in lower Pool 8, and

the Root River, located in upper pool 8, before and after the drawdown in 2001 to assess changes due to the drawdown. The drawdown should have had a greater influence on Coon Creek since it is located in lower Pool 8.

A comparison of cross sections before and after the 2001 drawdown on Coon Creek indicates degradation of less than 0.5 feet. A comparison of cross sections before and after the 2001 drawdown on the Root River indicates net aggradation exceeding 1 foot in the lower Root River; however degradation by as much as 2 feet occurred along the upper cross section. The Root River results are not consistent with those expected from a water level drawdown. If anything, bed degradation was expected at the downstream cross sections, with less degradation at upstream cross sections that are less influenced by the drawdown. Most likely these results are due to flow conditions on the Root River.

Conclusion

The results of this monitoring suggest:

- Large scale drawdowns, such as the 1.5-foot drawdown in Pool 8, increase main channel water discharge and sediment transport.
- Degradation occurred on Coon Creek; however it was generally less than 0.5 feet in the lower portion of this tributary.
- The high main channel dredging volumes that are needed in advance of a drawdown result in reduced future dredging.
- The lack of change in the main channel bed elevations in the study reach may be due to the fact that while the sediment transport rate increased, inputs balanced outputs. This is a desirable condition, since normally the study reach would be aggrading until dredging was needed.
- If a drawdown could be sustained during flow conditions approaching bankfull, when sediment transport is at its greatest, it is possible that main channel degradation could be induced. This is not possible in Pool 8, due to the high tailwater at Lock and Dam 8 that exists for high discharge, but may be possible in other pools such as Pool 5 where the operation plan would allow a drawdown up to the 5-year flood.

EFFECTS ON BIOLOGICAL PARAMETERS

Vegetation Sampling, U.S.G.S.

Vegetation Monitoring

Seedbank Study

Kevin Kenow, U.S. Geological Survey-
Upper Midwest Environmental Sciences Center

The drawdown was expected to dry and consolidate bottom sediments and, thereby, increase the area of emergent and submersed aquatic vegetation by natural seed germination. However, much of the river sediments that would be exposed during a drawdown had not been above water for over 60 years. The study was conducted to determine if a viable seedbank of desirable plants existed in the exposed area.

To quantify the availability of seed, we assessed the potential seed bank of selected areas of Pool 8 from substrate samples collected in spring, 2000. Fifty species of plants were identified in the seed bank samples. This included 29 wetland (10 submersed aquatic, 6 emergent, and 13 moist soil), 11 facultative wetland, and 10 upland species. Dominant taxa included arrowheads, false pimpernel, flatsedges, water star-grass, love grasses, and rice cut-grass. Submersed and emergent aquatic species were widely distributed, occurring in more than 90% of the samples. The plant response to the drawdown was very similar to the results of the seed bank study.

These results indicate experimental seed bank assessment is proving useful in determining, with some accuracy, the potential vegetation response to water level reductions.

Vegetation Response

Kevin Kenow, U.S. Geological Survey-Upper Midwest Environmental Sciences Center

Researchers assessed vegetation response to the water level reduction during the drawdown through:

- Use of high-resolution aerial photography and land cover data generated from that photography,
- Field measures of the distribution and biomass of submersed aquatic vegetation,
- Field measures of the composition and productivity of moist soil and emergent perennial vegetation on exposed substrates.

Extent of Plant Coverage

On 21 July, 2001, during the period of maximum drawdown, a total of 1,954 acres were exposed (8.2 % of the area assessed). Maximum extent of the drawdown in 2002 was similar to that of 2001. However, because river discharge rates were generally higher in 2002, area exposed at any given time during 2002 was generally lower than that of 2001.

Aerial photographs were taken of Pool 8, from Root River south to Lock and Dam 8, during August of 2000-2003, to map the extent of aquatic plant coverage. Substantial expansion in the area of desirable aquatic plant communities were documented in the lower third of Pool 8, following the 2000 and 2001 drawdowns. In 2003, increases in deep marsh perennial (209 acres), rooted-floating aquatic (310 acres),

and submersed aquatic vegetation (851 acres) communities were notable. Open water habitat was reduced by 1,362 acres during the same period.

Changes in the Plant Communities

Researchers monitored the development of vegetation on exposed substrates along transects at 13 sites throughout Pool 8 (south of Root River). They found:

- More than 50 species of moist soil, perennial emergent and aquatic species were found. Rice cut-grass, broadleaf arrowhead, water stargrass, nodding smartweed, chufa flatsedge, false pimpernel, and teal love grass were the dominant species that developed on exposed substrates. Many of these species are a valuable source of food and cover for wildlife.
- Plant density was largely related to the duration of substrate exposure, with higher plant densities and more plant development occurring on substrates exposed for a good portion of the growing season (i.e., mid-pool sites that remained exposed through mid-September) and low plant density on those substrates that were re-inundated in mid-August 2001. For example, plant density ranged from less than 5 plants per m² on substrates exposed in the lower end of the pool to more than 100 plants per m² in other areas (e.g., north of Turtle Island and Shady Maple (Figure 3.)
- Similarly, arrowhead tuber production ranged from none on substrates exposed in the lower end of the pool to 30 tubers per m² in other areas (e.g., Shady Maple, Stoddard Island Project Area.)

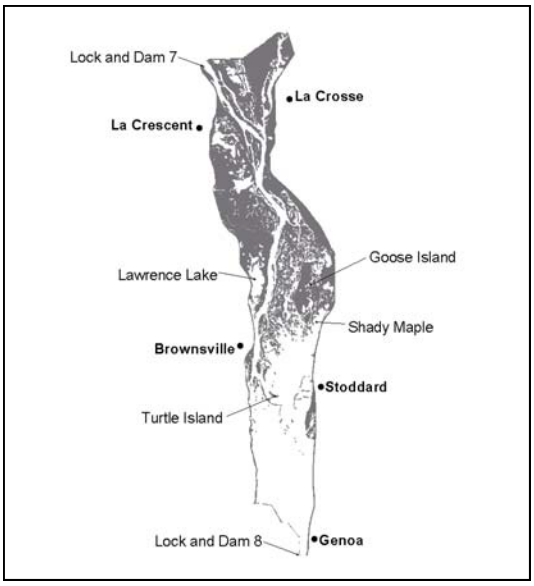

Figure 3. Map of Pool 8 .

- We observed a shift from a plant community dominated by annuals to one dominated by perennials in 2002. (Figure 4.)

Figure 4. Vegetation response to 2001 and 2002 summer drawdowns of Pool 8. The plant community on the exposed sites shifted from one being dominated by annuals in 2001 to one dominated by perennials such as arrowhead, water stargrass, rice cutgrass and chufa flat sedge in 2002.

In some areas, effects have persisted through summer, 2005. For example, vegetation change within a 500-acre area along the Raft Channel has been monitored annually since 2000. With drawdown, we observed the return of an important deep marsh perennial component to the Raft Channel area, and a return to the aquatic plant community diversity that had been present in 1975 (Figure 5.)

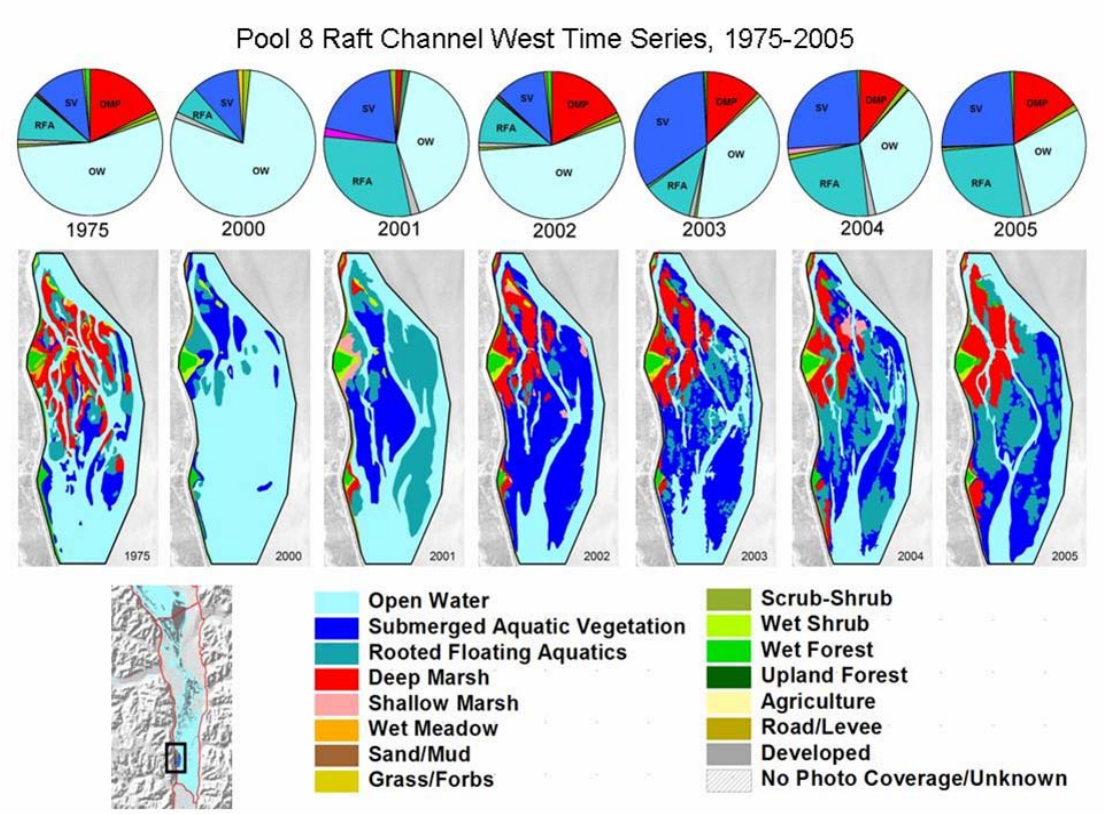

Figure 5. The deep marsh perennial plant community, essentially absent in 1999 and 2000, occupied 79 acres (16% of the area) in summer 2005. Rooted-floating aquatics occupied 97 acres and submersed aquatic vegetation 72 acres more in 2005 than prior to drawdown.

Seed and Tuber Production

A variety of moist soil and emergent plant species, important food resources to wildlife, grew on substrates exposed during the drawdown.

- Seed production in 2001 was dominated by annual plants including: rice cut-grass (51% of total production), chufa flatsedge (13%), barnyard grass (13%), and nodding smartweed (11%).
- Tuber production in 2001 was dominated by arrowhead (52%) and sago pondweed (44%). In 2002, arrowhead made up 94% of total tuber production. Arrowhead tuber production increased 16-fold (average = 3.4 g/m2 in 2001 vs. 55.3 g/m2 in 2002) across transects we examined during the two years.

Submersed Aquatic Vegetation Monitoring

Kevin Kenow-U.S. Geological Survey

Baseline information was collected on more than 200 open water sites in 1999 and 2000 to determine where and how much submersed aquatic vegetation was present prior to the drawdown. This monitoring was continued through 2004. In general, submersed aquatic vegetation did not appear to be negatively effected by the drawdown. Submersed aquatic vegetation standing crop biomass was significantly lower in 2000 and 2001 (0 <20 g/m^2) from 1999 levels (35 g/m^2) and rebounded to 32 g/m^2 in 2002. By 2004, the average standing crop increased to 44 g/m^2.

Long Term Resource Monitoring Program- Submersed Aquatic Plant Trends 1998-2005

Heidi Langrehr- Wisconsin Department of Natural Resources

Through the Long Term Resource Monitoring Program, personnel from the Wisconsin Department of Natural Resources and Iowa Department of Natural Resources have collected submersed macrophyte data from 1998 to 2005 in Navigation Pools 4, 8, and 13 (respectively), Upper Mississippi River.

- In Pool 8, submersed macrophytes were recorded at 49% of the sites visited in 1998, 58% in 1999 and 48% in 2000. Since 2000, the percent of sites where submersed macrophytes were recorded has steadily increased to 71.4 % in 2006. The number of species recorded each year ranged from 14 to 16 species.
- In comparison, submersed macrophytes were recorded at about 41% of the sites in Pool 13 from 1998 through 2003. The number of sites increased to 47% in 2004 and 61% in 2006. Twelve to 16 species were recorded each year.
- In Pool 4, submersed macrophytes were recorded at about 37.5% of the sites visited in 1998 through 2002. (No data was available for 2003.) In 2004, the frequency was 31% and it steadily increased to 43.7% in 2006.

Islands built in 1998 and drawdowns conducted in 2001 and 2002 most likely contributed to increased water clarity and the increase in submersed macrophytes in Pool 8.

Additional macrophyte information and graphs can be viewed using the Upper Mississippi River Graphical Vegetation Database Browser located at:
http://www.umesc.usgs.gov/data_library/vegetation/graphical/veg_front.html.

Fish

Although fisheries impacts due to a drawdown were likely to occur, monitoring for effects on fish was limited to surveillance for fish strandings and fish kills associated with the drawdown process. Fish monitoring data from the Long Term Resource Monitoring Program was assessed for evidence of short term negative impacts to fish.

Fish Strandings

The possibility existed that during a drawdown many small backwaters would become landlocked for a certain amount of time, some of which could dry up completely or become unsuitable for fish life.

Backwater areas that could become isolated were incidentally monitored for dead and dying fish during the drawdown by the many field crews performing monitoring work in Pool 8. The general public was also alerted to be on the look out.

No fish kills or strandings were reported in the backwaters, however one fish kill consisting of about 1000 bluegill in the 2-4 inch range, was reported in a pond connected to the Mississippi River by a ditch. The fish apparently were trapped in the pond as result of an artificial blockage to the culvert and died as the water levels receded during the drawdown. While the relatively quick lowering of water elevation from a near record spring flood to a full implemented drawdown may have contributed to this fish kill, the primary cause was the absence of an unobstructed escape route which left the fish vulnerable to entrapment and dewatering.

Long Term Resource Monitoring Program

Andy Bartels-Wisconsin Department of Natural Resources

Because Pool 8 is a trend pool for the Long Term Resource Monitoring Program, data on fish abundance were available from 1993- 2004. The following evaluation of LTRMP data was conducted using the graphical fish browser available at: http://www.umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html.

Fish species were selected to represent a variety of communities across different habitat types and were evaluated by comparing post drawdown catch rates in Pool 8 to pre drawdown catch rates from 1993-2004 in order to detect evidence of short term negative impacts. Sampling methods selected included day electro-fishing, fyke netting, hoop netting and mini fyke netting, which were used for the periods of August 1 – September 4 and September 15 – October 31 for all years except 2003. (In 2003 sampling was conducted only by electro fishing during late September and October due to significant funding reductions.)

Species List by Community Group:

Main Channel	Backwater
Channel catfish	Bluegill
Freshwater drum	Yellow Perch
Shorthead redhorse	Black crappie
Sauger	Largemouth Bass
Walleye	Small mouth bass

Forage Fish	Exotic Species
Spot fin shiner	Common carp
Emerald shiner	
River shiner	

Community Response

The response to the drawdown by community group was as follows:

- Main Channel Group-no short term trends or differences in catch rates surrounding the drawdown

were observed.

- Forage Fish Group- an increase in catch rates for day electro-fishing was observed in Pool 8 surrounding the drawdown .
- Backwater Group-some short term differences in catch rates for day electro-fishing existed, but they were in the observed variation or trend patterns outside the buffered drawdown period (e.g. bluegill, yellow perch, and black crappie.) There were increases in the catch rate for bluegill in mini fyke nets and largemouth bass in fyke nets.
- Exotic- an increase in catch rates for common carp in fyke nets was observed.

Overall, there were no negative short term trends or differences in catch rates that could be credited to the drawdown. An increase was observed in catch rates for the forage fish group surrounding the drawdown period which may warrant further investigation during a future drawdown.

Freshwater Mussels

Gretchen Benjamin-Wisconsin Department of Natural Resources, Ken Lubinski-U.S. Geological Survey

No formal monitoring was planned to determine the effect of the drawdown on mussels because:

- The drawdown zone generally supports a limited number of mussels due to ice scouring of these shallow areas during the winter, a condition that makes it difficult for mussels to survive. In fact this was also one of the reasons for the choice of the 1.5 foot drawdown level.
- A survey was conducted in 1999 of known mussel beds that might be impacted during a drawdown. The results of that survey also indicated limited numbers of mussels in the drawdown zone.

Volunteer Rescue Effort – July 2001

A volunteer rescue effort was organized by Mississippi River Revival to move stranded native mussels to deeper water as the water levels were down about 9-12 inches of the expected 18 inches. This timing was chosen to minimize excessive exposure of the mussels to the direct air, while also providing volunteers with the ability to move mussels in shallow water out to deeper water. The effort was concentrated in the lower portion of Pool 8 and along areas where mussel beds were thought to be present, similar to the pre monitoring effort described above. Volunteers including U.S. Geological Survey biologists and Marian Havlik (Malacological Consultants) enumerated, sorted by species and moved over 5000 mussels to deeper water. During the survey more mussels were observed on the exposed sites than expected possibly due to the effects of the extended flood of 2001. The extended flood just before a drawdown may have put more mussels at risk because they moved into shallow water.

As a result of this monitoring questions arose for future drawdowns, including:

- How to minimize future mussel mortality during a drawdown?
- Can mussel risk to drawdown be anticipated?
- How fast do mussels colonize shallow water areas?

Shorebirds

Lisa Reid, Lara Hill, Amy Sietz - U.S. Fish and Wildlife Service

While the Mississippi River is not a major migration corridor for shorebirds, drawdowns expose substrates and create shallow water areas that serve to attract hundreds of migrating shorebirds. Shorebirds using the interior migration corridor of North America tend to be opportunistic when it comes to stopover sites rather than showing a preference to a particular wetland. Therefore habitats created during a drawdown will still be used even if the habitat is not available on a regular basis. Fall shorebird migration typically occurs between mid July and late September in this area coinciding with the approximate times of the scheduled drawdown. A weekly shorebird survey between June 11 and September 26 was conducted in lower Pool 8 in 2001 and 2002, to determine the migratory shorebird use of new habitats created during the drawdown. A weekly shorebird survey was also conducted in Pool 7 in 2001 for comparative purposes.

The results for Pool 8 monitoring were:

2001

- Twenty-two species of shorebirds and 1,211 individual shorebirds were observed during this time.
- Due to the weather conditions and water flows, the target level drawdown of 1.5-foot was achieved for only 6 weeks, from July 10 through August 14. Late July through early August is the traditional peak fall migration period for shorebirds. During these six surveys, 921 (73%) of the 1,255 total individual shorebirds were observed and the average number of species observed was 8.3.
- The other nine surveys contributed only (27%) of the total shorebird observations, and the average number of species observed was 4.8.

2002

- The number of shorebirds observed during weekly monitoring surveys in Pool 8 nearly doubled from the 2001 season.
- Over 2,230 shorebirds of 22 different species were observed during 13 surveys compared to the 1255 shorebirds recorded in 2001.

Monitoring in Pool 8 in 2001 and 2002 suggests that the temporary feeding areas created by the drawdown attracted increased numbers of shorebirds as well as some uncommon species such as whimbrel and American avocet.

No data exists for shorebird use of Pool 8 before the drawdown but Pool 7 has historical data from surveys conducted in 1979-1983 (Unpublished data, Fred Lesher.) The results of

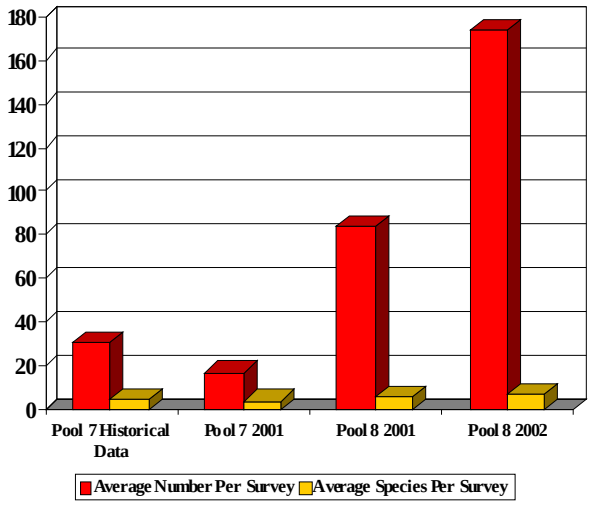

Figure 6. Comparison of average shorebird numbers and average species observed between Pools 7 and 8.

surveys conducted in Pool 7 in 2001 were similar to the historical data. A much lower average number of shorebirds were observed in Pool 7 for both the historical data and 2001 when compared to Pool 8 results for 2001 and 2002 (Figure 6.)

Even though there are no other surveys in Pool 8 for comparison, the data suggests that the water level reduction in Pool 8 created vital feeding habitat for migrating shorebirds as indicated by the number of shorebirds and the number of different species observed.

Waterfowl

Lisa Reid-U.S Fish and Wildlife Service, Ruth Nissen-Wisconsin Department of Natural Resources

Drawdowns have been an important tool of wildlife managers for many years to restore marsh vegetation, particularly emergent aquatic plants, and to manage annual moist soil plants to improve food resources for waterfowl. The Pool 8 drawdowns were therefore expected to have a beneficial effect for waterfowl and other wetland wildlife.

Aerial Surveys

Monitoring the effects of the drawdowns on waterfowl relied primarily on the results of the weekly aerial waterfowl survey conducted in Pools 4 through 13 by the U.S. Fish and Wildlife Service and the Wisconsin Department of Natural Resources. Waterfowl surveyed include tundra swans, Canada geese, and 18 species of ducks. American coots, great blue herons, great egrets, bald eagles, American white pelicans and double- crested cormorants were also counted. Birds are counted out from the aircraft to a distance of about 1/8 mile on established flight lines; hence, these counts do not provide a total count of birds using a pool but instead provide an index to the number of birds using the area.

Weekly flights generally begin during the last week of September and end the week after waterfowl hunting season closes in Minnesota and Wisconsin, usually in late November or early December unless the river freezes first. Not all pools may be counted each week due to weather or other flight delays.

Evaluation of Waterfowl Use

The presence of dabbling or puddle ducks, geese and swans was used as an indicator to evaluate the effects of the drawdown on aquatic emergent plants, as they exploit this vegetation type that grows in shallow water areas targeted by the drawdown. Swan use especially can be an indicator of the effect of the drawdowns as they feed primarily on the tubers of arrowhead, an emergent plant. Diving ducks generally use the open water part of the pool that contains submersed aquatic vegetation for both feeding and loafing. An important exception is the canvasbacks which will feed in open water areas on wild celery winter buds (a submersed plant), as well as in emergent beds that contain arrowhead tubers, while on the Upper Mississippi River.

Waterfowl Use Days

The extent of waterfowl occurrence is described in terms of waterfowl use days, a number calculated from aerial survey counts. Use days account for variability issues inherent to these surveys (see above). More importantly, they provide a measurement of the biological carrying capacity of an area, that is, how many birds available feeding and resting sites can support, and for how long. Additionally, habitat/

population goals established by the North American Waterfowl Management Plan for migrating and wintering waterfowl are expressed in use days.

In general, a use day(s) is defined as: One bird on the river for one day equals one use day. Use days are calculated by averaging the number of birds counted on two consecutive flights and multiplying by the days between flights. (If 5000 birds were counted on one flight and 15,000 birds were counted on the next flight ten days later; use days would equal 100,000.)

Waterfowl use days for puddle ducks, tundra swans and diving ducks were compared between Pool 8, the drawdown pool, and Pools 7 and 9, non-drawdown pools. In recent years, these three pools and Pool 13 have provided the main waterfowl use areas on the Upper Mississippi River National Wildlife and Fish Refuge.

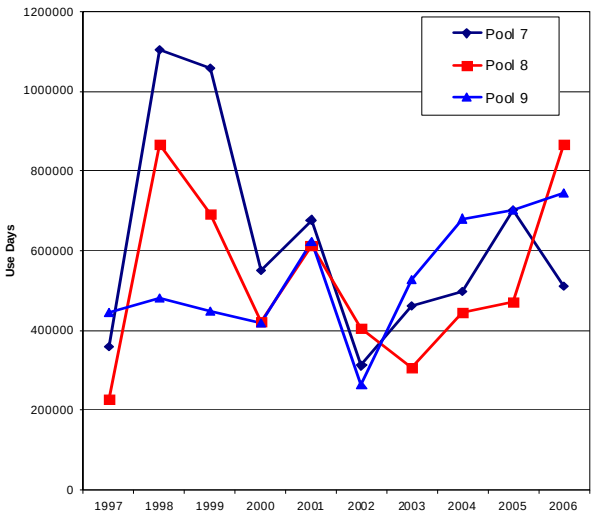

Figure 7. Puddle duck use days followed similar trends in Pools 7, 8 and 9 between 1997 and 2006.

Puddle Ducks

Some observations include:

- With two exceptions, year-to-year increases and declines in use days have followed similar trends in Pools 7, 8, and 9 between 1997and 2006 (Figure 7.)
- In the years prior to the drawdowns (1997-2000), Pool 7 consistently produced the most puddle duck use days of the three pools. However, from 2001 -2006 Pool 7 lost its prominence, and Pool 9 ranked highest in 2003, 2004, and 2005, while Pool 8 was highest in 2002 and 2006.
- Puddle duck use days in Pool 8 have continued to climb since 2003.

The response of puddle ducks to the change in vegetation which resulted from the drawdown is best observed on a localized level. The Goose Island No Hunting Zone, which covers 876 acres in the mid pool area of Pool 8, has historically provided the majority of puddle duck use days in Pool 8. In contrast, the Wisconsin Islands Closed Area (6,461 acres), also closed to waterfowl hunting and located in the lower portion of the pool, has not supported large numbers of puddle ducks. The Wisconsin Islands Closed Area which includes the Raft

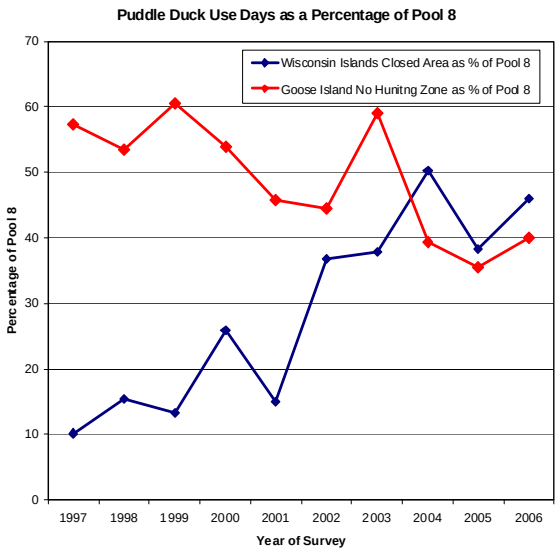

Figure 8. Puddle duck use days as a percentage of Pool 8 for Wisconsin Islands Closed Area compared to Goose Island No Hunting Zone. By 2004 the number of puddle duck use days recorded in the Wisconsin Islands Closed Area exceeded those in the Goose Island No Hunting Zone.

Channel area had a demonstrated vegetation change starting the first year of the drawdown in 2001. In 2006 the beds of emergent plants, primarily arrowhead, were still persisting in this area.

After 2001, there was a shift of puddle duck use within Pool 8 to the Wisconsin Islands Closed Area, as reflected by the steady increase in the percentage of use days in the Wisconsin Islands Closed Area and corresponding decrease in the Goose Island No Hunting Zone compared with the total pool. By 2004, the number of puddle duck use days recorded in the Wisconsin Islands Closed Area exceeded those in the Goose Island No Hunting Zone (Figure 8.)

Tundra Swans

Pool 8 has provided the most tundra swan use days on the Refuge each year from 1997-2006 with the exception of 2005 (Figure 9.) Prior to the drawdowns of 2001 and 2002 swans congregated in several places in Pool 8 including Wisconsin Islands Closed Area Goose Island No Hunting Zone, and the lower Pool 8 area open to hunting. For example in 1996 at the peak count there were 3,415 swans in the Wisconsin Islands Closed Area and 1,275 in the Goose Island No Hunting Zone. In 1998 there were 5,860 swans in the Wisconsin Islands Closed Area and 2,679 in the Pool 8 Open Area.

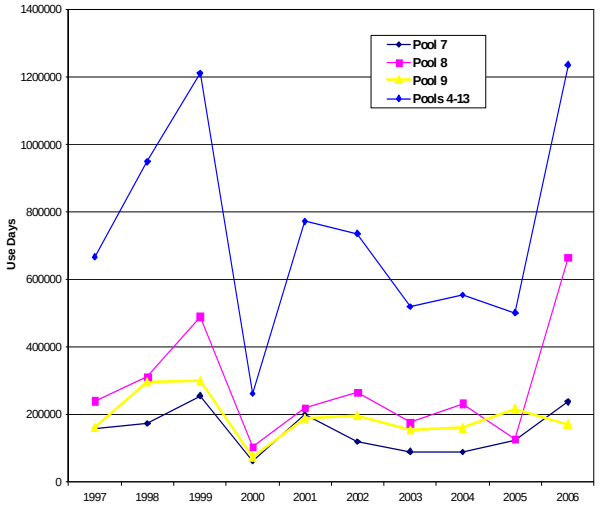

Figure 9. Tundra swan use days for Pools 7, 8 and 9. Pool 8 provided the most use days from 1997-2006 with the exception of 2005.

Tundra swans quickly responded to the development of arrowhead beds in the Wisconsin Islands Closed Area which resulted from the drawdowns as exhibited by the shift in swan use within Pool 8 after 2001 to the Wisconsin Islands Closed Area (Figure 10.) This 6,461 acre closed area provided the most swan use days on the entire refuge from 2002 through 2006 with the exception of 2005 when Pool 9 had the most. This trend culminated in 2006 when the Wisconsin Islands Closed Area had 50% of the total swan use days on the entire Refuge. In 2006 the peak count in the Wisconsin Island Closed Area was 31,560 swans, Pool 8 Open was 175 and Goose Island No Hunting Zone was 645.

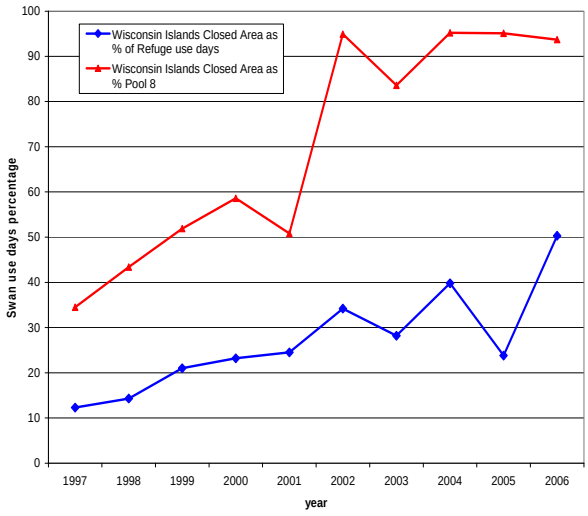

Figure 10. Tundra swan use days in the Wisconsin Islands Closed Area as a percentage of Pool 8 use days and as a percentage of the Upper Mississippi River National Wildlife and Fish Refuge which is comprised of Pools 4-13. Swan use within Pool 8 shifted after 2001 to the Wisconsin Islands Closed Area.

Diving Ducks

Diving ducks or divers generally use the deeper and more open portion of lower Pool 8 for both

feeding and loafing during fall migration. While eight species of diving ducks are found on Pools 4- 13 during fall migration; canvasback ducks comprise the large majority followed by lesser scaup and ring-necked ducks. Not all divers have the same diet. Lesser scaup feed on invertebrates whereas canvasbacks consume both invertebrates and plants, primarily feeding on wild celery winter buds and arrowhead tubers while on the Upper Mississippi River.

Diving duck use days on Pool 8 decreased in 2000, and continued the downward trend during the years of the drawdowns in 2001 and 2002. Use days then increased in 2003 and every year thereafter (Figure 5.) In contrast the submersed aquatic vegetation (SAV) standing crop biomass in Pool 8 dropped in 2000 from 1999 levels and then tended to increase through 2004. Wild celery biomass also increased in a rather consistent pattern during 2000 to 2004. These positive changes in SAV biomass during the drawdown years while canvasback use days decreased indicate that other variables affect the number of diving duck use days besides the abundance of SAV. For example, according to the USFWS Waterfowl Population Status for 2006 report the breeding population estimate for canvasback ducks hit a 10-year low in 2002, the second year of the drawdown and this may have had an effect. While there was a decline in diving duck use days on Pool 8 that year there was also a decrease on Pools 7 and 9 (Figure 11.) Likewise the increase in diving duck use days on Pool 8 since 2002 is probably the result of several variables including the increase in the abundance of submersed aquatic vegetation, especially wild celery.

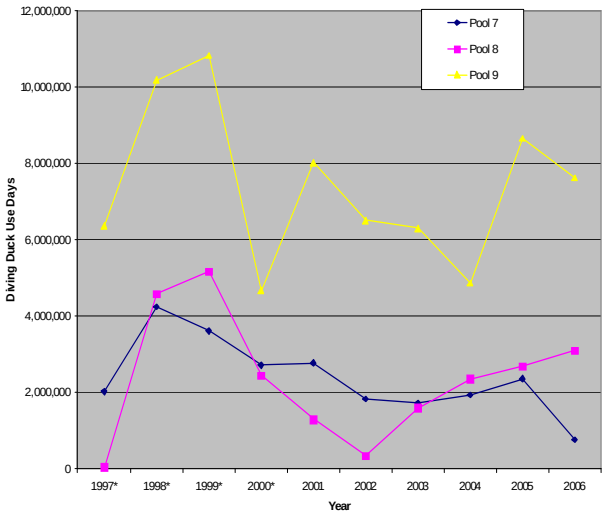

Figure 11. Diving duck use days on Pools 7, 8 and 9 of the Upper Mississippi River

Conclusion

It is difficult to assign changes in waterfowl distribution on an individual pool or a refuge basis to one event or variable such as a drawdown because distribution is influenced by many factors, including: the effects of hunting and other forms of human disturbance on waterfowl, the amount of available food, the longitudinal distribution of food resources on the river and the distances ducks are known to fly from roosting to feeding sites, and other biological needs.

Waterfowl use days are also affected by flyway waterfowl populations and the timing of freeze-up in the fall. For example, swan use days in 2005 were low because tundra swans spent far less time than normal on the river due to an early freeze-up, but also the midwinter abundance index (in thousands) for the Eastern population of tundra swans was 70.5 – the second lowest since 1996. Similarly, the breeding population estimate for canvasback ducks hit a 10-year low in 2002, the same year as the second drawdown in Pool 8. Hence, any trends in waterfowl use on a single pool or refuge-wide basis need to be evaluated with caution. With these caveats in mind the results of the surveys suggest:

- Use days for puddle ducks in Pool 8 fluctuated similarly to Pools 7 and 9,although the response to the drawdowns was more evident on a localized basis.

- Pool 8 has provided the most tundra swan use days on Pools 4-13 each year from 1997-2006 with the exception of 2005.
- The decline in diving duck use days during the drawdowns in 2001 and 2002 on Pool 8 were more than likely due to other variables as the frequency of submersed aquatic plants, including wild celery, actually increased during those years. However, the increase in the abundance of submersed aquatic plants on Pool 8 as well as other pools has certainly contributed to the increase in use days of diving ducks since 2002.
- The response of waterfowl to changes in habitat resulting from the drawdowns is perhaps best observed in a localized area such as the Wisconsin Islands Closed Area which demonstrated a vegetation change from 2001-2006.
    1. After the first drawdown in 2001, there was a consistent shift of fall season puddle duck use within Pool 8 to the Wisconsin Islands Closed Area. This closed area has not been the main source of puddle duck use days on Pool 8 in recent history providing 10-25% of the use days. Since 2002 this area has provided between 40-50 % of the use days in Pool 8.
    2. Tundra swan use in Pool 8 quickly shifted to the Wisconsin Islands Closed Area in response to the development of arrowhead beds. This closed area had a peak population of 31,650 swans counted during the waterfowl aerial survey on November 20, 2006. This area also produced 50% of all Refuge-wide (Pools 4-13) tundra swan use days in 2006.

Waterfowl Hunter Surveys

Lara Hill-U.S. Fish and Wildlife Service

In 2001, personnel from the U.S. Fish and Wildlife Service and U.S. Geological Survey conducted interviews with 924 waterfowl hunting parties at access sites around Pool 8. These interviews or "bag checks" occurred on 25 randomly selected days throughout the 60-day duck hunting season, September 29 through November 27. Hunting parties may have been interviewed on multiple occasions during the season.

During each bag check, hunters were asked a number of questions related to their day's hunting experience in addition to two questions specific to the Pool 8 drawdown. They were:

1) Were you aware of the water level reduction in Pool 8?

2) If yes, do you feel the water level reduction had a positive or negative effect on river habitat?

The results were:

A total of 921 parties answered the first question. Of those, 867 (94%) said they were aware of the drawdown; 54 (6%) reported they were not.

The second question drew responses from 865 parties.

- A total of 535 parties (62%) felt the drawdown produced positive results in 2001 and 124 parties (14%) thought the results were negative.
- The majority of responses from the remaining parties, 172 (20%), said they either did not know or

felt more than one year is needed to determine how Pool 8 habitat will be affected by the drawdown.

- Finally, 34 parties (4%) thought habitat conditions on the pool stayed ***about*** the same.

In 2002, interviews were conducted with 344 waterfowl hunting parties at access sites around Pools 7 and 8. These interviews occurred on 12 randomly selected days (five surveys days on Pool 7 and seven days on Pool 8) throughout the 60-day duck hunting season. Hunters on both pools were contacted because many hunters hunt waterfowl in both pools and a comparison between survey results for the two pools would offer some perspective. The results were:

- A total of 175 parties from Pool 8 answered the first question. Of those 139 (79.4 %) said they were aware of the drawdown, 36 (20.5%) were not. This was a slight increase from 6% of parties not aware of the drawdown in 2001.
- The percent of hunters who thought the drawdown had obtained a positive result was 66.9%, a slight increase from 2001. The percent of hunters who thought the drawdown had a negative effect dropped from 14% in 2002 to 6.4% in 2002, while the number of hunters undecided about the results rose from 20% to almost 22.3%.
- Survey results indicated Pool 7 hunters were only slightly less aware of the drawdown in Pool 8 but were inclined to be less positive about the results of the drawdown.

Table 2. A summary of the results of the drawdown questions on the hunter surveys.

Year	# of parties	Aware-Yes	Not aware	Positive results	Negative results	undecided	No change
2001	921	94% (865)	6% (54)	62% (535)	14% (124)	20% (172)	4% (34)
2002	216	78.7% (170)	21.2% (46)	64.1% (109)	7.6 % (13)	22.9% (39)	Not asked
Pool 8 total	175	79.4 % (139)	20.5 % 36)	66.9% (93)	6.4% (9)	22.3% (31)	
Pool 7 total	41	75.6% (31)	24.3% (10)	51.6% (16)	12.9% (4)	25.8% (8)	

Avian Botulism

William Thrune-U.S. Fish and Wildlife Service

Avian botulism is an often fatal disease of birds resulting from ingestion of toxin produced by the bacterium Clostridium botulinum. This bacterium persists in wetlands. Important environmental factors that contribute to initiation of avian botulism outbreaks include water depth, water level fluctuations, and water quality; the presence of carcasses; rotting vegetation; and high temperatures. Because many of these factors may be present during a drawdown, extra monitoring was planned for lower Pool 8 during the drawdown.

Crews from the Wisconsin DNR, U.S. Geological Survey, and U.S. Fish and Wildlife Service engaged in drawdown monitoring activities were also on the lookout for the presence of sick/dead waterbirds. They observed minimal waterbird mortality on lower Pool 8 during 2001 or 2002. The only occurrence of avian botulism was on a stretch of the Black River in upper Pool 8. (Botulism has occurred on this stretch in the past.) During the summer of 2001 nearly 50 sick/dead mallards and one herring gull were removed from the area. Additional mortality may have occurred but was not reported or observed. Many local residents, marina owners and boaters aided local resources managers in locating these birds. Avian botulism was confirmed by the National Wildlife Health Center in a mallard carcass collected August 8.

EFFECTS ON PHYSICAL AND CHEMICAL PARAMETERS

Water Quality Sampling, Wisconsin DNR

Sediment Consolidation

Prior to the drawdown it was known that sediment organic content in the drawdown zone would decrease depending on the sediment type, initial water content of the sediment, position in the drawdown zone, length of the drawdown period, rainfall during the drawdown, air temperature, wind, humidity, groundwater seepage, and reflooding. However more information was needed regarding impacts of changes in sediment characteristics as a result of the desiccation and rewetting process.

Experimental Determination of the Impacts of Sediment Desiccation and Rewetting on Sediment Physical and Chemical Characteristics in Lawrence Lake, Pool 8

William F. James, John W. Barko and Harry L. Eakin- U. S. Army Corps of Engineers

In June, 2000 over fifty intact sediment cores were collected at a station (depth = 0.7m) located near the entrance to Lawrence Lake. The surface sediments at this site exhibited high moisture content and low sediment density; characteristics which are typical of backwater areas of Pool 8. The sediments were dried under laboratory conditions and subjected to treatments to determine loss of moisture from sediment cores over time, chemistry of pore water, organic matter content, and concentrations of nitrogen and phosphorus compounds.

The results were:

- The desiccation process resulted in substantial sediment consolidation as the percent moisture and organic matter content declined while sediment density increased after the rewetting process.
- Sediment desiccation and rewetting resulted in marked changes in sediment P (phosphorus) characteristics including, pore water P mass, and mean mass of aluminum bound P and calcium bound P. However the mean mass of sediment organic P appeared to remain approximately constant.

- There was an overall net loss of organic N as a result of the desiccation and rewetting process that could not be accounted for by increases in other N fractions. This pattern suggested that N was being lost to the atmosphere via denitrification.

Increases in available nitrogen, coupled with consolidation of loose organic sediments suggested that desiccation of sediment in Lawrence Lake would likely result in improved conditions for submersed aquatic plant growth including: reduction in sediment resuspension potential, improvement of rooting medium (i.e. nutrients and sediment texture) for submersed aquatic plant growth, conversion of soluble nutrients to particulate forms and reductions in organic matter concentrations.

However, consolidation of sediments was limited during the drawdown in lower Pool 8 because much of the sediment exposed at the 1.5 foot drawdown level consisted of silty sand with low organic content.

Nitrogen Cycling in Backwater Sediment

Dr. William Richardson, U.S. Geological Survey-Upper Midwest Environmental Sciences Center

Nitrogen enrichment of the Mississippi River may be the cause of two important environmental issues in the Midwest—high levels of toxic ammonia in river sediments and wide spread hypoxia (low oxygen concentrations) in the Gulf of Mexico at the mouth of the Mississippi River. Little is known about how nitrogen in the Mississippi River is processed, stored or biologically removed by the River ecosystem.

Water level management has the potential to affect significant changes in nitrogen cycling and reduce the accumulation of potential harmful ammonia in highly organic backwater sediments. Ideally, a drawdown will dry and oxygenate organic sediments, increasing the oxidation of accumulated ammonia to nitrate. Upon rewetting, sediments again become anaerobic, and nitrate is removed through the natural process of bacterial denitrification (converted to inert nitrogen gas and released to the atmosphere). This process requires anaerobic conditions, highly organic sediments, and nitrate - all conditions provided by drying and rewetting of backwater areas (Figure 12.)

As part of a larger research program on nitrogen cycling in the Upper Mississippi River Basin, Dr William Richardson and team of scientists from the U.S.G.S.- Upper Midwest Environmental Sciences Center in La Crosse measured a suite of sediment characteristics and bacterial processes before, during and after the summer drawdowns of Pool 8 in 2001 and 2002.

In 2002 they determined the effects of sediment drying and rewetting resulting from the water level drawdown on patterns of sediment nitrification and denitrification and concentrations of sediment and surface water total nitrogen, nitrate and ammonium. In 2001 they only examined sediment ammonium and total nitrogen. The results were:

- Sediment ammonium (NH4) decreased significantly during periods of drying although there were no consistent trends in nitrification and denitrification or a reduction in total sediment nitrogen.
- The reduction of sediment ammonium (NH4) was likely a result of increased plant growth and nitrogen assimilation, which was then redeposited back to the sediment surface upon plant senescence.

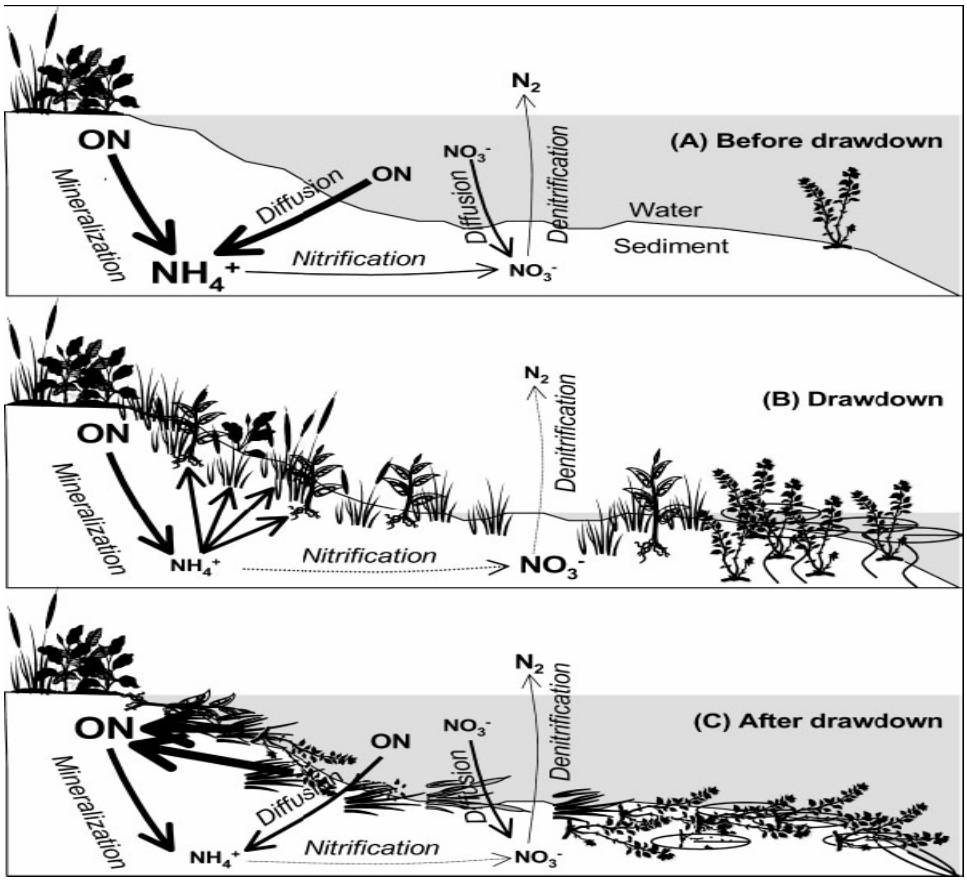

Figure 12. Conceptual model of nitrogen (N) cycling in Upper Mississippi River Pool 8 in 2002:
(A) saturated conditions before water level drawdown, (B) during water level drawdown, and (C) after rewetting.
Under normal pool management (A), there is a significant pool of sediment ammonium (NH4þ), primarily generated from mineralization of organic nitrogen (ON); nitrification and denitrification are coupled resulting in very low levels of sediment nitrate (NO3_).

During drawdown conditions (B), plant assimilation, initial increases in nitrification, and potentially a slowing of mineralization significantly reduces the sediment NH4þ pool, whereas nitrification and denitrification are uncoupled resulting in a build up of sediment NO3_.

Upon rewetting (C), plant senescence and decomposition increase the organic N pool, but the anaerobic conditions and low NH4þ in the sediment continues to inhibit nitrification. Anaerobic conditions also stimulate denitrification and subsequent reduction in sediment NO3_. Arrow line thickness and text size correspond to the relative concentrations of N in each pool.

- Water level drawdowns likely reduce denitrification due to reduced delivery of nitrate-rich river water, water retention time, and river floodplain connectivity, while promoting significant accumulation of organic nitrogen.

These results indicate that water level drawdowns are probably not an effective means of removing nitrogen from the Upper Mississippi River.

Water Quality

Continuous Water Quality Monitoring Results for Pool 8 Drawdown

John Sullivan - Wisconsin Department of Natural Resources

Continuous monitoring of dissolved oxygen, water temperature, light penetration and wind speed and direction were made in lower Crosby Slough off Stoddard, Wisconsin during June to September 1999 (pre-drawdown) and 2001 (during drawdown). In addition, daily composite samples of turbidity and total suspended solids were collected with a automatic water sampler and measurements of gross sedimentation were estimated using sediment traps. The purpose of this monitoring was to assess potential changes in water quality associated with the drawdown.

River flows were greater during the drawdown in 2001 than pre-drawdown measurements made in 1999 which presented difficulty in evaluating drawdown-induced water quality changes. It was suspected that drawdown would promote increased sediment resuspension due to wind stress over shallower water. However, wind-induced effects on sediment resuspension (increased total suspended solids or turbidity) were generally low at the monitoring site and were easily over shadowed by changes in river flow. Other results were:

- Mid-day light penetration was less in 2001 yielding a confounding response compared to measurements of total suspended solids.
- Diurnal dissolved oxygen fluctuation (maximum-minimum) increased noticeably in 2001 as compared to 1999 and was likely a drawdown-related. These changes in dissolved oxygen were attributed to increased submersed aquatic plant growth and attached algae in the vicinity of the monitoring platform in 2001 rather than increases in phytoplankton concentrations. Although dissolved concentrations showed large daily fluctuations in 2001, levels rarely fell below the 5 mg/L water quality standard.

In general total suspended solids and turbididty were not significantly greater during the summer of 2001 when the pool was drawn down 1.5 feet as compared to 1999 when accounting for changes in river flow between the monitoring periods. Wind induced effects on sediment resuspension explained less of the variation in total suspended solids, turbididty or light penetration than river flow. As a result, it can not be concluded that wind-induced effects on sediment resuspension were greater during the drawdown based on these data.

Long Term Resource Monitoring Water Quality Trends 1988-2005

Jim Fischer- Wisconsin Department of Natural Resources

A number of factors affecting water quality have been monitored in Pool 8 since 1988 through the Long Term Resources Monitoring program and these same factors were monitored during the 2001 drawdown. Notable trends include:

- Suspended solids concentrations during summer stratified random sampling (SRS) events continued on a decreasing trend. Median concentrations in the backwater and impounded strata (7.4 and 6.8 mg/L, respectively) of Pool 8 during 2005 were the lowest recorded since SRS began in 1993.

- A record-low dissolved oxygen concentration (DO) was observed at a lower pool fixed-site in July 2001, but it followed a trend that had started before the drawdown. The median DO concentration (8.9 mg/L) during summer SRS was similar to other years in the impounded stratum, suggesting that the drawdown had no detectable effect on DO concentrations in that stratum.
- Nutrient and chlorophyll a concentrations and patterns were generally similar to those observed in Pools 4 and 13 during the summer SRS period. For example, median nitrate-nitrite concentrations in the backwater stratum of the three pools ranged from 1.1 to 1.6 mg/L during 2001 and from 1.5 to 1.7 mg/L in 2002.
- The highest median nitrate-nitrite nitrogen concentration during 12 years of summer SRS was recorded for Pool 8 backwaters in 2004, however backwater concentrations were similarly high in Pool 4. Higher concentrations were also recorded in the main channel and were likely a result of increased watershed inputs.

In general, there were no obvious changes in water quality parameters that could be directly attributed to the drawdowns; most parameters were within the normal range of variability and followed the same patterns or trends as previous years.

Contaminant Monitoring

Numerous investigations have documented environmental contaminants and their effects in the Upper Mississippi River ecosystem. These investigations indicated that while environmental contaminants occur within the Pool 8 ecosystem with the possible exception of localized "hotspots", significant threats to fish and wildlife resources were not expected under normal circumstances. However the degree to which these contaminants could become available to the food chain and result in adverse effects due to water level management practices in Pool 8 was unknown.

Contaminants in Tree Swallows in Relation to Water Level Management

Dr. Thomas Custer and Dr. Christine Custer, U.S.Geological Survey-Upper Midwest Environmental Sciences Center

The purpose of this study was to determine the degree to which the bioavailability of environmental contaminants in Pool 8 was affected by the drawdown. Contaminants were a concern as sediments would be exposed in the lower part of Pool 8 for the first time in 60 years during the drawdown. Also flooding of previously dried out wetlands, such as a year following a drawdown, could have increased the rate of mercury methylation and in turn made mercury more available to terrestrial vertebrates that feed in aquatic environments. Tree swallows were a useful species for contaminant assessment of sediments. They feed on emergent aquatic insects and therefore their eggs and tissues reflect sediment contamination. Tree swallows were also used to identify contaminant pathways and to determine if these contaminants may affect reproductive success. Samples of swallow eggs and nestlings were collected and analyzed for mercury and other contaminants in 2000, 2001 and 2002. The findings were:

- Mercury concentrations in tree swallow eggs and nestlings did not significantly increase after the Pool 8 drawdown. Mercury concentrations in eggs were intermediate to levels reported in tree swallows from other North American locations.
- Metals and other elements, PCB's, and organochlorine insecticides did not increase following the 2001 drawdown and were not elevated compared to other samples collected from other North American locations.
- Hatching success of eggs did not differ among years or locations and was comparable to a nation wide average.

In conclusion, the bioavailability of contaminants did not appear to increase as a result of the drawdown.

RIVER USE MONITORING

Lower Pool 8, Wisconsin DNR

Commercial Navigation

Commercial Tow Operator Surveys

U.S. Army Corps of Engineers

Towboat operators were provided informal survey forms at L/D 8 (upbound) and L/D 7 (downbound) and asked to turn the forms in at the next lock and dam after they traversed Pool 8. Between 4 July and 15 August (dates of the earliest and latest returned forms) roughly 100 towboats passed through Pool 8. Of the 100 towboats, 10% turned in survey forms. Below are the questions asked and a summary of how they were answered:

1. Compared to previous years was navigating Pool 8.…
   About the same (6), more difficult (4), less difficult (0)
2. How have the main channel current velocities affected you during the drawdown?
   Same (7) Less (0), More (3)
3. How has the outdraft at L/D 8 affected you during the drawdown?
   Same (2), Less (2), More (4), No affect (2)
4. How has the drawdown affected your flanking ability/ maneuverability throughout pool 8 during the drawdown?
   Same (4), Less (0), More (4), No affect (2)
5. List any general or specific comments you have below regarding the pool 8 drawdown.
   Sub par channel conditions; too shallow and narrow (6)
   Great idea for habitat improvement (2)
   Barges pulled towards shallow water (1)

In summary, Pool 8 is generally described as a pool that is already tough to navigate. During the drawdown, navigating the pool was a bit tougher, however it was still navigable. The outdraft at L/D 8 seemed t be a bit more pronounced an maneuvering in some areas of the pool was tougher than usual.

Recreation and Commercial Uses

Although the long term environmental and ecological improvements expected from a summer drawdown in Pool 8 would benefit boating and fishing enthusiasts, the potential short term negative effects on these activities were recognized by the Water Level Management Task Force. These effects were primarily associated with reduced launch ramp or dock access, reduced harbor or marina access, reduced boat house access, reduced backwater access, and potential safety concerns due to submerged hazards such as wing dams. As a result an effort was made to minimize those effects prior to the drawdown and monitor the impacts of the drawdown on recreation during the drawdown.

Extensive information was gathered about boating access sites, beaches, popular backwater areas, wing dams in Pool 8, and commercial recreational facilities. On this basis as well as public input received at public meetings and results from questionnaire surveys provided to commercial and recreational interests, a minimum elevation at the La Crosse gage of 4.2 was selected, to minimize adverse effects in the La Crosse area on commercial and recreational interests. (Please note that the official La Crosse gage at Isle la Plume hit a low of approximately 3.8 - 4.0 during the weekend of August 11-12. Sand from the high floodwaters during spring filled the gage causing inaccurate readings. The gage was repaired and the water level was remedied as quickly as possible.)

The effect on commercial and public recreational facilities in lower Pool 8 also entered into the selection of a target drawdown level at Lock and Dam 8. Provisions were also made for dredging to provide adequate access at some recreational boat landings and access channels through the federal Continuing Authority Program – Section 1135 which provided a 75 percent cost share to local governments or residents. However, federal contract regulations increased the cost of dredging substantially for the 25 percent local cost share.

Recreational Use Assessment during the Drawdown in Pool 8

The impacts on recreational use during the drawdown of Pool 8 were evaluated using the biennial Recreational Boating Study of the Upper Mississippi River which began in 1989 and is repeated in odd numbered years. This aerial survey includes a study area from lower Pool 4 to the U.S. Army Corps of Engineers -St. Paul District line in Pool 11, near Guttenburg, Iowa.

It has since been estimated that aerial surveys confined to the main channel capture about 60% of total boating use based on the results of a mail in survey conducted in 2003. The other 40% is off the main channel in side channels and backwater areas. However the results of the aerial survey provide perspectives of trends in boating use over the 1989-2003 period and enable comparisons between Pools 7, 8, and 9 to determine effects from the drawdown.

While the techniques have remained consistent, the number of survey flights was reduced to five in 2003 due to a reduction in funding. The years 1999 and 2001 were more comparable with 11 flights in 1999 and 12 in 2001.

Results

In general, recreational boating activity within the study area (Pools 4-11) during 2001 appeared to be slightly lower than the levels documented between 1989 and 1999. In contrast the average peak day watercraft counts for 2003 greatly exceeded all of the other years in the study period. This may be due to the fact that the 2003 survey consisted of only five flights, four of which were on peak days and one of which took place on Saturday, July 5, a day when an exceptional amount of recreational boating activity occurred.

Geographic Distributions

The data suggest that watercraft were distributed widely within the study area from 1989 to 2003. Some geographic trends related to the drawdown in Pool 8 as well as Pools 7 and 9 include:

- Pools 4, 8 and 10 had the most boating activity during the study period.
- The proportion of boating activity in Pool 7 appears to be consistent. Even with a sharp increase in the number of boats counted in 2003 the percent distribution in Pool 7 remained relatively constant.
- The proportion of boats in Pool 9 declined from 1989 through 1997, but the trend began to switch direction in 1999 and boat proportions continued to increase in 2001 and 2003.
- The total numbers of boats observed during the 2001 surveys decreased for all pools in 2001 from 1999 levels. However the proportion of boating activity actually increased in Pool 8 during 2001 and was slightly higher (+/- 2%) than the 1989-2003 average (not including the Black River zone, which was discontinued after 1997.)

In terms of boat distribution on Pools 7, 8 and 9, the 2001 drawdown of Pool 8 does not appear to have had a significant positive or negative impact on recreational boating activity.

Active and Beached Watercraft Levels

Some trends of note:

- There were approximately 30% more beached boats than active boats inventoried in the study area in 2003, reversing the overall historic trend.
- In 2001 there were approximately 35 % more active boats than beach boats.
- The percent distribution of beached watercraft decreased slightly in 2001 for Pools 7 and 9 but increased slightly in Pool 8.

Based on the percentage of distribution for both active and beached watercraft among all pools, the drawdown in 2001 appears to have had little effect on the distribution of watercraft in either category.

In summary, there does not appear to have been any major fluctuation in recreational boat activity in Pools 7, 8 or 9 other than the general decrease in boating activity during 2001 which occurred in all pools in the study area.

CULTURAL RESOURCES MONITORING

Confiscated artifacts that were illegally collected , U.S. Army Corps of Engineers

Cultural Resources Investigation Associated with the Drawdown of Pool 8

Bradley Perkl, U.S. Army Corps of Engineers- St. Paul District

Cultural resources along the Upper Mississippi River have been profoundly impacted as a result of the lock and dam system and other modern land use practices. Among a variety of complex mechanisms affecting cultural resources is shoreline erosion, caused by flood events, fluctuating water levels of the pool, and wave action from wind and commercial and recreational boat traffic. The susceptibility of each archeological site to erosion has many factors but in general erosion is detrimental to cultural resources. In addition to site destruction, indirect impacts from erosion potentially include site vandalism and artifact looting. Thus, the effects of a pool drawdown to individual cultural resources are difficult to predict and the Pool 8 drawdown had the potential to impact numerous cultural resources.

In an effort to understand the impacts that a drawdown would have on cultural resources, a cultural resources monitoring study was conducted which focused on known archeological sites located on the shoreline portion of Pool 8. The monitoring was conducted in three phases:

- recording the conditions of the sites before the drawdown occurred;
- recording conditions at maximum drawdown;
- recording conditions after the pool was restored to normal levels.

In addition to examining the known sites, previously unrecorded sites exposed during the drawdown were identified.

The Pool 8 drawdown monitoring study included a total of 33 archaeological sites-29 previously identified sites and four unrecorded sites. Results of the monitoring survey determined probable impacts of the drawdown expressed as none, low, medium, high and unknown. Of the 33 sites studied, the probable impacts were:

None: 7

Low: 7

Medium: 3

High 15

Unknown: 1

Unfortunately in between the time of the first location and the post drawdown assessment the Upper Mississippi River was subjected to severe spring flooding (pool elevations were more than 8 feet higher than the pool elevation during the drawdown). This rise in water levels affected the ability to evaluate the

impacts of the drawdown on the sites and the above results should be viewed as provisional.

The biggest threat to these sites is shoreline erosion, although the damage in this case was possibly the result of the severe spring flood rather than the fluctuation of water levels during the drawdown. Regardless of the cause, sites exposed through erosion are vulnerable to illegal collecting. Three sites in particular were very susceptible to looting activities due to their location near sites of heavy public use. Four others were of concern for illegal collecting to a lesser degree. As a result, a listing of those sites that are most likely to be illegally collected were forwarded to law enforcement personnel of the Upper Mississippi River National Wildlife and Fish Refuge to aid in the enforcement of historic preservation laws.

Appendix A: Animal and Plant Species Lists

Birds	
Common Name	**Species (Scientific Name)**
American avocet	Recurvirostra americana
American coot	Fulica americana
American wigeon	Anas americana
American white pelican	Pelecanus erythrothynchos
Bald eagle	Haliaeetus leucocephalus
Blue-winged teal	Anas discors
Canada goose	Branta canadensis
Canvasback	Aythya valisineria
Double-crested cormorant	Phalacrocorax auritus
Gadwall	Anas strepera
Great blue heron	Ardea herodias
Great egret	Casmerodius albus
Herring gull	Larus argentatus
Lesser scaup	Aythya affinis
Mallard	Anas platyrhynchos
Ring-necked duck	Aythya collaris
Sandhill crane	Grus canadensis
Tree swallow	Tachycineya bicolor
Tundra swan	Cygnus columbianus
Whimbrel	Numenius phaeopus

Fish	
Common Name	**Species (Scientific Name)**
Black crappie	Pomoxis nigromaculatus
Bluegill	Lepomis macrochirus
Channel catfish	Ictalurus punctatus
Common carp	Cyprinus carpio
Emerald shiner	Notropis atherinoides
Freshwater drum	Aplodinotus grunniens
Largemouth bass	Micropterus salmoides
River shiner	Notropis blennius
Sauger	Stizostedion canadense
Shorthead redhorse	Moxostoma macrolepidotum
Smallmouth bass	Micropterus dolomieu
Spotfin shiner	Cyprinella spiloptera
Walleye	Stizostedion vitreum
Yellow perch	Perca flavescens

Plant Species	
Common Name	**Species (Scientific Name)**
Barnyard Grass	Echinochloa crusgalli (L..) Beauv. Or muricata (Beauv.) Fern
Common Burreed	Sparganium eurycarpum Engelm.
Broad-leaf arrowhead	Sagittaria latifolia Willd.
Water stargrass	Zosterella dubia (Jacq.) Sma;;
Nodding smartweed	Polygonum lapathifolium L.
Chufa flatsedge	Cyperus esculentus
False pimpernel	Lindernia dubia (L..) Pennell
Teal lovegrass	Eragrostis hypnoides
Rice cut-grass	Leersia oryzoides (L.) Sw.
Sago pondweed	Potamogeton pectinatus L.
Wild celery	Vallisneria americana Michx.

For more information contact:

Jeffrey DeZellar U.S. Army Corps of Engineers St. Paul District 190 Fifth Street East St. Paul, MN 55101-1638 651-290-5433 Jeffrey.t.dezellar@usace.army.mil	Mark Andersen Wisconsin Dept of Natural Resources 3550 Mormon Coulee Road 108 State Office Building LaCrosse, WI 54601 608-785-9994 Mark.Andersen@Wisconsin.gov
Mary Stefanski U.S. Fish and Wildlife Service 51 East 4th St. Winona, MN 55987 507-494-6229 Mary_stefanski@fws.gov	Tim Schlagenhaft Minnesota Dept of Natural Resources 1801 S. Oak St. Lake City, MN 55041 651-345-3365 ext. 233 Tim.schlagenhaft@dnr.state.mn.us

Or visit the following website:
www.drawdowns.com