A Promising Approach for Ecological Restoration of Large Impounded Rivers: Process, Policy and Implementation Of the Pool 8 Drawdown On the Upper Mississippi River

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Introduction

The Upper Mississippi River is defined as the 1393-km (866 miles) section of the Mississippi River between Minneapolis, Minnesota and the Mississippi confluence with the Ohio River at Cairo, Illinois. The first main channel modification of 4-feet was authorized in 1824, a 4.5-foot channel was authorized in 1878 and a 6-foot channel was authorized in 1907. Channel modification activities included removing snags, dredging, constructing wingdams and closing dams to create the necessary depth for each authorization. The next major authorization came in 1930. Congress authorized the 9-foot channel project, which required the construction of 26 locks and dams between St. Louis, Missouri and St. Paul, Minnesota. The Upper Mississippi River navigation system, which currently includes 29 locks and dams, is managed by the U.S. Army Corps of Engineers divided into three districts, St. Paul, Rock Island and St. Louis.

Upper Mississippi River dams are operated with the intended purpose of providing a navigable 9-foot channel not flood control. Consequently, lower river flows are held back by the dam system but high river flows are allowed to pass by completely opening the dam gates. This operational mode allows beneficial floodwaters to pass in a more natural manner, allowing for some of the dynamic processes of a large river flood pulse. However, the majority of the year, the river system is impounded and the symptoms of an aging reservoir system are evident.

Although most modification of the Upper Mississippi River has been for commercial navigation, the river ecosystem has long been recognized as being a nationally significant resource. As early as 1924, Congress formally acknowledged the ecological significance of the Upper Mississippi River and its floodplain and authorized the Upper Mississippi River National Wildlife and Fish Refuge. The refuge extends from Rock Island, Illinois, to Wabasha, Minnesota. More recently, the Water Resources Development Act of 1986 reaffirmed the importance of this floodplain for fish and wildlife habitat when it formally declared the Upper Mississippi River a nationally significant ecosystem. Both designations have been paramount for the protection and restoration of the Upper Mississippi River ecosystem.

For years, state and federal natural resource managers and scientists have documented declines in habitat abundance as a result of impounding the Upper Mississippi River (UMRCC, 1946-2002, Environmental Studies Work Team, 1981; Lubinski et al, 1993; Szcodronski et al, 1993; U.S. Army Corps of Engineers, 1997; McGuiness, D. 2000; Theiling et al, 2000; WEST Consultants, Inc. 2000). The most readily observable change occurred as a result of the loss of islands eroding from continual elevated water levels and wave action associated with wind and boat wake waves. Landform maps from pre-locks and dams to the present document the loss of islands (Figure 1). Less visible, deep-water channels, slough and backwater lakes have been filling from the material of eroding island and sediment coming from adjacent watersheds. This loss is primarily documented by numerous accounts of long-time river users and managers describing the shallowing of traditional deep-water lakes and channels. In recent years, limited data has

been collected but the lack of depth data over time is something that can never be recovered (U.S. Corps of Engineers, 2000).

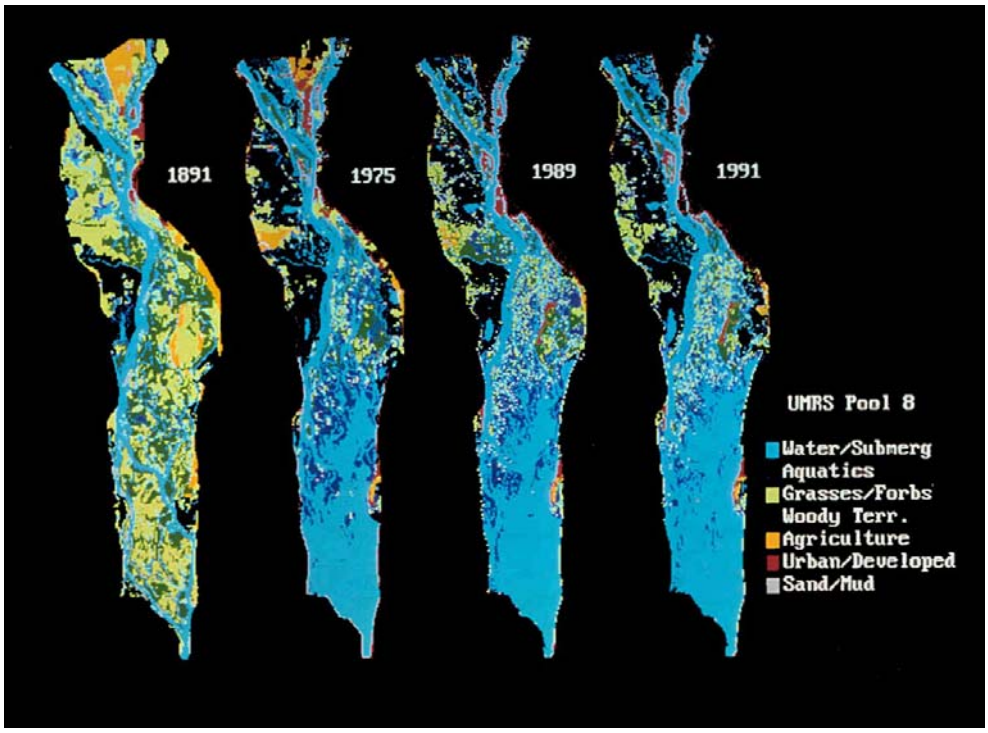

FIGURE 1: LANDCOVER AND VEGETATION CHANGES IN THE UPPER MISSISSIPPI RIVER

Today rather than deep, free-flowing channels routed by island structure, laminar flow characterizes the pooled portion of the river across wide areas. The littoral zones associated with islands have declined or have disappeared altogether. In many areas, the river is a vast, windswept water body with persistent turbid conditions. These abiotic structural habitat changes led to additional losses in the biotic community specifically noted in the aquatic plant community. Cumulatively, these conditions, as well as increased water levels from impoundment, have led to a loss of aquatic plant habitat for invertebrates, fish, wildlife, waterbirds and all species associated with the floodplain of the Upper Mississippi River. The loss of aquatic vegetation has diminished an essential ecosystem component of the Upper Mississippi River.

Over the years, natural resource managers have addressed many factors associated with habitat degradation and losses in the biological community on the river. The Clean Water Act provisions provided standards for effluent discharge to the river and tributary system, effectively minimizing or eliminating problems associated with low dissolved oxygen or contaminants inputs. Other water quality issues, such as non-point source pollution from urban and agricultural runoff, remain but in some instances the severity of

the problem has decreased. Actions ensued under the authority of National Environmental Policy Act (1969) eventually led to a new standard for dredging and dredge disposal in the Corps of Engineers' St. Paul. Environmentally sound practices for dredging and disposal of dredge material on the Upper Mississippi River is now used routinely.

With species-specific concerns, natural resource managers have successfully used traditional methods of conserving fish and wildlife populations. Commercial and sport fisheries population health is assessed through population studies and, if necessary, regulation changes are recommended on harvest. Waterfowl species are annually assessed on a national population level to determine the safe harvest levels for each species. These methods have often proven effective and, in many cases, have allowed this biota to persist in a degraded system.

Despite these large-scale water quality improvement and resource management tools, the river ecosystem has continued to decline. This has been attributed to changes that were occurring as a result of impounding the Upper Mississippi River (UMRCC, 1946-2002, Environmental Studies Work Team, 1981; Lubinski et al, 1993; Szcodronski et al, 1993; U.S. Army Corps of Engineers, 1997; McGuiness, D. 2000; Theiling et al, 2000; WEST Consultants, Inc. 2000).

The Upper Mississippi River System - Environmental Management Program, established through the Water Resources Development Act (1986), represented the first opportunity to restore lost habitat resulting from impoundment on the Upper Mississippi River. This federal program has two components. Habitat Rehabilitation and Enhancement Projects (HREPs), which feature island construction and backwater dredging, received two-thirds of the funding, or approximately $166 million since 1986 (USACE, 1997). The second component - Long Term Resource Monitoring Program (LTRMP) received one third of the funding.

An interagency team of river biologists, managers and engineers, led by the Corps of Engineers, plan the HREPs. These projects are a work in innovation, since this type of restoration work had not previously been done on a large river. Each new design builds on the successes and failures of past construction. Approximately 48 HREPs have been constructed or are under construction as of April 2003. Today, most of these projects function in a compatible manner with natural river systems**.**

Commencing Water Level Management

In the early 1990s, after a near complete system-wide collapse in aquatic vegetation, natural resource managers began discussing all feasible options for habitat rehabilitation and restoration. Within the direct and shadow area of influence of habitat projects (HREPs) habitat structures were producing conditions conducive for many aquatic plant communities, especially submersed aquatic vegetation. However, emergent aquatic plants did not respond with the same vigor most likely because natural seasonal low

water levels during the summer growing season had been eliminated, particularly in the lower portion of the pools as a result of impoundment (Lubinski, et al, 1993).

In 1994, the Corps' St. Louis District, in coordination with additional local, state and federal natural resource managers, completed the first pool level drawdown on the Upper Mississippi River. This experiment, in Pool 25, consisted of holding the pool level approximately 2 feet lower than in previous years, for a period of about 30 days during the growing season (Figure 2). This "drawdown" was followed by a slow rise back to "full pool". What resulted was an expanse band of moist soil plants, that when flooded, provided habitat and food for both fish and wildlife. All work was done within the USACE existing operating range and authority so there were no impacts to infrastructure, such as marinas, boat landings and commercial fleeting sites, which had to be built to accommodate the entire operational range (about 5 feet).

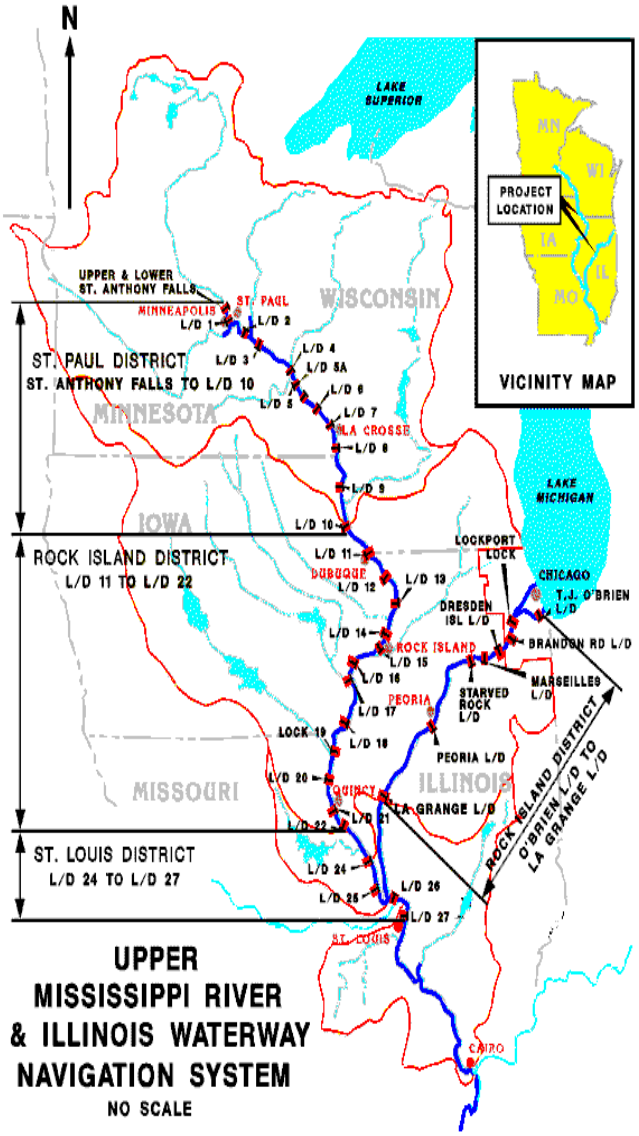

FIGURE 2: UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY NAVIGATION STYSEM

Following the success in 1994, Environmental Pool Management (EPM) was expanded to all three pools within the St. Louis District. EPM goals change each year based on expected flow conditions and input from the natural resource managers. In some years, the pools are held near the top of the operating range to improve to fish spawning opportunities; while in other years, the pools are held low to allow for maximum vegetation growth. Other years are somewhere in-between (Peterson, B, 2003, Personal Communication).

Encouraged state and federal natural resource managers and scientists from the Corps' St. Paul District wanted to evaluate the potential for water level management in the northern reaches of the Upper Mississippi River. As a result, a study was conducted under the direction of the Water Level Management Task Force of the River Resources Forum in cooperation with the St. Paul District. The River Resources Forum is an advisory body to the St Paul District, formed to offer recommendations and coordination of river-related issues. The Water Level Management Task Force is a technical advisory group established by the River Resources Forum in 1995.

Representatives from the Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the U. S. Coast Guard, the Iowa Department of Natural Resources (DNR), the Minnesota DNR and Department of Transportation (DOT) and the Wisconsin DNR and DOT became members of the task force. The membership was also extended to non-traditional representatives from the commercial navigation industry, the public and non-governmental groups. This expanded task force provided an effective forum to discuss all the potential issues during the planning stages of the investigation before discussing the issue with the general public and political leaders.

The Water Level Management Task Force, with funding and technical support from the Corps' St. Paul District, began the task of identifying all the water level management alternatives that may be feasible to implement. Ten alternatives were identified, and each alternative was sorted into high, medium and low priority based on criteria for habitat benefit, ease of implementation and expense (U.S. Corps of Engineers, 1996). Today, those categories are only slightly altered to define the current course of action for the Water Level Management Task Force.

Low Priority Alternatives – *These alternatives may be considered in the future but limited fiscal and human resources were best used on other tools.*

1. **Large-scale winter drawdowns** – This alternative could consolidate sediment and could potentially provide access to areas for habitat construction, but the adverse effect on fish and furbearers would be substantial. Additionally, this action would be in direct conflict with the Anti-Drawdown law of 1948.
2. **Spring Pool Raises** – This alternative could improve conditions for species that use flooded habitat for spawning but the ability to increase water levels without costly modification to the dam are limiting.

Medium Priority - *These alternatives may hold promise for the future but are costly to implement.*

1. **Increase the Frequency of Gate Adjustments** – This alternative could smooth out the daily water level fluctuations. It would require automatic gate adjustment in the lock house or an extra staff person 24 hours a day to implement.
2. **Modify Discharge through the Dam Gates** – This alternative would be done to improve riverine habitat below the dam. This alternative would also require automatic gate adjustment in the lock house or an extra staff person 24 hours a day to implement.
3. **Converting to Dam Point Control –** This alternative recommends the conversion most hinge point dams in the St. Paul District to dam point control to more closely replicate natural river water level fluctuations, which would benefit aquatic habitat. Hinge point control was pursued in the 1930's because it required less land acquisition for the management of the lock and dams so converting to dam point control would require lengthy deed searches and land acquisition.

High priority alternatives - *These alternatives were inexpensive to implement and were expected to provide significant habitat benefits. Therefore, after the completion of the Problem Appraisal Study (1996), these alternatives became the focus of the work of the task force.*

1. **Change the winter operation at the dams** – This alternative would eliminate the winter drawdown at the dam and operate the water levels on the high side of the operation band.
2. **Conduct drawdowns** – This alternative would be conducted during the growing season to promote aquatic plant restoration and sediment consolidation.
   a) small-scale
   b) medium-scale
   c) large-scale

The first alternative to be implemented by the task force was a change in the winter operation at the dams in the Corps' St Paul District. During the winter of 1995-1996, the task force along with the Upper Mississippi River Conservation Committee submitted a request to the Corps' St. Paul District to discontinue the practice of implementing winter drawdowns. Historically, pools were drawn down 0.3 feet during November so the water level could be raised during the spring melt and ice jams above the dam could be floated downstream. For the remainder of the year, the pools were regulated on the high side of the operation band. Therefore, just as many fish and wildlife species were settling into winter habitats, the pool level was reduced by 0.5 foot. Of particular concern, this reduction meant there was 0.5-foot less of water in deep backwater habitat, which is one of the most limiting habitats for a variety of backwater species, most notably the centrarchid fish family

In response, the Corps discontinued this practice in 1996 and made permanent modifications to its lock and dam operation plans. The habitat improvements from this

change were relatively minor and, therefore, difficult to document but data from the Long Term Resource Monitoring Program in Pool 8 may help evaluate the positive or negative changes over time. At present, the operational change was done at no appreciable cost and with no effect on the operations of the locks and dams and should provide positive benefits.

The other high priority alternative, drawdowns during the growing season, received further evaluation from the task force as a management action to improve conditions for the growth of aquatic vegetation and renew biological and chemical sediment characteristics through exposure and drying (USACE, November 1996). Three different scales of drawdown were evaluated, small, medium and large-scale drawdowns.

Small-scale drawdowns are defined as small water bodies (less than 50 acres) that can be isolated from the river with dikes or berms and drawn down temporarily. Medium-scale sites are larger waterbodies (50 to several hundred acres) that could be isolated in the river floodplain, similar to small-scale site but the dikes or berms would need to be more elaborate and/or permanent due to the size of the area. Both small and medium-scale drawdowns are considered expensive and labor intensive, but three small-scale drawdowns were pursued to determine if the assumed benefits would be realized on the upper portion of the river.

In 1996, the Minnesota DNR used sandbags to dike off a small backwater area called Small Bay West, Pool 5. The bay was dewatered for about 60 days, from mid-June to mid-August, as river water levels allowed. Pre- and post-vegetation sampling showed taxa increases from 22 to 42 species within the sampling transects with emergent/terrestrial plant species, increasing the most from 9 to 31 species. Community composition reflected a shift from 7 percent emergents pre-drawdown to 17 percent post-drawdown, 52 percent floating –leafed pre-drawdown to 42 percent post-drawdown, and submersed remained the same at 41 percent for both monitoring periods (Winkelman, 1997).

Two other sites, Lizzy Pauls Pond, Pool 5, and Peck Lake, Pool 9, were also drawn down using funds from the Environmental Management Program. Lizzy Paul's Pond was isolated using a sandbag dike in a culvert and then dewatered from June 24 to September 30, 1997. Pre-drawdown aerial photography showed the pond to contain 89 percent floating/submerged aquatic vegetation and 11 percent emergent vegetation. Post-drawdown aerial photography showed a shift to 65 percent floating/submersed and 20 percent emergent.

Peck Lake was scheduled for drawdown in 1997, but efforts were abandoned when high water in Pool 9 overtopped the sandbag closure in early July. In 1998, mudflats were exposed late in the season, and the drawdown maintained for a short portion of the growing season. Consequently, vegetation development on exposed mudflats was limited due to the late exposure date in 1998, and most plant species were dwarfed in size. Seed and tuber production were poor. Peck Lake was successfully dewatered for 90 days in 1999. Conditions were favorable for arrowhead plants that arose from tubers produced

during 1998. Plant growth was robust, and tuber production increased more than 600 percent of that in 1998. Pre-drawdown aerial photography from 1996 indicated that Peck Lake contained less than 5 percent emergent and less than 2 percent floating-leafed vegetation. A 140-180% increase in vegetative cover for Common Arrowhead (*Sagittarria latifolia)* and a 600-700% increase in plant height were documented on the 1998 to 1999 vegetation sampling transects. Unfortunately, the arrowhead established with the drawdown did not persist past 2000 (Kenow, Personal Communication, 2003).

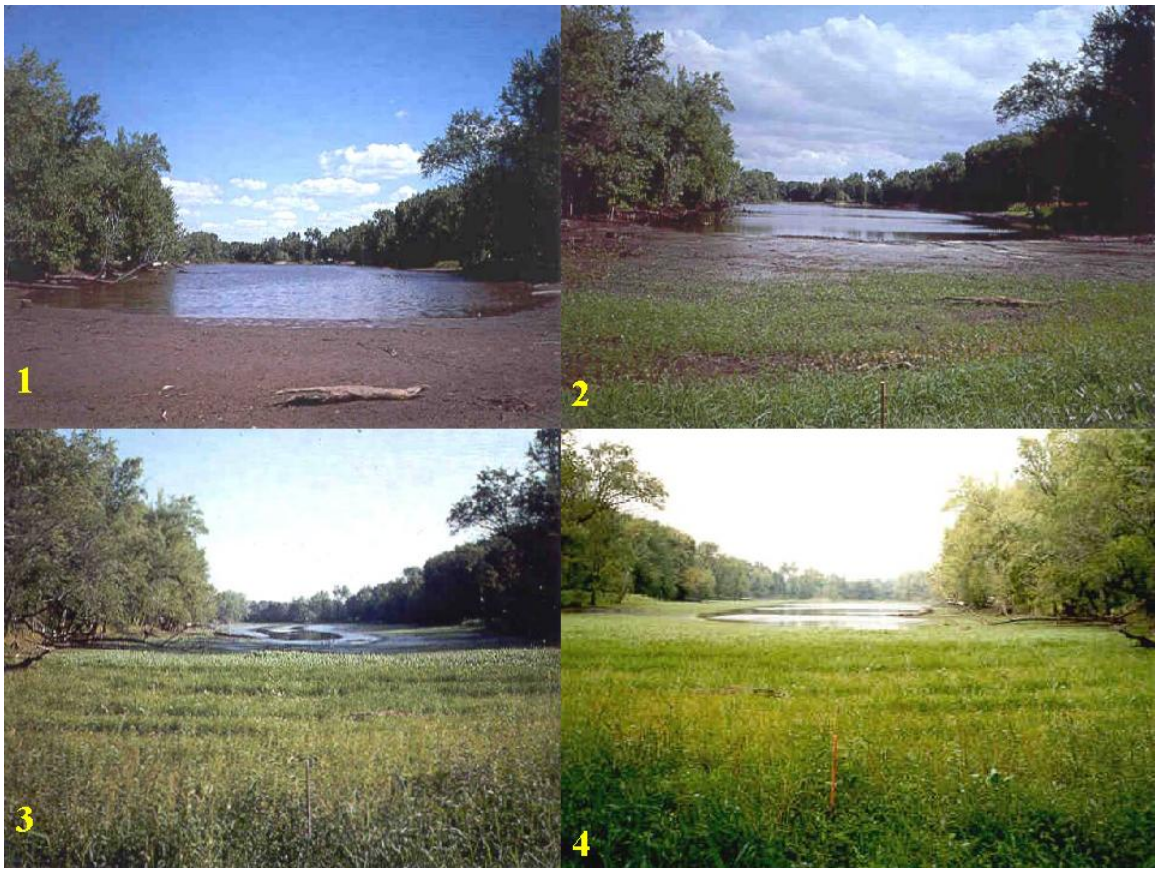

FIGURE 3: VEGETATION CHANGE IN PECK LAKE, UMR. POOL 9, 1997 TO 1999

Large-Scale Drawdown Process

All three small-scale drawdowns demonstrated improvement in the density and diversity of aquatic vegetation. These results prompted the task force to take the next step, to conduct a drawdown on a pool-wide scale. Screening began on the Upper Mississippi River pools in the St. Paul District to determine which pool might be the best candidate for this work. Initial screening took into account criteria such as the extent of aquatic area that would benefit from the drawdown, estimates of dredging requirements to maintain the main channel, unusual hydrology and unique socioeconomic factors. This process eliminated Upper and Lower St. Anthony pools and Pools 1 through 4(Palesh, July 1997).

The second level of screening took into account the criteria for the initial screening but expanded into recreation effects, monitoring information availability and operating conditions within each pool. Through this screening, Pools 8 and 9 appeared the best suited for the demonstration drawdown but Pools 5 and 7 were also considered. Pools 5a, 6 and 10 were eliminated during this stage.

The next step in pool selection required input from the public. Information about the initial response from small-scale drawdowns, the desire to move forward on a larger scale drawdown and the pools under consideration were provided to the public. Many different venues were used to attract public participation, including traditional media, websites and, eventually, public meetings.

During a series of three public meetings, attended by more than 200 people, the public cited a desire for the benefits that a drawdown may bring. However, they also had concerns about recreational access during a drawdown. In Pool 7, the recreational and residential access concerns reduced public support; and in Pool 9, many believed the current aquatic vegetation conditions were better than most pools, so the first demonstration drawdown would be better suited for a pool with a greater need. In the end, the strongest public support to conduct the first demonstration drawdown in the Corps' St. Paul District was for Pools 5 and 8.

To select the final candidate from the remaining four pools under consideration, the task force developed a matrix that considered seven major questions:

- How many acres would benefit from a proposed drawdown?
- What was the likelihood of success for a 90-day drawdown based on the discharge constraints at the dam?
- How much additional dredging would be necessary to conduct a drawdown and was there sufficient capacity to place the dredged material?
- If recreation and commercial navigation facilities are adversely effected by a drawdown, are there actions that could be taken to minimize the impact?
- Is there sufficient background data in a pool to detect changes as a result of the drawdown?
- Are there resources available to do additional pre, during and post monitoring?
- What pools do we have public support to move forward on?

Based on the results of the matrix, Pool 8 was the clear choice for the first demonstration drawdown. The drawdown of Pool 8 would expose an estimated 2,400 to 5,600 acres depending on depth of drawdown and the likelihood of having the right discharge conditions were relatively high. Main channel dredging was relatively low and disposal of that material was manageable. The majority of recreational and commercial facilities were in the upper end of the pool, where the drawdown would be reduced to less than half of the drawdown at the dam. Long-term monitoring had been conducted on Pool 8 for more than 12 years, and there were many agency personnel available to do additional monitoring. The public was supportive of Pool 8 for the first demonstration pool.

Once the decision to move forward with Pool 8 was formalized, the results of the selection process were again presented to the public. Information presented included why Pool 8 was selected for the demonstration drawdown and how much of a reduction could be considered for implementation. At this point, members of the public who had been silent during the initial stages voiced concern about the choice of Pool 8. This new opposition came from people who felt that the high recreational use on the pool did not make it a good choice to conduct a drawdown, especially the first demonstration drawdown.

River resource managers knew asking river users to accept a 1- to 3-foot water level reduction would create concern for some river users. Public meetings were held to present information and gain feedback from audience participants about questions and concerns associated with reduced water levels. A citizen's advisory group was established to work on some of the more difficult issues. This process allowed for the development of a compromise plan to implement a large-scale drawdown in Pool 8.

The foundation of the plan was to draw Pool 8 down 18 inches at the dam, beginning on or around June 15 and hold the drawdown until mid-September. One constraint was added to minimize the impact to the upper portion of the pool, where most of the recreational and commercial facilities were located. The drawdown in the upper portion of the pool would only be 0.5 foot or less by guaranteeing that water levels did not drop below elevation 630.5 msl (4.2 on the gage) at the La Crosse, Wisconsin, gage. This would mean water levels at the dam would be increased as river discharge approached 28,000 cubic feet per second (cfs) so that the gage reading in La Crosse could be maintained at 630.5 mean sea level. If river discharge continued to drop, the water level would be incrementally raised until discharge reached 22,000 cfs when the drawdown in the lower portion of the pool would be eliminated. Using a computer model, it was determined that without the upper pool constraint, river discharge at Lock and Dam 8 between 22,000 and 75,000 cfs would expose up to 2,775 acres, depending on river discharge or about 11.7 percent of the pool. With this constraint in place, up to 2,575 acres would be exposed or 10.8 percent of the pool.

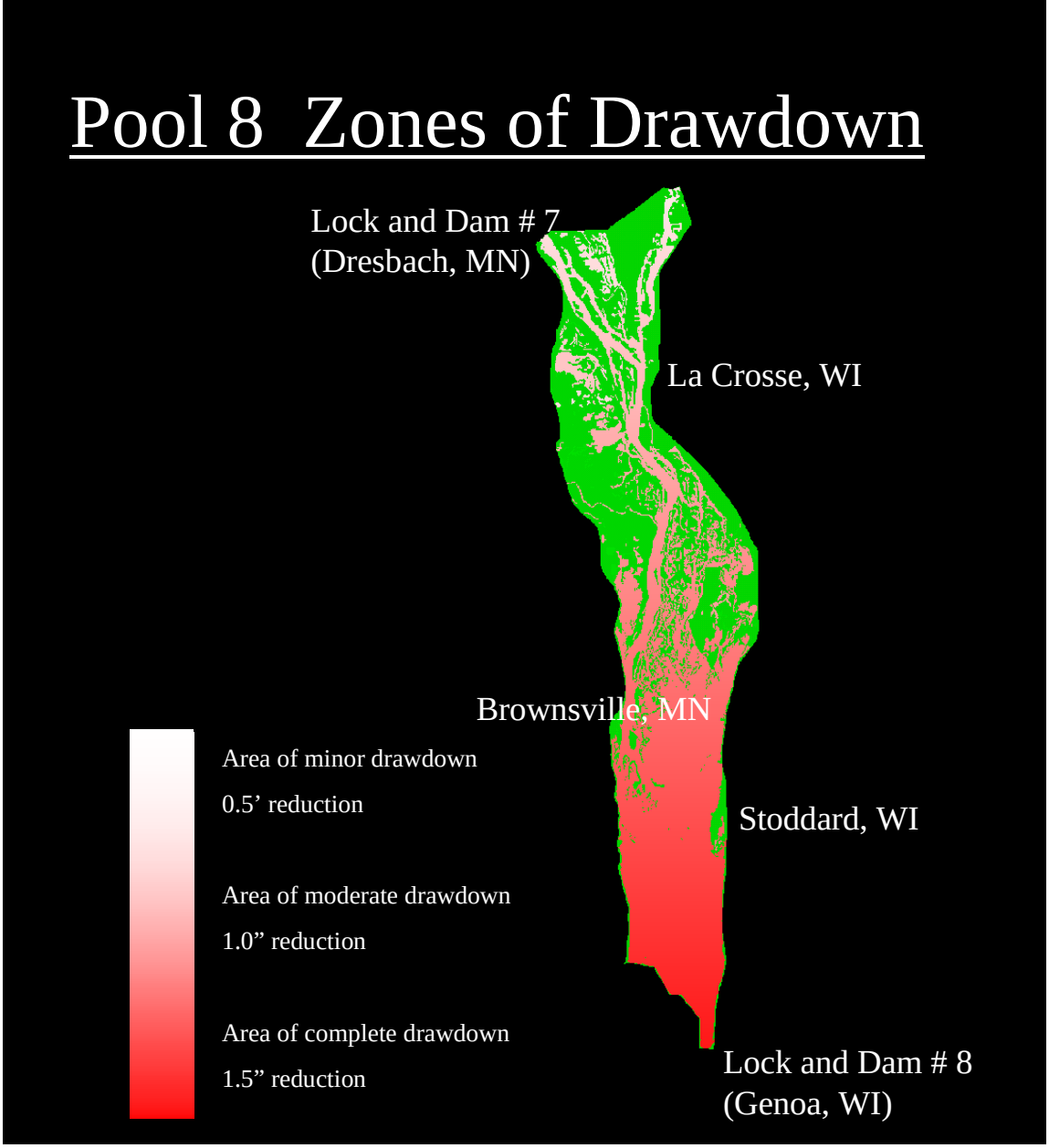

FIGURE 4: MAP DEPICTING AREAS OF DRAWDOWN WITHIN UMR, POOL 8

Logistics of Implementation

The next phase, planning the logistics of implementation, was detailed in the Definite Project Report and Environmental Assessment. Based on this plan, the drawdown of Pool 8 was scheduled to occur during the summer of 2000 (U.S. Army Corps of Engineers, 1999). However, the river management agencies would have to complete all the logistical details prior to the drawdown.

The main channel of the river had to be surveyed and dredged to accommodate the drawdown. Using historical information, the St. Paul District estimated that 80,000 cubic

yards of additional material would have to be dredged at the estimated cost of $330,000 dollars. Adjustment had to be made in the Corps' operation and maintenance budget to assure extra funding would be available prior to the drawdown to accomplish additional dredging.

The St. Paul District additionally had to secure permission to operate outside the approved water level operating band for Pool 8. Initially, district staff believed it would be necessary to go to Corps Headquarters in Washington, D. C., to obtain authority. However, it was determined the Mississippi Valley Division had the authority to grant the district permission to operate 18-inches below routine operation at Lock and Dam 8, which they did in September 1999 (Mississippi Valley Division, 1999).

Some recreational boat landings and access channels would be too shallow during the drawdown so provisions had to be made for dredging to provide adequate access. The federal Continuing Authority Program – Section 1135 was used to provide a 75 percent cost share to local governments or residents. This had to be matched with 25 percent local funding. Three of the eight sites qualified for Wisconsin cost share money, so the federal and state government covered the dredging. Local government or residents that benefited by the increased depth adjacent to their property funded the remaining five sites.

In 1999, partner agencies organized to cooperatively provide expertise and resources for a monitoring effort to document changes resulting from the drawdown. Pool 8 is a trend pool for the Long Term Resource Monitoring Program; consequently, stratified random sampling data from more than 10 years were available for water quality, vegetation and fisheries. This wealth of information provided a strong data foundation for Pool 8 but intensive site-specific sampling was also determined to be necessary, as well as a number of components the Long Term Resource Monitoring Program did not monitor.

Components not covered by the Long Term Resource Monitoring Program were divided among the partner federal agencies. The U.S. Geologic Survey would provide expertise and staff resources to monitor aquatic plant shifts, nitrogen cycling and aerial photography and interpretation. The Corps of Engineers would provide expertise and resources for channel depth surveys in the main channel and backwaters. This information would be used to manage channel depths during the drawdown and to assess the residual effects of overdraft dredging on the actual cost of main channel dredging during the drawdown. The Long Term Resource Monitoring Station would continue to do routine sampling and provide comparative analysis to other years of data on water quality, fisheries and vegetation. The Fish and Wildlife Service would monitor shorebird use on a weekly basis during the time of the drawdown; and following the drawdown, the Service would conduct a waterfowl-user study to determine perceptions of hunters response of the drawdown.

Partner state agencies also had a role. Wisconsin DNR would establish a continuous monitoring water quality platform in 2000 and 2001. Data would be collected for wind speed, turbidity, light penetration, dissolved oxygen, temperature, gross sedimentation

rates, total volatile solids and total suspended solids (Sullivan, 2003). Minnesota and Wisconsin DNRs would establish a series of land-based photo stations and take pictures on a biweekly basis at these locations for visual comparative purposes.

Along with the basic planning for implementation, all the agencies worked to intensify the public information campaign to make sure the public understood exactly what would happen. During this stage, the fundamental message of why the drawdown was being done was sent out to every venue possible. Other messages followed the basic messages with the specific details, such as when the drawdown would begin and end, where the impacts would be apparent and where expected habitat changes could be observed.

This information was provided to the public in a number of different forms, including public meetings, talking to local civic and conservation groups, websites, 1-800 number, signs at boat landings, signs at the Locks and Dams 7 and 8, radio, TV, newspapers and newsletters. The task force considered this public information campaign to be one of the most important components of the first demonstration of a large-scale drawdown. The reason being, if the public did not understand and support this activity, then the chances of doing other drawdowns would decrease even if this one were successful.

Implementation of the Pool 8 Drawdown

The winter and spring of 2000 was dry. Corps of Engineers' calculations indicated only a partial drawdown could be implemented if discharge was less than 28,000 cfs; and at 22,000 cfs, a drawdown could not be implemented. A mid-May date was established to look at river conditions and make a decision on whether or not to implement a drawdown of Pool 8 or postpone it for another year. Past Corps of Engineers' records indicated that low flows in the spring typically were followed with a low flow summer pattern. On May 15, river discharge at Lock and Dam 8 was 31,600 cfs, (the average flow on May 15 n is 60,773 cfs with a mean value of 67,900 cfs), so the task force decided this first large-scale demonstration drawdown should wait for better hydrologic conditions, hopefully in 2001.

In reviewing the records of the summer of 2000, the river discharge would have been within acceptable ranges for the drawdown until August 1, when river discharge went to 27,000 cfs and continued to drop throughout the remainder of the planned drawdown period to September 15. During the window of adequate river discharge, water levels fluctuated significantly. Exposed mud flats would have been continually wetted and dried. The decision was debatably for the best.

The winter of 2001 was again very dry, and the same concern regarding favorable weather conditions surfaced. However, there was a dramatic change in the weather pattern in late February, with large snowfall accumulation throughout the Mississippi River basin above Pool 8. This snowfall melted relatively fast and was accompanied by rain. River discharge reached 234,200 cfs on April 20, 2001, to account for the third highest flood level on record. Perhaps more notable was the length of time this flood

persisted. On May 20, 2001, river discharge finally dropped below 100,000 cfs; and on June 16, 2001, the river discharge was still at 85,100 cfs at Lock and Dam 8.

The task force decided the drawdown would go forward based on trends from past years, which indicated that in years with a major spring flood, the summer discharge was within the target range. On July 7, 2001, the target reduction of 1.5-foot at the dam was met, but river discharge was still 78,200 cfs which meant the effect of the drawdown was not present more than a couple of miles upstream from the dam (Figure 5). However, from July 7 to July 12, river discharge dropped to below 50,000 cfs at the dam, and the effect of the drawdown crept upstream in the pool. July 2001 provided a volatile swing from late spring floodwaters to hot, dry weather, resulting in a continual loss of river discharge.

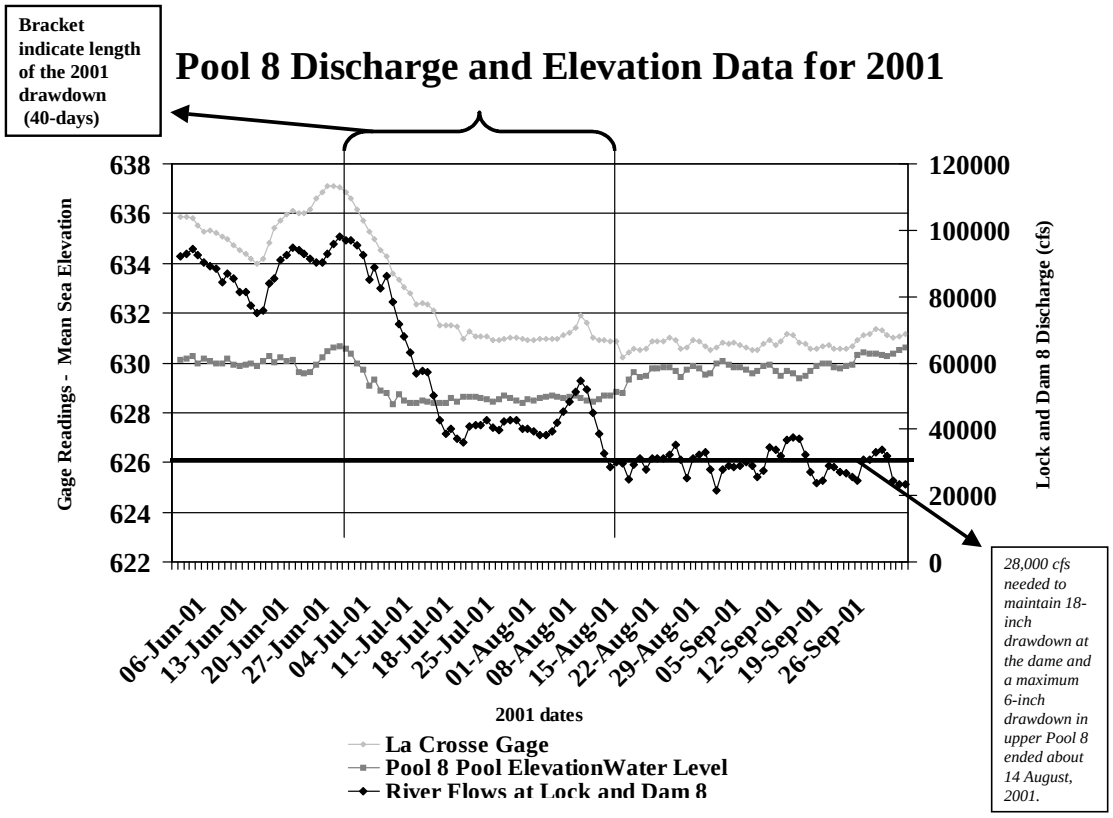

FIGURE 5: POOL 8 DISCHARGE AND WATER ELEVATION DATA FOR UMR, POOL 8, JUNE THRU SEPTEMBER 2001. THE DRAWDOWN WAS IMPLEMENTED ON JULY 1, 2001 AND REFLOODED ON AUGUST 14, 2001.

August 2001 provided little relief from the hot, dry conditions experienced in July. As a result, river discharge dropped below the 28,000 cfs needed to maintain the objective water levels at both the La Crosse gage and at the dam. The Corps' St. Paul District monitored river conditions and gage readings carefully during this transition time, but

sand had plugged the La Crosse gage, resulting in erroneous readings. From August 11 to August 14, water levels in the upper portion of the pool were probably five inches lower than the agreed upon management level of 0.5-foot (630.5 msl). The Corps responded as soon as the problem was detected and brought the water levels up at the dam to provide adequate depth in the upper portion of the pool. Initially, public outcry was harsh but it subsided as water levels were returned to the approved level.

For the remainder of the planned drawdown period, August 14 to September 17, water levels were managed at 630.0 msl or essentially no drawdown at the dam. However during a normal year, routine regulation of Pool 8 discharge below 28,000 cfs would require the Corps to implement secondary control or raise water levels at the dam incrementally from 630.0 msl to 631.0 msl to maintain the nine-foot navigation channel. During the 2001drawdown demonstration this practice was not followed, which resulted in lower than usual water levels in the mid-pool section (Figure 4). When water levels were fully returned to routine regulation in September, the lower portion of the pool had been drawn down for about 40 days, but the mid-pool section was down for about 85 days

Both annual and perennial emergent plants were expressed in the exposed sediments. Monitoring of the sample transects indicated that plant composition closely matched the results of a pre monitoring (1999) seedbank study of Pool 8. Common arrowhead *(Sagittaria latifolia),* false pimpernel *(Lindernia dubia),* water stargrass *(Heteranthera dubia),* stiff arrowhead *(Sagittaria ridiga),* teal lovegrass *(Eragrostis hypnoides),* rice cutgrass *(Leersia oryzoides)* and chufa flatsedge *(Cyperus esculentus)* were dominate in both the seedbank study and the plants expressed during the drawdown. Initial plant density and diversity was dependant on substrate type with sand dominated areas producing the fewest plants and fine sediment areas producing the most plants. However, the dry conditions of July impacted all substrate types because significant cracking was observed in the fine sediment areas. Beneficial rainfall in the upstream watershed provided a temporary increase in the river discharge, which irrigated the young plants at a critical time (Kenow, et al, in preparation).

Aquatic vegetation response was also a function of the duration of substrate exposure, so the mid-pool transects showed an increase in plant density and diversity over other lower pool sampling transects. A shift from annual emergent plants to perennial emergent plant, as well as larger tuber size and density, were noted in the mid-pool section over the lower pool section. These results confirmed suspicious natural resource mangers and researchers that drawdowns of longer duration would increase the likelihood of stronger more robust plants, as well as a shift to perennial emergent. These findings convinced managers there would be a benefit to trying to drawdown Pool 8 for a second year.

Throughout the public involvement process, the possibility of a second year drawdown was communicated to the public with reassurances that they would be a part the decision. They were also informed that the maximum drawdown in the upper section of the pool would be 3-inches or half of the first year drawdown. As had become customary, the task force presented the information for a second year drawdown to the public through

newsletters, newspaper articles, radio, and TV and public meetings. Managers were concerned the public would reject the proposal due to the low water levels they experienced during the gage malfunction. However, the public reaction was mostly positive, due in part to the readily apparent habitat changes, which resulted from the 2001 drawdown. The decision to repeat the drawdown became easy with public support.

The summer of 2002 began with a higher discharge than normal but within acceptable range to begin the drawdown on June 17 (Figure 6). Weather patterns delivered a continuous onslaught of rain, and the river flows were above 28,000 cfs all summer with lowest level dipping to 37,700 cfs at the dam. The summer average flow was much higher than usual, providing sufficient water for no drawdown in the upper portion of the pool (lowest levels were 0.76 foot above routine low water levels.) and an 18-inch drawdown in lower portion of the pool for the entire 90-day drawdown period. Although a slightly lower river discharge would be preferred, drawdown conditions provided ample temporal and spatial exposure of river substrate to not only produce robust perennial emergents but to produce arrowhead tubers that were 16 times bigger than 2001.

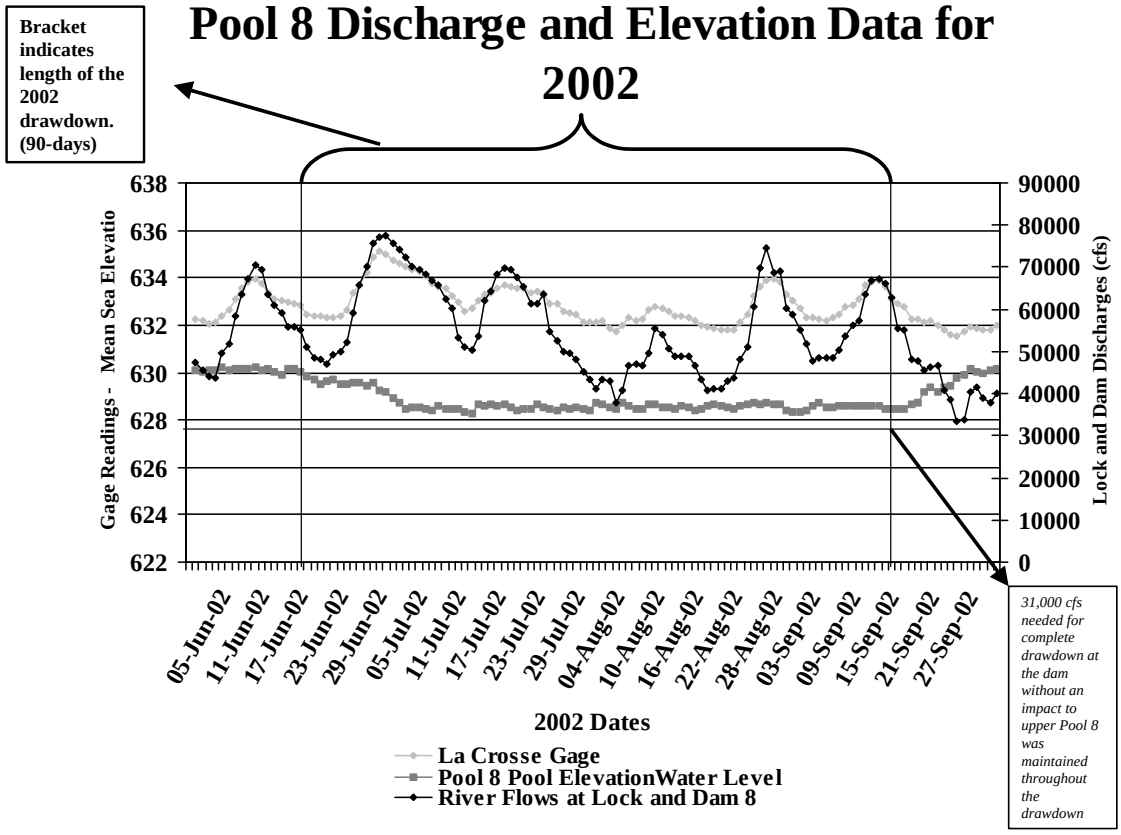

Figure 6: Pool 8 Discharge and Water Elevation Data for UMR, Pool 8, June through September 2002. The drawdown was implemented June 17, 2002 and reflooded on September 16, 2002.

Ending the two-year demonstration of a large-scale drawdown on Pool 8 with the favorable 2002 water levels provided a lasting legacy of positive public support for the drawdown concept. The positive vegetation response on the river was easily viewed by the public from highways in close proximity to Pool 8. These highly visible changes and the lack of impact to recreational and commercial use on the river has even the harshest critics noticing that this habitat restoration technique holds promise for future use.

River managers were encouraged by immediate response from aquatic plant beds in Pool 8 and the ease of conducting the demonstration drawdown the second year. However, there are still many questions left to answer. Aquatic plant researchers must continue to monitor the longevity of these revitalized aquatic plant beds to determine how often this practice must be repeated to maintain plant vigor. The response of the floating leafed and submersed aquatic plant communities must also be assessed.

The Corps must continue to monitor main channel response to overdraft dredging done in preparation for the drawdown. Initial cost of doing the extra dredging was assessed at $640,000. If during the next three years dredging quantities are reduced by the level of overdraft dredging or some portion of that level, then the cost of conducting the drawdown could be substantially decreased for channel maintenance. Through ongoing sampling programs, wildlife, fish and invertebrate use and numbers will be monitored to detect if changes have occurred in those populations.

Perspectives and Discussion

Numerous guiding principles were learned from the demonstration drawdown for future water level management action. Public involvement became one of the most significant issues, in terms of time spent and establishing the most effective methods to facilitate information exchange. The comprehensive effort and commitment from both the river managers and the public became the cornerstone that allowed this project to move forward to a successful implementation. A formalized public involvement strategy was never adopted, which may have allowed more flexibility to adjust to circumstances and address concerns as they arose. The method of communication was adapted to the user group, whether it required additional public meetings, small group face-to-face discussions or some other new form of communication. This fluid process allowed the managers to respond to public information needs in a timely manner, which was crucial to gaining the respect and trust of the public. This process helped to garner public support for both years during the drawdown.

Continuing this rapport with the public will be key to continuing water level management on the river. The information flow to the public needs to start at least two years before any action will be potentially taken. These early communications provide a mechanism to initiate the conversation and get all interested parties involved. Therefore, this early effort must concentrate on who the vital stakeholders are and finding the best way to communicate with them.

One of the biggest issues for conducting the drawdown in Pool 8 was the need to dredge existing channels in backwater areas to maintain river access for recreational pursuits. For the Pool 8 drawdown, the federal Continuing Authorities Program - Section 1135 was used to provide a 75 percent cost share to local sponsors where their access would be impacted by the drawdown. The Corps determined that 1135 could be used one time for dredging recreational access for the drawdown, but it did not follow the true intent of the program. Other funds would be necessary if another large-scale drawdown was conducted.

The task force must assess all potential sources of funding for recreation dredging, however, a new federal authority may be necessary to secure funding to conduct recreational dredging for future drawdowns. The experience with the 1135 program showed that restrictive contracting by the federal government probably tripled the cost of dredging, so the 25 percent local cost share was almost prohibitive. Any new program should be reasonable in contract requirements, so the local sponsors can recognize the value in working with the program.

Under the requirement of not interfering with commercial navigation on the river, the river discharge dictates the spatial extent and temporal length of the drawdown. As such, flexibility becomes the foundation of drawdown implementation. For example, the Pool 8 drawdown was originally scheduled for 2000 but was postponed due to low discharge. The start was again delayed in 2001 due to high discharge. In 2002, the discharge was almost perfect all summer. In order to cope with unpredictable weather patterns and river conditions, natural resource managers, river recreational users and commercial navigation users will have to be flexible.

This can be problematic because the public will want specifics such as starting and ending dates, the number of days the water will be low and exactly how low it will be. The only solution is to provide the public with intentions of implementation and then let them know that the dynamics of the river will dictate whether or not the work will be implemented as planned. This will create confusion, so continual reinforcement of this information will be necessary.

Next Steps

The initial success of the Pool 8 drawdown has both river managers and the public encouraged by this river restoration tool. The next steps for this effort have two major components. First, resource managers must continue to assess the preliminary success of the Pool 8 drawdown as defined earlier in this article to determine the long-term restoration implications. This will take a number of years to fully assess but moving forward on other similar projects still appears to be practical.

Therefore, the Corps of Engineers proposed the task force examine the feasibility of conducting minor drawdowns of a foot or less in pools where little to no additional dredging would be needed. Pools 6 and 9 met the criteria, and the information was brought to the public for concurrence and to determine an acceptable level of drawdown

for each pool. Overall, the public was enthusiastic about these potential projects and plans were made to implement minor drawdowns in both pools during the summer of 2003. However, last minute problems halted both projects, so they will be pursued again during the summer of 2004.

Simultaneous to the planning for minor drawdowns on Pools 6 and 9, another plan has begun for a large-scale drawdown on Pool 5. Based on the preparation needed to conduct the large-scale drawdown on Pool 8, task force members felt comfortable proceeding with planning for a similar project in another pool. A drawdown of one foot to four foot is being considered and will involve intense planning for the next two years. Pool 5 habitat would benefit from a drawdown but problems with extra dredging to maintain the commercial navigation channel and access for the recreating public will need to be addressed carefully.

The Water Level Management Task Force, with strong support from the Corps' St. Paul District, will analyze these initial demonstration projects to determine what the future significance and implementation of water level drawdowns will be for habitat restoration. Eventual outcomes may lead to changes in operation of the navigation pools and general drawdown strategies for each pool to promote and maintain the ecological health of the Upper Mississippi River Pools in the St. Paul District.

During the next 10 years, the task force expects to make continual progress toward appropriate changes in dam water level operation and general drawdown strategies for each pool. This tool, in addition to many other restoration techniques, will help to provide a long-term solution to the restoration and sustainability of the Upper Mississippi River ecosystem.

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