UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL DESIGN HANDBOOK

CHAPTER 7

FLOODPLAIN RESTORATION

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FLOODPLAIN RESTORATION

7.1. Resource Problem

Floodplain habitats are integral components of large river ecosystems because of the seasonal flood pulse that inundates them and connects them to the river. Many species of plants and animals are adapted to this flood cycle and take advantage of habitat and food resources as they are made available. Many important sediment and nutrient transfers also occur when floodplains are inundated. Floodplain habitats throughout the Upper Mississippi River System (UMRS) have been altered for many reasons. In northern river reaches, dams spread water across low elevation floodplain areas to greatly increase aquatic habitat connectivity in the floodplain. Floodplain restoration in the north is a mix of protecting some areas with islands, connecting isolated backwaters, and restoring tributary channels. In southern river reaches the floodplain is much more developed for crop production and flood protection, and is thus much more isolated from the river. Floodplain restoration in southern reaches includes a mixture of water level manipulation in management areas, wetland/habitat management in leveed areas (e.g., WRP, CRP, etc.), or restoration of agricultural areas to aquatic, floodplain forest and prairie habitats. Restoration of privately-owned floodplain areas requires landowner cooperation or acquisition of real estate interests from willing sellers and donors. Some floodplain restoration methods include

- Topographic Diversity
- Potholes or Perched Wetlands
- Mast Tree Planting
- Native Grass Planting
- Wetland Species Planting

7.2. Topographic Diversity

Increased floodplain water table elevation can result in the elimination of flood intolerant tree species that require a dry root zone. Improving topographic diversity simulates the ridge and swale topography of the natural floodplain by using material dredged from the channel. This newly elevated land area may then be planted with oaks and other mast trees. At Johnson Island, an experiment was conducted in 2001 where hydraulically dredged material was placed in and around existing mature trees. Care should be taken if this method is used as tree mortality may occur depending on the type and age of trees.

Most work on topographic diversity on the UMRS has occurred in conjunction with island creation or dredge management activities. Nonetheless, the considerations on topographic diversity for floodplain restoration are similar. Improving topographic diversity simulates the ridge and swale topography of the natural floodplain.

The severing of floodplains from rivers by levee systems also stops the processes of sediment erosion and deposition that regulate the topographic diversity of floodplains. This diversity is essential for maintaining species diversity on floodplains, where relatively small differences in land elevation result in large differences in annual inundation and soil moisture regimes. These differences regulate plant distribution and abundance (Sparks, 1992).

7.2.1. Design Methodology

Potential Environmental Benefits. As proposed, this measure could be achieved through either the modification of existing geomorphic surfaces or through the creation of new ones. Increased topographic diversity in turn, would increase habitat diversity and benefit targeted species. It could also potentially serve to improve conditions for the recruitment and development of riparian vegetation. Improving riparian conditions would benefit wildlife that depends on this type of habitat.

Potential Constraints. During the summer months flows are relatively high due to the un-natural containment systems of the locks and dams. Thus, the impaired flow regime does not resemble the unimpaired regime either in timing, magnitude, or duration of peak flows. This has implications for both the design and possible functioning of floodplain surfaces that might be created.

The principal constraint to effectiveness will be the prescribed flow regime. Unless a complementary flow regime is implemented, the created or modified topographic surfaces will not function as habitat. Secondary constraints include the availability of substrate with which to create surfaces and the potential short-term water quality impacts of in-channel construction.

Design Considerations and Evaluation. If new benches are created or floodplain surfaces modified, they require bank protection to prevent erosion. Bank protection could be accomplished through the addition of rock (i.e., rip-rap) imported from outside the area or with bioengineering approaches (willow mattresses, ground cover, etc).

It is assumed that the modified surfaces or benches would be constructed at elevations corresponding to different magnitudes of flow, simulating a natural floodplain setting. It is conceivable that stage-discharge relationships corresponding to unimpaired flood flows could be developed and used to design the geomorphic restoration. However, the existing flow regime does not often resemble the unimpaired hydrograph.

If the benches and flow regime approximated a natural condition, it would probably represent a scaled-down version of the former alluvial system. That is, it would be an alluvial system within the entrenched channel operating on an impaired natural flow regime. Although not difficult to envision, it would likely prove difficult to design as a self-regulating system. Probably the most challenging aspect would be estimating and negotiating the prescribed flow regime.

Any proposed action would include planting or otherwise establishing vegetation on the benches and is best coordinated with riparian vegetation enhancement. It is assumed that the vegetation on the benches would attempt to simulate a natural riparian successional pattern. The vegetation on different geomorphic surfaces would correspond to flood exposure. Reference conditions would be needed; specific items to consider include erosion control, desired future riparian vegetation, control of exotics, and relationships between flow and vegetation.

The effects of the geomorphic restoration on downstream and upstream geomorphic processes would need to be evaluated. If the emphasis were on modifying surfaces that already exist, the potential effects would probably be relatively insignificant. If entirely new surfaces were created, they would change flows and geomorphic processes in an already unstable system. Therefore, the latter would probably be more risky and would likely require more detailed evaluation.

Another major issue to consider in the design would be the potential response to extreme peak flow events. During events of magnitude, massive erosion on the created or modified geomorphic surfaces could occur. Measures of effectiveness could include mapping of created surfaces and associated vegetation and population surveys of targeted fish species, (Sparks). The main uncertainties with this measure are the flow regime requirements; availability of substrate for geomorphic construction; effects of geomorphic constructions on channel behavior; and effects of peak flows.

This is a conceptually appealing feature but it is probably best to combine it with side channel creation and enhancement. Even better would be combining topographic and geomorphic restoration with riparian restoration and looking at both together. This would facilitate evaluation of alternative flow regimes that would support restoration proposals. However, even before all that, the approach to restoration needs to be clarified. Is the intention to engineer restoration or to restore processes so that the stream naturally restores itself?

7.2.2. Lessons Learned. When constructing topographic features, it is imperative to mimic the elevations currently in the nearby area and to consider the natural slope of the river from the main channel to backwaters. In general, higher bermed islands or floodplain features work better next to channels because higher ridges are better able to withstand wave and wind action without being overtopped or eroded, while further off the main channel and away from high fetch areas, lower ridges may be more stable.

Proper placement of the feature in relation to current or wave action is important to ensure success. Topographic features that are misplaced relevant to current may actually increase undesired events such as increased sedimentation in backwaters as the current may bring in sediment-laden water which is retained by the island, thus converting the backwater into a settlement basin, (Orville Facilities).

7.2.3. References

Orville Facilities Relicensing Efforts, Environmental Work Group, Draft Narrative Reports for Resource Action Discussion, *Modify or Reconstruct Trenches in the Feather River Channel to Enhance Spawning and Rearing Habitat*, 05 February 2004.

Protecting Riparian Areas: Farmland Management Strategies Soil Systems Guide, Barbara C. Bellows, NCAT Agriculture Specialist, ATTRA - National Sustainable Agriculture Information Service, March 2003

Environmental Assessment, Material Placement Site for Maintenance Dredging, Johnson Island, Mississippi River Pool 18, Des Moines County, Iowa, July 1995, Revised May 1996

Richard E. Sparks, *Risks of Altering the Hydrologic Regime of Large Rivers* Pages 119-152, 1992, Illinois Natural History Survey

7.2.4. Case Studies

Weaver Bottoms, Pool 5. The islands are effectively separated from the water table thus making it nearly impossible for mast tree growth. Additionally, swale habitat that is too low may be lead to infestations of undesired invasives, such as reed canary grass and purple loosestrife.

Lansing Big Lake, Pool 9. A channel close-off was constructed with sand that included a ridge and swale feature. The ridges were built higher than the surrounding land features. As a result, the river cut new channels through the close-off, thus demonstrating the importance of carefully considering ridge elevation in design and the need for fine materials to help ensure stability.

Pool 8 Islands Phase II. During the spring flood of 2001, the constructed ridges remained above the water surface, however, the current eroded around them, leading to the loss of many ridges. A similar situation occurred in Lansing Big Lake where a channel close-off was constructed with sand. The close-off included a ridge and swale feature. The ridges were built higher than the surrounding land features. As a result, the river cut new channels through the close-off, thus demonstrating the importance of carefully considering ridge elevation in design and the need for fine materials to help ensure stability.

Johnson Island, Mississippi River Pool 18, Des Moines County, Iowa

7.3. Potholes or Perched Wetlands

Potholes are constructed to create open water habitat by excavating deeper pockets within a mudflat. These pockets fill with water and allow for the growth of submergent aquatic vegetation, drawing in wildlife that utilizes that habitat. Potholes therefore add to the biotic diversity of the project, in both the plant and animal communities. Potholes may be considered perched wetlands if little to no interaction with the groundwater occurs. This makes the pothole dependent on surface flows for moisture.

Material excavated to create potholes may be used for berm construction or to create topographic diversity. Please refer to the previous section for additional information regarding topographic diversity.

7.3.1. Design Methodology. Potholes can be constructed through mechanical excavation or through the use of explosives. Empirical studies by the Bellevue LTRM at Potters Marsh HREP indicate that, if designed properly, there is no difference in usage by waterfowl between the two construction methods. This study indicated that pothole usage was linked to the amount of cover in the immediate vicinity of the pothole, where potholes with the best proximate cover saw the most usage by migrating waterfowl, and wading birds.

If the potholes are mechanically excavated, the borrow material can be used to construct berms. These berms can be used to reroute local hydrologic patterns or as topographic diversity to encourage diverse species growth within the project area. If borrow material is needed for a project, designers should consider incorporating pothole designs into the project, thereby gaining habitat benefits through both borrow and placement activities.

Potholes are more effective from a habitat perspective if many smaller potholes are constructed in close proximity. Potters Marsh HREP constructed many, smaller potholes. The total surface area at the 7-year performance evaluation was 8.3 acres, with most individual potholes less than 0.75 acres in size. Cottonwood Island HREP constructed three potholes, two 1-acre potholes, one ¾-acre pothole, and two ½-acre potholes were mechanically excavated. The larger potholes constructed at Cottonwood Island HREP have been used by amphibians, great blue herons, deer, and turkeys, but not waterfowl. Potholes constructed at Potters Marsh HREP are utilized by migrating waterfowl for nesting and brooding. Smaller, more frequent potholes may offer more cover, as they have more bankline for the volume.

Though smaller, more frequent potholes are desirable, each individual pothole should be larger than 0.1 acres in surface area. The potholes constructed at Big Timber, 0.03-0.08 acres each, were primarily used as cover for predators and are not considered desirable habitat.

Pothole side slopes should be gradual, no steeper than 3V:1H. Steep side slopes are conducive to predators, but not for brood rearing or other habitat uses. Pothole depth varies from 3 feet to 8 feet deep. Depth does not appear to be a limiting factor for pothole usage by migrating waterfowl. The shallowest potholes, at 3-4 feet in depth, were constructed at Potters Marsh HREP, where migrating waterfowl have successfully utilized the feature. If fish habitat is desired from the pothole, depths should be sufficient for overwintering.

7.3.2. Lessons Learned . If borrow material is needed for other project features, potholes should be considered for additional habitat benefits. The side slopes should be gradual. Multiple smaller potholes provide more cover than one larger pothole, and thus may provide more habitat value. Potholes less than 0.1 acres in surface area and those with steep slopes serve as cover for predators and should be avoided.

Terracing of the side slopes of larger potholes does not appear to be a cost effective practice. After a few years, the terraces erode into the pothole, leaving a bowl-shaped depression similar, if not identical, to the shape of potholes created by excavation or explosives.

Potholes experience some sedimentation and should be constructed deeper than needed to account for this. For waterfowl use, potholes 3-5 feet in depth were sufficient at Potters Marsh. However, at that depth it is possible that the pothole would freeze to the bottom in the winter. If it is anticipated that fish would be present in the project area over the winter months, potholes should be a minimum of 8 feet deep to prevent them from freezing through the entire depth.

Explosives regulations are prone to frequent change. It may not be possible to obtain permits to create potholes through the use of explosives. Designers should check permitting requirements in the early stages of feasibility if explosives are proposed.

7.3.3. References

US Army Corps of Engineers, Rock Island District (USACE, Rock Island), *3-Year (YR) Post-Construction Performance Evaluation Report For Cottonwood Island Habitat Rehabilitation and Enhancement Project*, June 2001.

USACE, Rock Island, *3-Year (YR) Post-Construction Performance Evaluation Report For Princeton Refuge Habitat Rehabilitation and Enhancement Project*, November 2001.

USACE, Rock Island, *7-Year (YR) Post-Construction Performance Evaluation Report For Potters Marsh Habitat Rehabilitation and Enhancement Project*, October 2003.

USACE, Rock Island, *9-Year (YR) Post-Construction Performance Evaluation Report For Big Timber Refuge Habitat Rehabilitation and Enhancement Project*, June 2001.

USACE, Rock Island, *Big Timber Refuge Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-5) with Integrated Environmental Assessment*, July 1989.

USACE, Rock Island, *Cottonwood Island Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-16F) with Integrated Environmental Assessment*, June 1996.

USACE, Rock Island, *Princeton Refuge Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-10F) with Integrated Environmental Assessment*, February 1995.

USACE, Rock Island, *Potters Marsh Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-9F) with Integrated Environmental Assessment*, April 1992.

USACE, Rock Island, *Operation and Maintenance Manual Big Timber Refuge Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 17, Mississippi River Miles 443-445, Louisa County, Iowa*, June 1994.

USACE, Rock Island, *Operation and Maintenance Manual Cottonwood Island Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 21, Mississippi River Miles 328.5-331, Lewis and Marion Counties, Missouri*, March 2001.

USACE, Rock Island, *Operation and Maintenance Manual Princeton Refuge Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 14, Mississippi River Miles 504.0-506.4R, Scott County, Iowa*, July 2002.

7.3.4. Case Studies

Big Timber Refuge. Ten 0.03-0.08 acre potholes,, 8 feet deep, constructed with explosive; used as cover for predators, not desirable habitat.

Cottonwood Island. Two 1-acre potholes, one ¾-acre pothole, and two ½-acre potholes were mechanically excavated. Areas used by local wildlife but not migrating waterfowl.

Potters Marsh. Nineteen potholes, ranging in size from 0.11 acre to 1.31 acres for a total of 8.3 acres, constructed with explosives and excavation. Used by local wildlife and migrating waterfowl.

Princeton Refuge. Strips of borrow material taken for berm construction with 10 foot staggers between strips; supposed to function as potholes. More thought in designing potholes could have led to better habitat value.

7.4. Mast Tree Planting

7.4.1. Design Methodology. The Corps employs talented foresters who are responsible for maintaining forested lands owned by the Corps. They have a vast knowledge of best management practices for tree plantings and should be consulted at every step of the planning process.

7.4.2. Lessons Learned

- Tree mortality along the Upper Mississippi River has been positively correlated with flood duration and amplitude. This mortality seems to be greatest in small trees. In fact, mortality of saplings was as high as 80% near St. Louis, Missouri, after flooding in 1993, with many areas experiencing 100% mortality of seedlings. In addition, numerous studies have shown that flood tolerance of trees is species specific. Thus, reforestation success at sites that have a high flood potential can be increased by planting taller seedlings or tree species that are more flood tolerant.

- It is important to quickly establish vegetation in the littoral zone of newly created islands in order to protect them from erosion. Black (Salix nigra) and sandbar willow (Salix exigua) cuttings have been successfully planted on EMP islands in the past and are planned for future projects. Cuttings are collected in the spring prior to leaf-out and are cut 20-25 inches long, as straight as possible, and range from 3/8 to 3/4 of an inch in diameter at the small end. They should be planted as soon after cutting as possible or stored properly. If planting will take place within a few days, the cuttings may be kept safely by placing the butt ends in water or by heeling-in in moist soil. Cover with wet burlap sacks to prevent exposure to sun or wind. If longer storage is needed (i.e. until after the start of the normal growing season), the cuttings should be placed in cold storage with temperature between 28 and 32 degrees F.

The cuttings may be bundled together, stacked, and covered with moist burlap. Moisture should be maintained by lightly sprinkling with water as needed. Planting rods made of rod iron with a handle and step, or small power augers have been used successfully to plant cuttings quickly. If soil moisture is high, the cuttings may be pushed into the ground by hand. If rods or augers are used, the cuttings should be pushed to the bottom of the hole to prevent air voids. Approximately 5 inches of cutting should remain above ground and the top of the hole should be closed with a kick of the heel. Eastern cottonwood (Populus deltoides) cuttings can also be planted above the littoral zone on newly created islands using similar techniques. Other species that can be established easily with cuttings are dogwoods (Cornus sp.) and indigobush (Amorpha fruticosa).

- Willow and cottonwood seedlings often regenerate naturally and fairly quickly on sites at low elevation. In some cases, it may be possible to rely on natural regeneration, in combination with a protective cover of grass, to meet vegetation establishment goals. These sites may eventually succeed into floodplain forest. However, the potential exists for invasive species such as reed canary grass (Phalaris arundinacea) to form dense monocultures. Actively planting islands is the preferred option in most cases.

- Consideration should be given to using large-sized (3 ft. or greater) tree seedlings for reforestation of bottomland hardwoods. Although the cost for planting materials and labor for planting are higher, survival and growth are generally better. In addition, the larger seedling stock can be planted at a wider spacing, saving on overall costs. Most private nurseries and some state nurseries can supply large seedlings. A fairly recent innovation in tree seedling production is the RPM tree, or root production method. Local tree seed can be collected in the vicinity of the project site 18 months prior to construction, then delivered to the nursery where the seed is grown into RPM seedlings. Average seedling height when ready for transplant is 4-7 feet. Survival and growth characteristics of these seedlings have been excellent, mainly because of the robust root systems that are produced in the RPM process. RPM seedlings can be available for either fall or spring planting.

- Tree plantings have been successfully established in both the spring (mid-April to mid-June in MVP) and fall (mid-Oct to mid-Nov in MVP). Seedling availability from nurseries is usually better in the spring.

- Tree plantings need weed control for a minimum of three years. Tree mats can provide this and are highly recommended at the time of planting. But depending on the height growth of surrounding grasses, even trees with mats may need weed control for several growing seasons after they are established.

- Tree shelters also require regular maintenance. Floods and wind can tip the shelters over or cause them to lean. Other vegetation can grow up inside the tube and choke out the seedling. Use caution when cleaning out tree shelters during the summer and fall as they sometimes contain bee and wasp nests inside the tube.

- Tree shelters come in various heights. Four to five foot tubes are good if the potential for deer damage is severe. However, shorter tubes (2-3 foot) may be adequate for protection from other animal damage. Of course, the shorter tubes are cheaper and easier to install.

- At low elevations, tree shelters can collect significant amounts of sediment during flood events, sometimes causing seedling mortality.

- Avoid using tree shelters on plantings where prescribed fire is to be used within five years of project completion.

- If possible, avoid row planting of tree seedlings to make the site look more natural and improve aesthetics.

- Quality assurance is very important during contract planting operations to ensure seedling survival and success. Among the critical items to check for is how well the planting stock was protected during storage and handled during planting. The sensitive roots of seedlings must be kept cool, moist, and out of the wind and sun from the moment they are lifted out of the nursery bed until they are covered with soil in the transplant location.

- Quality assurance is also very important in verifying the source of planting materials. The general guideline is to acquire materials where the seed source is within 200 miles of the project location. Closer is better. The seed source should also be from a parent plant that actually germinated and is growing in a floodplain environment.

- Voles and other rodents can cause severe damage and mortality to tree plantings by girdling the lower stems and/or roots. Tree shelters, tree wrap, and rodent repellants are among the options that have been used to address this problem. However, tree shelters must be properly installed so as not to leave a gap at the base of the tree for rodents to enter.

7.4.3. References

USACE, Rock Island, *Brown's Lake Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-5) with Integrated Environmental Assessment,* November 1987.

USACE, Rock Island, *Initial Post-Construction Performance Evaluation Report For Brown's Lake Habitat Rehabilitation and Enhancement Project,* February 1993.

USACE, Rock Island, *2003 Post-Construction Performance Evaluation Report For Brown's Lake Habitat Rehabilitation and Enhancement Project,* October 2003.

USACE, Rock Island, *Cottonwood Island Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-5) with Integrated Environmental Assessment,* June 1996.

USACE, Rock Island, *3-Year (YR) Post-Construction Performance Evaluation Report For Cottonwood Island Habitat Rehabilitation and Enhancement Project,* June 2001.

USACE, Rock Island, *2002 Post-Construction Performance Evaluation Report For Cottonwood Island Habitat Rehabilitation and Enhancement Project,* April 2002.

USACE, Rock Island, *Long Island (previously Gardener Division) Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program Definite Project Report (R-5) with Integrated Environmental Assessment*, Sep 2000.

USACE, Rock Island, *Post-Construction Performance Evaluation Report Memorandum for Record For , Long Island (previously Gardener Division) Habitat Rehabilitation and Enhancement Project,* June 2004.

Wlosinski, Joseph H. and Laurie B., *Predicting Flood Potential to Assist Reforestation for the Upper Mississippi River System.*

7.4.4. Case Studies

Brown's Lake. Pool 13, Upper Mississippi River Miles 544.0 - 546.0, Jackson County, Iowa. One feature of this project involved placement of dredged material into a terrestrial site to depths of 6 to 8 feet and re-planting with mast production trees. One of the project goals was to establish bottomland hardwood.

In May, 1990 a 150 foot wide strip immediately adjacent to the upstream dredge material containment levee was direct seeded with pin oak acorns. Approximately 25,000 acorns were dropped by helicopter onto this 150 foot wide strip. On May 20, 1991 a strip survey of this area was conducted by the COE. Strips three feet wide and fifteen feet apart were surveyed for pin oak seedlings. Based on this survey it is estimated that 1200 pin oak seedlings were growing on the site at this time. The pin oak seeding immediately adjacent to the upstream containment levee was somewhat successful. Approximately 5 percent of the acorns dropped produced seedlings after the first year.

These seedlings have since died from extended inundation in 1992 to 1993. This site was re-planted with mast producing hardwoods in June 1992. No planting of trees within the placement site was successful before this time due to consolidation and drainage problems. Future projects which consider dredged material placement sites for reforestation should include design of a drainage system for the placement site.

In addition to the objective of increasing bottomland hardwood diversity this project has the secondary objective of developing valuable data regarding the planting of mast production trees on dredged material deposits. Iowa State University has been contracted to plant the trees and monitor their survival while evaluating the following objectives:

- species suitability based on growth survival
- the use of nurse crop species on early growth survival of trees
- the use of different kinds of seedling stock types on early growth and survival of trees
- the use of applications of sewage sludge and fertilizer on early growth and survival of trees

Only species native to the region were selected for planting. Species known for their value as wildlife food were given priority for planting. Two kinds of plots have been established on the study site. The first consists of smaller 16-tree plots that will test the suitability of 13 different mast producing species for planting on this site. The second kind of plot is large and in total covers most of the area. These plots were planted with 3 mast-producing species, Black Walnut or Shellbark Hickory, Red Oak and Bur Oak. Nested within these plots are subplots to test the use of sludge as an organic amendment, the use of nurse crops to control competition, and the use of fertilizer to increase growth rates.

The technique of aerial pin oak seeding immediately adjacent to the upstream containment levee was somewhat successful. While creation of the dredged material containment area did succeed in raising the elevation of the placement site, much of this area remains too poorly drained to be suitable for regeneration of mast-producing tree species. Mast trees planted as part of the Iowa State University revegetation study are growing on sites in the containment area that are relatively higher in elevation and better drained than the surrounding ground. This mast tree component currently occupies only a small percentage of the replanted area. Persistent poor drainage in much of the containment area limits the likelihood that further active mast tree revegetation efforts would be successful. Natural revegetation of the area by wet-soil adapted tree species such as willow and cottonwood appears to be underway. Over time, further consolidation of the dredged material may provide more favorable conditions for mast tree production. Although some mortality of the mast trees currently established on the site will continue to occur, those that survive to maturity could provide a future seed source for natural mast tree regeneration in the long term.

Long Island Division (Gardener Division). Pool 21, Upper Mississippi River Miles 332.5 - 340.2, Adams County, Missouri. Two of the project objectives were to 1) reduce forest fragmentation and 2) increase bottomland hardwood diversity. The project area also has one of the last high quality stands of bottomland forest in the middle reaches of the Upper Mississippi River. In order to meet the objectives it was decided to plant 67 acres of mast-producing trees on the dredged material placement site located on Long Island's eastern agricultural field.

A meeting was held on November 12, 2003 at the project's construction site on Long Island to inspect the mast tree plantings and assess the success and condition of the previous two plantings. The team had concerns about tree survival due to the abundant weed growth. The tree plantings appeared to have good survivability, but were stressed by the amount and height of weeds around them. The tall weeds have the potential to lay over the tree plantings stunting their growth or killing them. It was decided to use herbicide and seeding options to aid in the tree's survival. It was suggested that in future mast tree plantings, that berms be seeded as well as the rows between the berms.

During a later inspection, District foresters felt that the flooding helped manage the weeds around the mast trees and will give the trees a better survival rate.

Cottonwood Island. Pool 21, Mississippi River Miles 328.5 through 331.0, Lewis and Marion Counties, Missouri. One of the project objectives was to increase bottomland hardwood diversity and quality. The features used to obtain this objective were the planting and attempted establishment of trees in existing management/crop areas and on elevated ridges.

Several sites were been selected for planting throughout the project area. Restoration of a mast-producing tree component to these areas would provide wildlife with an additional winter food source for a period of up to 100 years. Pin oak, swamp white oak, bur oak, pecan, and sycamore would be planted on a 30-foot spacing. Species would be intermixed at each site to avoid solid blocks of individual species.

Large stock seedlings greater than 4 feet in height would be planted to introduce a component of mast-producing trees to the project area. The tree plantings would be spaced and distributed to allow for a natural appearance. This enrichment planting technique differs from a plantation tree culture, where the objective would be to make mast-producing trees the dominant species. Instead, enrichment plantings are designed to introduce a component of mast-producing trees to create a mixed forest stand.

Pin Oak, Sycamore, Bur Oak, Northern Pecan, and Swamp White Oak were planted at designated locations at each planting site. Ground disturbance for mast tree planting occurring on previously harvested forest management areas consisted of cutting and removing all woody vegetation within 6 feet of the center point for the planted tree and then excavating a planting hole 2 feet in depth and 3 feet in diameter. Tree planting operations within the agricultural field involved disking to a depth of 4 inches, this was followed by excavation of planting holes. The forest management areas maintained a natural appearance throughout the establishment process, as only the vegetation directly surrounding the seedling was controlled. On the dredged placement site, soil disturbance for tree planting was limited to the newly placed material only.

A cover crop of red top grass and annual grains was to be established in the tree planting sites to help control unwanted weed species. Herbicides were used to control any competing vegetation. After a 3-year establishment period, the surrounding ground in all planting areas were allowed to assume natural regrowth.

Better than 95% of the Mast trees planted in the Agricultural field have survived with most thriving. Some of the Sycamore trees planted in this area are over 20 feet tall with the trunks of some of the Oak trees over 8 inches in diameter. It is not known why the trees in this area are doing so much better than the others areas. It was noted that the trees were container grown when planted and the mats placed around the trees at the time of planting are present for nearly every tree in the Agricultural field. The additional size of the plantings and the removal of competition for nutrients and other benefits gained by the securely placed mats seem to have been of great benefit.

The following reforestation recommendations and guidelines were provided by Kurt Brownell and Randy Urich, Foresters, St. Paul District

- Mast is an important diet component of many wildlife species and the most important mast-producing tree found within the bottomlands of the upper Mississippi River in the St. Paul District is swamp white oak (Quercus bicolor). The La Crescent Natural Resource Project Office surveyed a number of locations in 2003 and determined that the average minimum elevation above mean pool elevation where swamp white oak occurs is 2.17 feet, and for black oak (Quercus velutina) it is 3.01 feet. While this conclusion is based on data from only three pools, it at least establishes rough guidelines.

- Consider flood frequency and current velocity before using tree shelters on low elevation islands. Floodwaters can tip over or remove shelters, resulting in dead, deformed or damaged trees. Tree mats may not hold up on low areas either, but are more likely to stay in place than shelters. The weed control that mats provide may still be worth the risk of using them on low areas.

- Fine sediments with a high percentage of clay may be more difficult to establish trees on. This is especially true if there is significant compaction from heavy equipment during construction. One potential solution is the use of power augers during tree planting to loosen the soil in the planting hole.

- An excellent set of modeling tools are available to assist in selecting sites, trees species, and tree sizes for successful reforestation. These flood potential models for the Upper Mississippi and lower Illinois Rivers are available from USGS at http://www.umesc.usgs.gov/reports_publications/psrs/psr_2001__01.html.

7.5. Native Grass Planting

Native prairie grasses provide habitat, cover, and food sources for indigenous wildlife. Much of the native grasslands that once existed throughout the Midwest have been lost due to agricultural conversion, urbanization of open spaces, fire suppression, and changes in nutrient content of surface water runoff. Reestablishing native grass stands restores this lost habitat structure.

The Anfang and Wege Report (2000) provides a large amount of information on the establishment of vegetation on islands and dredge material placement sites. The establishment of vegetation on HREP projects was successful and helped reduce site erosion, improved aesthetic appearance, and provided valuable wildlife habitat.

7.5.1. Design Methodology . A mixture of native prairie grasses including switchgrass, Indiangrass, little bluestem and Eastern gamma-grass is recommended. A mixture has proven to support more wildlife than a solid stand of any one grass. Some individuals believe that it is best to acquire seed from a site that is within 100 miles of the restoration site in order to preserve the genetic integrity of local plant populations, (*Prairie Establishment and Landscaping).*

Preparation of the seedbed is one of the most important steps in a prairie restoration. Proper restoration will reduce weeds, facilitate planting, and provide a suitable bed for seed germination. A good seedbed will increase the success of a prairie planting while a poor seedbed will promote failure.

If planning a spring planting, begin seedbed preparation in the fall prior to planting the following spring. Preparation of the site in the fall will damage root systems of perennial weeds and expose them to freezing temperatures and the dehydrating action of the winter winds. In the following spring, the ground should be worked at a shallow depth at least twice to break up clods and eliminate annual weeds. Deep cultivation exposes more weed seed, eliminates the firm underbase which is necessary for successful prairie establishment and may cause prairie plant seeds to be planted several inches deep, making it impossible for the seedling to reach the surface.

The ideal spring planting date varies with location and climate but generally includes a two-month period from April 15 to June 15, with the earliest planting being made in the southern reaches. Plantings made after the middle of June run the risk of encountering hot, dry weather which will reduce seed germination and seedling survival. It is also possible to plant during the late fall, thus allowing seeds to stratify naturally in the soil. If planting in the fall, be sure to plant late enough so that seeds germinate the following spring. The freezing temperatures could kill the seedlings if planted too early, (*Prairie Establishment and Landscaping).*

It is important for the designer to remember that increased plantings are less likely to work if the site management does not alter. Fire is a vital part of the genesis of native grass prairies. Though fire suppression is a natural instinct, it should be discouraged for the healthy development of grasslands. Fires eliminate the accumulation of dead leaves and stems of prairie plants and retard the encroachment of trees and shrubs. Trees and shrubs have vulnerable living tissue above ground and, therefore, are subject to the intense heat of fire. In contrast, most prairie plants are deep rooted perennials that go dormant in the autumn and winter months leaving only dead, extremely flammable tops exposed to fire. These grasses do not need to be reseeded after fire if have already been established, (*Prairie Establishment and Landscaping)*.

The seeding rate may vary according to your objectives for the planting. If you want a pure stand of grass, a seeding rate of 8 to 10 pounds per acre should be sufficient for this purpose. If you desire a mixed stand with numerous prairie flowers, reduce the amount of grass to 2 to 4 pounds per acre, particularly the larger grasses such as Indian grass and big bluestem. Increase the amount of wildflower seed until the mixture is 60% grass and 40% wildflowers by weight (Rock 1977). It is also possible to reduce the volume of grass by utilizing a process known as “debearding”. In this procedure, the seed of big bluestem, Indian grass, or little bluestem is processed in a machine which removes the awns or "beards". The removal permits the seeds to pass through seeding devices more easily. If the seed has been debearded, reduce the amount listed by one-fourth.

When planted together, the total weight of the grasses should not total more than 6 pounds. This is a recommendation. The ratio of grass to forb seed will often be a matter of personal preference, seed availability, and cost.

Additionally, efforts should be made to reduce the exposure of the grasslands to nutrient-rich runoff. Certain invasive species, for example reed canary grass, are highly nutrient tolerant. The introduction of nutrient-rich runoff favors these invasive species and may reduce the likelihood of success in native grass plantings.

When dealing with large stands of undesirable or invasive species, herbicides may be needed to kill or weaken the existing plants. This allows the more desirable native species to gain a stronghold in the area. It is recommended that a habitat friendly herbicide, such as Aqua Master® is utilized in this application, as runoff from the upland areas will wind up in wetlands, streams, and rivers prior to chemical degradation, (*Better Wetlands*).

The seed of prairie plants can be planted by a variety of methods, including specially made drills, rotary spreaders, or hydraulic mulchers. Any large scale planting which does not drill the seed into the ground will require the use of a harrow to "set" the seed. If the conditions are suitable, and the seed viable, it should germinate within two or three weeks.

The use of no till prairie seed drill has increased dramatically. Using no till planters reduces the costs, saves time, and prevents disruption of the soil that could be experienced with traditional methods of planting.

During the first year of after planting, do not expect to see much growth from the prairie plants. It is during the first year of growth that most prairie plants establish their root systems. After two or three years, if survival is good, the prairie plants will be well established. Both Betz (1986) and Schramm (1990) describe the importance of establishing the "prairie matrix", a group of easily established prairie plants that represents the initial stage of succession that eventually leads to the development of a planting much like a native prairie remnant.

7.5.2. Lessons Learned

- A higher percentage of seeded species were dominant on sites with more than 1 foot of fine material (68%) than on sites with less fine material (56%).

- Fine material sites with more than 35% silt/clay had a higher average percent cover than sites with lesser amounts. At least 15% fines in the topsoil is sufficient to establish vegetation, however.

- Prescribed burns should follow herbicide treatments. After grasslands are treated with herbicides, large amounts of dead biomass exist on the ground. It is difficult for new seeds to germinate under this biomass, and seeds that are broadcast may not reach the ground surface at all. A prescribed burn consumes this excess biomass, preparing the soil for future new growth, (*Prairie Establishment and Landscaping*).

- Fine material increased the density of vegetation (both planted and naturally occurring). Six inches of fine material should be the minimum used for capping. The percent cover is highest on vegetation sites that were capped with more than 1 foot of fine material. A thicker cap of fine material with a higher percentage of fines may encourage a dense growth of woody and herbaceous cover.

- The fine material should contain sufficient coarse material to allow for aeration and water infiltration. This should be included in the specifications for the project.

- Switchgrass was recorded as the most common species on vegetation sites twice as often as any other species. At some sites the high density of switchgrass may have reduced the abundance of other vegetation by shading or other means.

- It may take several growing seasons (three to six) before vegetation reaches a desired/maximum density.

- The monitoring effort could not explain why some vegetation sites quickly convert from grasses to dense herbaceous and woody vegetation. Possible explanations include the proximity of some sites to other woody vegetation, whether or not the site was seeded to grass in the first place, the elevation of the site (higher sites favoring grasses), and the depth and consistency of fine sediments used as topsoil.

- 8-inches of fine sediment is too much for disking with standard farm equipment.

The following reforestation and revegetation recommendations and guidelines were provided by Kurt Brownell and Randy Urich, Foresters, St. Paul District

Soils

- Coarse, sandy dredged material is a poor medium for plant growth. It is important to incorporate some form of organic material with the sand to provide a suitable environment for seed germination, plant establishment and survival. To date, UMR revegetation projects have generally utilized fine sediments dredged from backwaters for topsoil. This has worked well. Sewage sludge and compost are other options being explored on a limited basis.

- Fine material placement techniques that have worked successfully include: mechanical dredging in backwaters with placement using front-end loaders; hydraulic dredging in backwaters using containment cells for placement on the site and follow-up spreading and incorporation with heavy equipment; use of an irrigation sprayer to apply fine material dredged from a backwater using a small hydraulic dredge; and use of dump trucks to deliver topsoil where the project site is accessible by land.
- Ideally, fine material and soil amendments should be incorporated into the base material. Six inches of soil depth is often suitable for planting grass and forbs, with dry prairie species possibly requiring a bit less.

- To help promote long-term survival and health of vegetation plantings, project sponsors should be encouraged to monitor soil nutrient levels at reasonable intervals after the project is completed. Color and condition of foliage plus plant size may be used as an initial indicator. If a problem is suspected, a soil test will confirm the nutrient levels and can be arranged through local extension offices. Follow-up action may include application of fertilizer.

- Soil erosion can be very effectively controlled using vegetation. However, soil-holding capabilities vary between plant type and species. It is important to consult a vegetation specialist during the planning and design phase to help with plant selection.

Elevation

- Even within the floodplain, the flood tolerance of different plant species varies considerably. Elevation differences of six inches or less can determine whether a site will support certain types of plants. Therefore, it is very important to match plant species to elevations. A good general reference is Whitlow, T. H., and Harris, R. W. (1979). "Flood tolerance in Plants: A State-of-the-Art Review," Technical Report E-79-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS., NTIS No. AD A075 938.

- Post-construction flooding on low elevation islands usually results in establishment of new plant species from seed that is washed onto the site. Sometimes this new vegetation can significantly change the original composition and density of plants, and often includes undesirable species, such as vetch, purple loosestrife, reed canary grass and others. Therefore, it is recommended that simple, relatively inexpensive planting mix be used on these lower areas.

- Islands have the potential to support diverse stands of vegetation that can then provide benefits such as wildlife habitat, visual barriers, and protection from wind. Vegetation types include bottomland forest, grassland, and shrubby woody vegetation. Designing islands with diverse topographic relief provides managers with a greater number of vegetative options

Grass and Forbs

- Recommend using a diverse mix of native grass and forbs to ensure good overall survival. Wildflowers can enhance the appearance of the site.

- The Spring Lake EMP project delivery team designed two grassland seed mixes in 2004 for use on islands as shown in tables 7.1 and 7.2. For sections of islands where vegetative management will be minimal, the abbreviated prairie mix should provide a relatively quick cover of native species. On higher sections (4 feet above average pool), the diverse prairie mix is recommended. Planners should be advised that active management is required to maintain grassland on the river, to include mowing during establishment of the stand and periodic controlled burns later to control invasive species and woody vegetation. In addition to providing habitat benefits, native prairie grasses form deep, dense root systems that will ultimately provide more protection to the islands.

- On projects where mulch is utilized, planners should consider weed-free certified mulch. The Minnesota Department of Transportation has such a program and vendors are listed on their website. By using this mulch, the risk of infesting your island with an invasive plant species is much reduced.

Table 7.1. Abbreviated Prairie Mix

Common name	Scientific name	Seeding rate (ounces per acre)
Virginia wild rye	*Elymus virginicus*	48
Wild canada rye	*Elymus Canadensis*	48
Switchgrass	*Panicum virgatum*	32
Indiangrass	*Sorghastrum nutans*	16
Prairie cordgrass	*Spartina pectinata*	3
Black-eyed Susan	*Rudbeckia hirta*	2

Table 7.2. Diverse Prairie Mix

Common name	Scientific name	Seeding rate (ounces per acre) PLS
Big bluestem	*Andropogon gerardii*	25.5
Little bluestem	*Andropogon scoparius*	25.5
Sideoats grama	*Bouteloua curtipendula*	25.5
Rough dropseed	*Sporobolus compositus*	1
Virginia wild rye	*Elymus virginicus*	25.5
Wild canada rye	*Elymus canadensis*	25.5
Switchgrass	*Panicum virgatum*	4
Indiangrass	*Sorghastrum nutans*	25.5
Prairie cordgrass	*Spartina pectinata*	2
Black-eyed susan	*Rudbeckia hirta*	3
Evening primrose	*Oenthera biennis*	2
Purple prairie clover	*Dalea purpurea*	3
Brown-eyed susan	*Rudbeckia triloba*	2
Yellow coneflower	*Ratibida pinnata*	2
Bergamot	*Monarda fistulosa*	1
Blue vervain	*Verbena hastate*	1.5
Hoary vervain	*Verbena stricta*	1.5
Sky blue aster	*Aster oolentangiensis*	0.5
Frost aster	*Aster pilosus*	0.5
Showy sunflower	*Helianthus laetiflorus*	0.5

7.5.3. References

Illinois DNR Division of Natural Heritage, *Prairie Establishment and Landscaping, Natural Heritage Technical Publication #2*, 1997.

Anfang, R.A., and G. Wege, 2000. *Summary of Vegetation Changes on Dredged Material and Environmental Management Program Sites in the St. Paul District*, Appendix B, Habitat Parameter 4, Terrestrial Vegetation, Corps of Engineers.

7.5.4. Case Studies

Potters Marsh. One of the project features was to develop grassland on a CPS (confined placement site), with the objective of enhancing habitat for migratory birds by increasing feeding or resting areas by increasing suitability. Seven acres were designed for this feature.

The grassland area was constructed after initial settlement of dredged material. The area was seeded with selected grasses. This grassland area helped compensate for any lost vegetation due to the CPS construction and further enhanced the habitat values on the site. This grassland provides habitat for dabbling ducks as well as non-game species like the dickcissel and the indigo bunting. These improvements would provide an enhanced aesthetic environment for recreationists hunting or fishing within the complex boundaries.

The Refuge Manager reported that during the spring of 1997 several pairs of Canadian geese had nested in the interior of the CPS and mallards had nested on the associated berm and grassland areas. Small numbers of sandhill cranes visit the Savanna District each year. During 1995, a sandhill crane nest located near the containment site successfully hatched two young. This was the first documented sandhill crane nest in northwestern Illinois since 1872. Refuge staff observed nesting activity by sandhill cranes on or around the CPS grassland and berm in the spring of 1997, although actual nests or hatching success were not confirmed.

A third site visit to the CPS by Corps staff on October 2, 1997, showed cover crop rye grasses were still dominant on the berm and grassland. This third inspection revealed an increased presence of warm season grasses and forbs. Several species encountered, such as little bluestem, sideoats grama, and blue grama, were included in the seed mixture specified for the CPS. Other species, such as New England aster, Indian grass, and big bluestem, were not included in seeding specifications, but could either be natural components of the seed bank in the area or incidental inclusions in the seed mixtures applied after construction of the CPS.

During the October 2, 1997, site visit, Corps staff encountered a plant specimen tentatively identified in the field as the federally listed threatened species decurrent false aster (Boltonia decurrens). This identification was confirmed the following day by the endangered species coordinator at the Rock Island Field Office of the USFWS. The known range for this species in Illinois is limited to floodplains of the Illinois River and of the Upper Mississippi River downstream of the confluence with the Illinois. This species is not recorded as occurring in Carroll or Whiteside Counties, and the reason for its presence on the CPS feature at Potters Marsh is not known. There is a possibility that seeds of this species may have been accidentally transported to the site in seeding mixtures or through some other construction-related activity.

The initial vegetation response and observed waterfowl use of the area since construction indicates a positive response to the HREP and suggests that the project is providing benefits to migratory bird species. Establishment of a plant community dominated by warm season native grasses and forbs typically requires at least 3 to 4 years to fully develop, with periodic maintenance activity such as controlled burning to control less desirable vegetation (e.g., cottonwood seedlings). Continued monitoring of vegetation changes and migratory bird use within and around the CPS will help to determine the long-term performance of this feature.

On April 1, 1998, USFWS refuge staff conducted a maintenance bum of the berm and grassland areas of the CPS. Site visits conducted by Corps staff on May 22 and July 15, 1998, revealed an increased dominance of warm season grasses and forbs, as well as an increase in the number of species present. These initial observations suggest that the grassland community responded well to the initial maintenance bum.

Burning should be applied to the grassland and containment berm annually or biennially when possible. Mowing may also be beneficial where encroachment is initiating or when burning is not practicable.

The managed marsh continues to be submerged year round in order to control the encroachment of willow and cottonwood trees by keeping the marsh too wet for the trees to thrive. The project has been operated in this manner since June 2000. The strategy of flooding the marshland has been somewhat successful in killing undesirable vegetation, but encroachment remains a problem and would most likely worsen if the managed marshland were operated as a moist soil unit (moist soil units are drawn down in the summer months). Encroachment continues to be worse in the grassland area where the land is higher and flooding is not possible. Grassland and forb species were especially threatened by the encroachment.

The grasslands planted met the project objective of enhancing wildlife habitat.

7.6. Wetland Species Planting

Floodplain wetlands provide important nursery grounds for fish and export organic matter and organisms back into the main channel (Junk et al. 1989, Sparks 1995, Welcomme 1992).

7.6.1. Design Methodology. Before restoring a wetland, the designer should consider their primary goals. For instance, water levels may be regulated differently for waterfowl benefits than for water quality improvement.

Wetlands designed for waterfowl should be managed so that at least 50 percent of the surface area is less than 18 inches deep. This will enable emergent vegetation such as cattails to become established and grow vigorously. The other half of the wetland can range from 2 to 6 feet deep, but 3 to 4 feet of water is all that is necessary to assure water for duck broods.

Where water quality improvement is the primary goal, water depths should be less than 3 feet with vegetation over 75 percent of the wetland.

Water control structures can be used to periodically drain water off wetlands to enhance plant germination and otherwise manage wetland plants. The control structure can also be used to increase water depths to create open water areas.

Slow drawdowns ultimately result in more food and habitat for waterfowl and shorebirds. The drawdowns must be timed carefully to avoid adversely affecting invertebrates and amphibians, however.

It is a good idea to seed the adjacent land to a restored wetland to forbs and native grasses such that at least an acre of grass is available for each wetland acre, (*Better Wetlands*).

7.6.2. Lessons Learned. Studies have shown that it is not necessary to plant any wetland plants in the wetland itself. Simply returning water to the area results in aquatic vegetation developing within two years.

The aquatic plants that will likely grow include prairie cordgrass, arrowhead, cattails, sedges, marsh milkweed, water smartweed, and bulrushes, (*Better Wetlands*).

7.6.3. References

*Better Wetlands***,** October 1995, USDA NRCS, Iowa Association of Soil and Water Conservation District Commissioners, IDALS, Division of Soil Conservation

7.6.4. Case Studies. None listed.