UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DESIGN HANDBOOK

CHAPTER 9

ISLANDS

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Habitat projects alter the physical condition of the river to attain a biologic response that achieves a habitat goal. Project monitoring to determine if goals and objectives were met has provided some information regarding cause and effect relationships, however given the complexities of the Upper Mississippi River, much uncertainty remains. Development of a GIS data base like that used for the habitat needs assessment (Thieling, 2000) allows delineation of land cover and the species likely to occur in an area. This same data could be used to develop biological models that predict the habitat response based on physical parameters like water depth, current velocity, substrate, and wind fetch. In the future, models such as these could be used during the planning and design of island projects to evaluate biological benefits.

The natural river paradigm, which states that restoration to natural conditions provides the best habitat for the native species, should be considered also. However, this requires information regarding the condition of the natural river, which often doesn't exist, and ignores the fact that the altered river provides valuable habitat for many species. One consistent theme between habitat objectives for island projects and the natural river paradigm is the recognition that floodplains should convey water during floods, but for low flow conditions, water should be conveyed in channels with minimal floodplain flow. Figure 9.B.1 illustrates how this has been accomplished in Pool 8 by constructing islands.

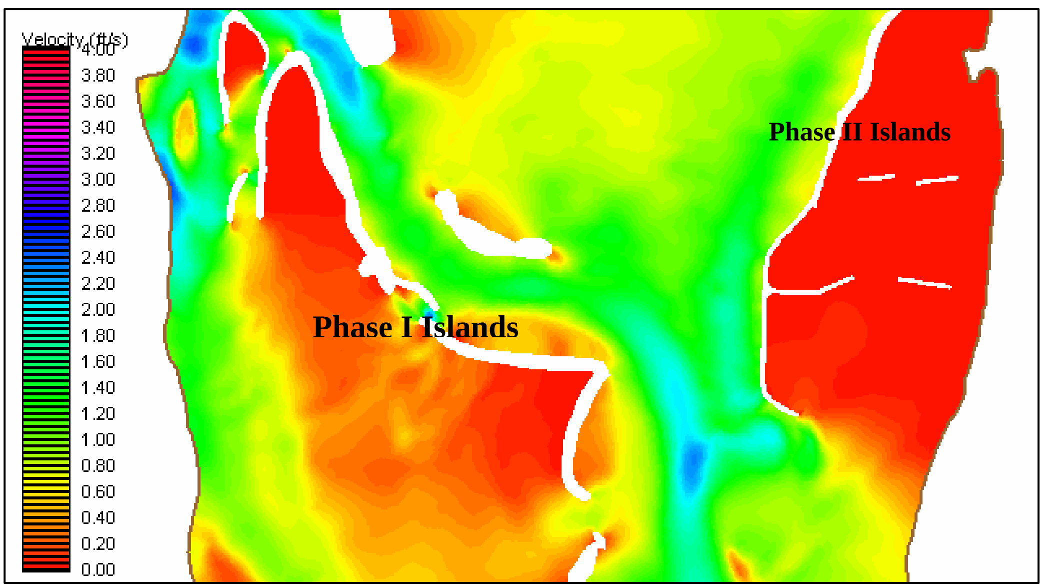

Figure 9.B.1. Current Velocity in the Pool 8, Phase I and II Areas Based on Two Dimensional Modeling Red indicates low velocity floodplain areas created by the islands during non-flood conditions.

Regardless of the tools available to HREP design teams, the most critical factor in island design is to have well-articulated habitat objectives and habitat parameters that lead to the final design and ultimately to a constructed island that meets the objectives. The spatial scale these objectives and parameters cover might include the entire project area (e.g. creating specific physical and water quality conditions in the project area for backwater fish) or they may be focused on specific components of the project (e.g. the design of loafing structures associated with shoreline stabilization).

The following is a list of habitat parameters that have been established for island projects to meet habitat objectives. The Fish and Wildlife Work Group (FWWG) provided most of this information. The FWWG is a group of natural resource managers and biologists established by the River Resources Forum in the St. Paul District, to study fish and wildlife issues in Pools 1 through 10.

Habitat Parameter 1. Fish Habitat. Table 9.B.1 lists the physical conditions that have been established for various species of fish. The conditions listed for Centrarchids (bluegills, bass, crappies) were established for the Pool 8, Phase II island project. This resulted in increased fish populations in Stoddard Bay (WDNR data). The objective was to create 200 acres of over-wintering habitat between the months of November and March. Island and rock sill elevations were set high enough so that overtopping during these months would occur less than once in ten years, while at the same time minimizing the number and duration of overtopping events during the remainder of the year. The depth criteria of over 4 feet provides optimum conditions, however surveys indicate that Centrarchids will use shallower depths if ice thicknesses are not too great. Groundwater inflows can have an effect on winter habitat, however data does not exist to quantify this impact.

Table 9.B.1. Physical Conditions for Fish Habitat

Species	Velocity (fps)	Temperature (° C)	D. O. (mg/L)	Depth (feet)	Substrate
Centrarchids, Winter	< 0.01 over 80-percent of area	4° C, 35 % of area 2 – 4° C, 30% of area	> 3	> 4 over 40% of area	
Centrarchids, Summer			> 5		
Centrarchids, Spawning	< 0.016		> 5		
Centrarchids, Nursery	< 0.016		> 5		
Lake Sturgeon	0.35 – 1.3			3 – 13	silt - sand
Shovelnose Sturgeon	0.65 – 1.5			13 - 25	sand
Paddle Fish	< 0.16			13 – 25, > 19 is preferred	

The physical conditions for Lake Sturgeon, Shovelnose Sturgeon, and Paddle Fish was discussed at a meeting between researchers, managers, and engineers on April 15, 2003. The purpose of the meeting was to explore the possibilities of creating this type of habitat with island projects. It is an example of some of the research that has been occurring on the UMRS and of what pro-active communication can accomplish.

Knights et al., 2002, based on a study of radio tagged Lake Sturgeon, found that core areas and other sites used extensively by lake sturgeon appeared to contain hydraulically similar conditions characterized by transition from high current velocities to slower velocities. These transition areas which are due to local changes in river morphometry, result in depositional substrates (ie. silt-containing) and probably represent important feeding habitats for lake sturgeon Examples of existing areas with these physical conditions include: areas in or near impoundments, the confluence of the main channel with large secondary channels or tributaries, and the boundary between the main channel and main channel border in impounded reaches. The lake sturgeon tagged during this study moved over a large geographic extent (as much as 100 miles) but they frequently returned to and used the core areas.

The data on Shovelnose Sturgeon is from research in Pool 13 (Hurley et al. 1987, Curtis et al. 1997), the LTRMP Open River Field Station, and UMESC trawling data in Pools 10 and 26. The shovelnose sturgeon used small home ranges, described as being 50 meters in length, for extended periods, but could move large distances (as much as 120 miles), usually returning to their home range. Observed shifts in fish location were noted based on the flow regime.

Zigler et al., 2003, based on a study of radio tagged paddlefish, found that areas used extensively by paddlefish had a combination of deep water, low current velocities, and was often influenced by eddy currents, which concentrated phytoplankton, a major food source. These physical conditions appeared to be more important in determining paddlefish use rather than location in a pool (upstream versus downstream) or aquatic area type (secondary channel versus lower impounded area). Although paddlefish frequently concentrated in specific areas in Navigation Pools 5A and 8 during summer through winter, large-scale movements occurred in both upstream and downstream directions, especially during spring.

Other considerations include rock gradations and woody structure used on island projects. Surveys done by the St. Louis District, Corps of Engineers (Niemi and Strauser, 1992) indicate that rock gradations that include larger rocks and subsequently larger voids improved habitat for fish. Incorporating woody structure into shoreline stabilization designs could provide fish cover if the near shore depths are relatively deep.

Habitat Parameter 2. Fall Waterfowl Habitat. Table 9.B.2 lists the physical conditions that have been established for dabbling ducks and diving ducks. These were established for the Pool 8, Phase II and Phase III island projects. Key factors to be considered when evaluating migration habitat are fall water conditions, plant species composition and distribution, human disturbance, visual barriers, sandbars/mudflats, loafing structures and thermal protection. Generally a 50/50 mix of open water to emergent/floating leaf vegetation is considered ideal for dabbling ducks. Large bodies of water (> 200 acres) with extensive beds of submersed aquatic vegetation and limited emergent vegetation are generally more preferable for diving ducks.

Islands effectively reduce wave action up to 1 mile downwind of the island, creating conditions more conducive to the establishment and maintenance of vegetation beds. The zone downwind of the island that is completely sheltered from wind is equal to ten times the height of the island plus trees.

Table 9.B.2. Physical Conditions for Waterfowl Habitat

Habitat Type	Velocity (fps)	Wind Fetch	Water Depth, d (feet)	Other Desirable Features
Dabbling Duck Migration Habitat	< 0.5	< 0.5 miles	d < 0.33, 15 – 25% of area 0.33 < d < 2, 40 – 50% of area	sand bars, mud flats, loafing structure, visual barriers,
Diving Duck Migration Habitat	< 0.5	< 1 mile	1.5 < d < 5, 40 – 70% of area	visual barriers

The following is based on information in the literature and input from resource personnel on the UMR.

- Optimum water depths for dabbling ducks to feed are between 4-18 inches. In riverine conditions, deeper water that supports rooted floating aquatic plants and submerged aquatic plants may still provide food plants and invertebrates at optimal feeding depths for dabbling ducks.

- High quality habitat provides a diverse assemblage of preferred food plants as opposed to a monotypic stand of one species. The physical conditions in a riverine system create the potential for the presence of a wide variety of vegetation communities. Shallow (<2 feet), low flow areas that are protected from wind provide ideal conditions for the establishment of emergent vegetation. Deeper areas (>2 but <8 feet) that are afforded some protection from wind provide suitable conditions for a variety of rooted floating aquatic and submersed aquatic vegetation. Each of these communities may provide food/cover plants and invertebrates that are important to waterfowl during migration.

- Loafing sites/structures offer the opportunity for dabblers to rest and conserve energy. Areas with extensive loafing areas are generally higher quality than areas without. Loafing areas can be present in the form of sandflats/mudflats, low islands, tree stumps, muskrat houses or floating vegetation. Several sites scattered throughout an area are better than one large area.

- Protection from prevailing winds during severe weather allows dabblers to conserve energy. Numerous studies on large reservoirs and rivers, and observations by UMR refuge personnel, have shown that waterfowl utilize protected shoreline areas during severe weather. Cutbank shorelines, protected coves, backwater wetlands, large stands of persistent emergent vegetation or islands can all provide the needed structure to provide thermal protection. The presence of this type of habitat, a function of the downwind shadow zone of structures such as islands, on at least 5 percent of the area dramatically improves migration habitat value.

- Emergent vegetation can be an important component of diving duck migration habitat, but not if it is too extensive in coverage. Areas that are predominately emergent vegetation (50 percent or greater) are usually considered to provide minimal migration habitat for diving ducks. Emergent vegetation beds may be used by diving ducks later in the migration season when the plants have withered and the areas are more characteristic of open water.

- Invertebrate populations can be a key food source for diving ducks during migration (especially in the Spring). Many species (such as mayflies, midges and snails) are associated with submersed and rooted floating leaf aquatic vegetation beds. Fingernail clams are also important. Fingernail clams seem to thrive best in areas that are fairly deep (3-8 feet), have flat bottoms and have current velocities between 0.1-0.3 fps.

- Susceptibility of an area to human disturbance may lower the value of an area as migration habitat. Disturbance in a migration area limit feeding opportunities and force the birds to expend energy in avoidance activities. In some cases the disturbances from bird watchers, researchers, fisherman and boaters may have as great an impact on specific birds as the more obvious disturbances such as hunting. Islands and or extensive beds of emergent aquatic vegetation can provide visual barriers between potential sources of disturbance and aquatic habitat. Large areas and multiple lines of barriers may often lessen the disturbance factor.

- The presence of extensive, protected aquatic vegetation beds is important in providing valuable migration habitat for waterfowl. While the design criteria provide conditions that are favorable for the establishment of aquatic vegetation in a mix that is desirable for the target species, it must be recognized that a variety of other conditions may affect the establishment or maintenance of aquatic vegetation including water quality, water levels during the growing season and the presence of invasive species.

Habitat Parameter 3. Aquatic Vegetation. The following information is from Jeff Janvrin, Biologists, WDNR & FWWG member with input from Yao Yin, Heidi Langher, Kevin Kenow, Jim Nissen, Eric Nelson, Sharonne Baylor

Earlier sections of this report have described how island erosion by waves, ice and river currents have reduced the number and acreage of islands in the lower sections of many pools in the St. Paul District. When an island is lost due to erosion, the impact is more than losing some land within the River's floodplain. A chain of events begins to occur. River currents now enter into the once protected area, increasing velocities and uprooting some of the vegetation beds. More vegetation beds are uprooted and lost because of the unchecked energy of waves rolling across miles of open water. The waves continue to build in size and eventually begin stirring up sediment from the bottom. Once the sediment is suspended in the water turbidity is increased, acting like a liquid veil, shading out light the underwater plants need to grow. Islands provide floodplain structure that can reduce the impact of wave action and current on aquatic vegetation.

Meeting the habitat objectives for many island projects includes providing suitable physical and chemical conditions for the germination, growth and maintenance of emergent, floating leafed and submersed vegetation. Aquatic vegetation provides food resources and cover for a variety of species. Aquatic vegetation also provides a wave damping affect that reduces shoreline erosion and sediment resuspension.

The following criteria were developed during planning for more recent HREPs and also include additional criteria proposed by a subgroup of the FWWG for consideration in the design of future island complexes to improve environmental conditions aimed at aquatic vegetation communities. Several of the criteria are based on queries of the LTRMP databases and will require additional analysis to refine the recommendations. This additional analysis is recommended to occur in the near future.

Some of the criteria are presented as a range. Diversity for these will most likely result in colonization and maintenance of a variety of species within the specified community. However, more specific criteria can be developed for specific species by further literature review, queries of the LTRMP database or research. Establishing the objectives will require the planning team to consider the best ecological potential in the area. Ideally, a project should be designed to meet the needs of all aquatic vegetation communities to provide the most habitat benefits. Water depths within the project area will be a major factor in determining the distribution and areial extent of aquatic vegetation communities.

The Pool 8 vegetation SRS data from the Environmental Management Program's Long Term Resource Monitoring Program was merged with a velocity model developed by the COE (90,000 cfs) and the bathymetry data. Table 9.B.3 summarizes the velocity and depth ranges in aquatic areas where emergent and floating leaved vegetation was present at SRS sites from 1998 to 2004. Over 80 percent of the emergent vegetation was present at locations with <0.6 m of water and velocities <0.1 m/sec. Over 80 percent of the floating leaf vegetation was present at locations with <0.8 m of water and velocities <0.1 m/sec. The preferred limit for water velocities is most likely less than indicated by this simple analysis since a flow of 90,000 cfs represents approximately a 2 year flood event.

Table 9.B.3. EMP LTRMP Vegetation SRS Points Where Emergent and Floating Leaf Vegetation Were Present Merged With Water Depths and Velocities (from Model of 90,000 CFS Flow). [1]

	Floating Leaf Vegetation		Emergent Vegetation	
Water Depth (m)	**SRS Points Present**	**%**	**SRS Points Present**	**%**
< 0.2	374	45%	350	58%
0.2 - 0.4	135	16%	104	17%
0.4 - 0.6	115	14%	69	11%
0.6 - 0.8	94	11%	35	6%
0.8 - 1.0	71	8%	28	5%
1.0 - 1.2	28	3%	8	1%
1.2 - 1.6	16	2%	11	2%
1.6 - 2.0	4	0%	2	0%
2.0 - 2.5	1	0%		
2.5 - 3.0	1	0%		
Totals	**839**	**100%**	**607**	**100%**

Velocity (m/sec)				
0	666	77%	491	76%
0.0-0.1	75	9%	42	6%
0.1-0.2	77	9%	42	6%
0.2-0.3	24	3%	14	2%
0.3-0.4	11	1%	19	3%
0.4-0.5	8	1%	19	3%
0.5-0.6	3	0%	11	2%
0.6-0.7	2	0%	5	1%
0.7-0.8	3	0%	3	0%
0.8-0.9			1	0%
1.0-1.1			1	0%
Totals	**869**	**100%**	**648**	**100%**

[1] Total points do not equal since model and bathymetry was not available for all areas SRS data was collected

Using the information provided by Table 9.B.3, along with experience and objectives from other projects and design considerations from other sections of this handbook, the following design criteria to promote the establishment and maintenance of aquatic vegetation were developed.

Emergent Vegetation

Water Depth: <0.6 meters
Water Velocities: 0.0 m/sec preferred, <0.1 m/sec acceptable over portions of the area
Substrate: Wide range, but not highly organic/flocculent or pure sand
Wind Fetch/Island Placement: Determine based on equation provided under Engineering Consideration 4: Wind-driven Wave Action for the water depth <2 feet that makes up the majority of area in shadow zone of island (for example, if 75 percent, of the water depth in the shadow zone of the island is 1 foot, then spacing should be based on minimizing sediment resuspension in 1 foot of water).

Rooted Floating Leaf Vegetation

Water Depth: <0.8 meters
Water Velocities: 0.0 m/sec preferred, <0.1 m/sec acceptable over portions of the area
Substrate: Wide range, but not highly organic/flocculent or pure sand
Wind Fetch/Island Placement: Determine based on equation provided under Engineering Consideration 4: Wind-driven Wave Action for the water depth 3 feet that makes up the majority of area in shadow zone of island (for example, if the majority (i.e. 75 percent) of the water depth in the shadow zone of the island is 1.5 foot, then spacing should be based on minimizing sediment resuspension in 1.5 foot of water).

Submersed Vegetation - To be provided by Yao Yin.

Water Depth: <x.x meters
Water Velocities: x.x m/sec preferred, <x.x m/sec acceptable over portions of the area
Substrate: Wide range, but not highly organic/flocculent or pure sand
Wind Fetch/Island Placement: Several different "types" of floodplain structures were recommended for consideration in meeting physical parameters for aquatic vegetation. Several of these structures have been incorporated as features of completed projects: islands; sand/mud flats; seed islands; and isolated wetlands in conjunction with island construction. Bob Drieslein, Refuge Manager (retired) with the Upper Mississippi River Wildlife and Fish Refuge has provided observations regarding vegetation response at the Polander Lake HREP, an HREP that also included the construction of isolated wetlands.

"The best response from vegetation, particularly emergents, was in Interior island No. 1. This was not surprising since this was the one that had the fines pumped into it. Water depths within the three interior islands were in the 2 1/2 - 3 foot range, which is too deep for emergents except on the margins. On island 1 we pumped in fines and reduced water depths to about one foot, which created an environment for emergents to grow. Floating-leaved aquatics like lotus and water lilies responded positively throughout the interior complex. It appears that aquatic plant beds outside the island perimeter have increased in size, due to the shadow effect affording protection from wind and wave action. Diving duck (primarily canvasback) use in the Pool 5A closed area which includes the island complex, was greater in fall, 2004 than in any year since the islands were built."

Water level management, both small scale and pool wide, has been used to provide environmental conditions suitable for the establishment of aquatic vegetation, especially emergent vegetation. The effects of periodic water level management are more prolonged in areas protected from river currents and wind fetch.

Other Design Considerations. Monitoring of emergent vegetation beds that grew in response to water level management in Pool 8 during 2002 and 2003 drawdowns showed herbivory by muskrats and waterfowl can have an impact on the emergent vegetation bed. Observations from these monitoring efforts indicate some consideration may need to be made to reduce suitable habitat for muskrats in some areas. Some potential design considerations to reduce the impacts of muskrat feeding on the emergents include:

- Shallow "breakwater" type islands that would provide poor quality shelter for muskrats
- Greater slopes on the island to prevent burrowing activity
- Provide greater variety of slope of the island (sacrificial berm tie in to the main island) based on water depth/fetch.

Monitoring/Research Needs. The interagency team formed to refine the island design criteria for aquatic vegetation identified several potential monitoring and research needs to better define criteria for the establishment and maintenance of aquatic vegetation. Following is a partial list of these needs, however, many other needs have been identified in other planning efforts:

- Query/analysis of existing LTRMP data to further develop and define physical factors affecting aquatic plant distribution with the Mississippi River floodplain.
- Impact of velocity on germination and growth of various types of aquatic vegetation.
- Affects of island on seed and tubor transport and settlement.
- Impacts of animal feeding activity on aquatic vegetation.
- Changes in animal use patterns after island construction.
- Complimentary benefits of island construction and water level management:
    - Affect of island and water level management on distribution of submersed vegetation.
    - Animal use patterns before and after island construction and water level management.

Habitat Parameter 4. Terrestrial Vegetation on Islands. 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 following observations by Anfang and Wege are listed because of their direct implications for island projects.

- The establishment of vegetation on HREP projects was successful and helped reduce site erosion, improved aesthetic appearance, and provided valuable wildlife habitat.

- Fine material increased the density of vegetation (both planted and naturally occurring).

- 6 inches of fine material should be the minimum used for capping. The percent cover was 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.

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

- Fine material sites with more than 35 percent silt/clay had a higher average percent cover than sites with lesser amounts. At least 15 percent fines in the topsoil is sufficient to establish vegetation, however.
- 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. As a general rule, 6-12 inches of soil depth will support bottomland hardwood trees. Six inches of soil depth is often suitable for planting grass and forbs, with dry prairie species possibly requiring a bit less.

- 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.

- 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 island 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 island 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.

- 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.

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

- An excellent reference is Wege, G. and Anfang, R. (2000). *Summary of Vegetation Changes on Dredged Material and Environmental Management Program Sites in the St. Paul District, Corps of Engineers,* Corps of Engineers and Fish and Wildlife Service report.

- The Spring Lake EMP project delivery team designed two grassland seed mixes in 2004 for use on islands as shown in the following two tables. 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 a 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.

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

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

Trees

- 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 ¾ 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 indigo bush (*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 feet 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.

Establishment

- 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.

Long Term Maintenance

- 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.

Other Considerations

- 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.

Habitat Parameter 5. Loafing Habitat. Islands and associated shoreline stabilization structures provide loafing habitat for many species (Photo H.14). The Fish and Wildlife Work Group (FWWG) established the following parameters for loafing habitat. The FWWG is a group of natural resource managers and biologists established by the River Resources Forum in the St. Paul District, to study fish and wildlife issues in Pools 1 through 10. Another excellent reference on large woody debris structures is Shields, et al. (2004). This reference discusses design procedures, costs, and successes of woody debris structures.

Design Criteria for Logs

- **Height Above Water.** Main trunk of the tree should be gently sloped so that with changing water levels there are loafing areas available most of the time and turtles can climb on easily. It would be ideal if the tree had multiple branches so the bottom branches provide fish cover while the upper branches provide loafing areas - even during high water.

    - Mixture of elevations is best, due to the different preferences and capabilities of different species and varying water levels. Two to 12 inches or more above summer levels are recommended.

- Pelicans, cormorants, eagles, etc, like open areas and 2-3 feet above the water seems to be better than near the surface. Most ducks seem to like structures that are a few inches above the water surface. Herons and egrets will readily perch on logs that are just under the surface to a little above the surface. Turtles, snakes, ducks and some other critters will want logs that are submerged in one area and out of the water in others. This allows them to swim up to the log and easily climb out of the water. The larger birds like pelicans, cormorants and eagles prefer to fly to a branch that is above the surface. The added height helps provide for an easier take-off.

- **Length.** 25 foot minimum length, the longer the better - 60 ft. plus could be used.

- **Diameter.** Trunk diameter of 10 inches or greater would be best. Bigger logs are easier for some wildlife to access at varying water levels and are generally available at more levels. They may persist longer as well. Bigger logs seem to hold up better and appear to attract more water birds. Smaller logs will be more prone to breaking with ice movement. Logs larger than 2' are a lot harder to work with and likely do not attract anything more than a 1' diameter log would.

- **Tree Species.** Trees like black locust will last a lot longer while others like cottonwood might rot faster. A list of tree species in priority order based on resistance to rot, density and possibly other characteristics is discussed in Engineering Consideration 7 (EC 7). Preliminary list based on longevity. The best species are black locust, white oak; the worst species are willow, cottonwood, box elder. Other species would fall in between.

- **Location (Sheltered Areas Versus Wind Swept Areas, Backwaters Versus Channels).** Areas sheltered from wind-generated waves in both backwaters and along secondary/tertiary channels would be best. Different species of turtles prefer different flow/depth conditions. When basking, most prefer calm winds, small waves and plenty of sun in a low traffic area.

    - Most should be located in sheltered backwaters, although if possible some should be placed in flowing channels for riverine turtles, amphibians, birds and other critters. Also, placing some in deeper areas could attract fish.

    - Woodducks, teal and some other ducks like secluded quiet backwaters, while mallards seem to like a more wide open area.

- **Number of Logs Needed for a Structure (Multiple Logs Versus Single Logs).** Multiple logs with variable trunk and branch heights at any given location (as described above) would probably be best. Single trees would work too if that is all that is available or doable. Multiple logs do not need to be bundled. Logs grouped together offer more options available at one site, plus multiple logs tend to create a quiet zone around them.

    - We have not completely addressed the effects of ice on the log structures. We know that rock holds up reasonably well, but ice damage has occurred at some sites (e.g. rock on Broken Gun island, Brice Prairie barrier island in Pool 7, Trempealeau NWR Pool 6). If the Rosebud Island logs are damaged, we may want to consider putting logs in cover or the inside of a bend where they will not be sticking out for the ice to hook them.

- If anchoring loafing logs within the rock of the groins or mounds, it would be a good idea to fill the rock voids with sand within a radius of 20 feet or so from the trunk/rock interface to avoid luring small creatures to being accidentally trapped in the rock.

- Loafing logs can be anchored into the shoreline of an island by notching the bank, placing the root mass and covering with rock. This technique was used successfully on Indian Slough in Pool 4 and Polander Lake in Pool 5A. Extremely large, spreading root masses might have to be partially trimmed or removed on some species before placement.

Habitat Parameter 6. Nesting Habitat. The following is a brief synopsis of parameters that have been established for nesting habitat.

Waterfowl. The following information is from Randy Devendorf, Biologist, USACE.

Establishment of adequate vegetation cover on islands can provide nesting habitat for waterfowl. While isolated wooded islands can provide suitable nesting habitat, dense grassy vegetation is preferable. Large islands may be designed to provide waterfowl nesting habitat, but they may become a significant management issue if predators become established on the island. The following criteria have been identified by UMR resource managers as guidelines for islands designed as nesting habitat:

- Locate island at least 1/2 mile from the nearest land
- Locate island within 1/2 mile of brood habitat (emergent aquatic vegetation)
- Size: <1 acre (< 1/2 acres is ideal)
- Vegetation cover should have an obscurity reading of at least 1.5 dm (6 inches)

Islands. The following information is from Mark Anderson, Biologists, WDNR & FWWG member:

- 0.1 to 5 acres. in size, 0.5 to 2.5 acres preferred
- At or above 10 yr. flood elevation (5 yr. minimum)
- 700 feet or more from permanent shoreline
- Adjacent to brood cover, "hemi" marsh or emergents interspersed with submergents
- Free of mammalian predators - small (.5 to 1 acre) islands are best in this regard
- No trees or other perches higher than 4 feet

Grassy and herbaceous cover, dominated by grasses is the preferred vegetation. Scattered brush, grapevines and small trees are acceptable. Woody plants need to be controlled by periodic prescribed fire, which will also rejuvenate the vigor of the nesting cover. Approximately every 5 years is a common interval. Residual (from previous growing season) cover should provide at least 70 percent visual blocking at a .3 foot height. 100 percent visual blocking (of a Robel Pole) is greatly preferred. Fertilization is not needed for establishment if 1 foot or more of fine particle soils are used to cap the island. Prairie grasses, like switchgrass, are preferred since they resist flattening by snow better than most cool season grasses. Please refer to seed mix #2 being used at Spring Lake (Pool 5) and the Pool 8, Phase III islands.

Turtles. The following information was obtained from Scot Johnson, MDNR and FWWG member.

Island Location

Aquatic Plants. Islands should be designed and located as to support the development of aquatic plant beds and protect existing plant beds. Aquatic plant beds in shallow backwater areas provide cover and food resources for nesting turtles and are necessary to insure the recruitment of hatchlings into the turtle communities. Following nest emergence, hatchlings tend to move towards protected areas with aquatic vegetation. Aquatic plants also provide staging areas for nesting turtles (some species are capable of producing two or more clutches of eggs over a single nesting season). Aquatic vegetation can provide a refuge from higher flow velocities during moderately high discharge periods.

Islands should be designed to break up long, open-water wind fetches in order to reduce wind wave heights, resuspended sediments, island erosion, and protect aquatic plant beds.

Pond/Backwater Turtles Species. Nesting sites should be located near shallow waters (<6 feet depth) that are well vegetated in a mixture of submersed and emergent plants. Soft to moderately soft substrates in shallow water with little to no flow velocity is desirable for over-wintering turtles. Coarse woody debris and rock groupings can be used to create flow velocity shelters near the bottom of the backwater within these over-wintering areas.

River Turtle Species. Nesting sites should be located near low to moderate flow velocity areas during the open water season with water depths ranging from shallow to very deep (20 feet +). Well to moderately vegetated areas should be in close proximity to the deeper water. Over-wintering refuges are found in areas with low velocities, water depths ranging from 8 to 30 feet. Again, large woody debris and rock can be used to create zones of reduced flow velocities near the bottom to improve over-wintering conditions.

Island Spacing. Islands spaced 500 feet apart or greater may reduce predation rates. Sparsely vegetated islands located some distance away from large, moderately vegetated islands may provide a refuge from high predation rates. It is recognized that islands spaced too far apart may reduce their effectiveness in reducing wind generated waves and their associated problems.

Deadwood/Loafing Structures. Map turtle densities have been correlated to nearby deadwood densities. The incorporation of deadwood into island design would provide refuge, basking, over-wintering and foraging areas for all size classes of riverine turtles. Deadwood placement should not be uniform but rather include the clustering of varying size branches and trunks entering the water at irregular intervals, various angles and elevations. Large woody debris, coarse woody debris and deadwood are terms used to describe tree snags and can be used interchangeably. Additional guidance on loafing structures (tree snags placed near shore and for the most part above water) has already been provided by the FWWG.

Rock Shoreline Protection. Rock shoreline protection and offshore mounds should be avoided in areas designed to attract nesting turtles to avoid accidental trapping of hatchlings. Rock can be a trapping hazard for some adult species of turtles as well. Rock groins and vanes may be better choices when rock stabilization is required, especially if the rock is choked with gravel or sand to eliminate the trapping hazard.

Nesting Areas. A mixture of nesting area sizes is ideal. Large nesting areas may promote lower predation rates because of reduced nest detection efficiencies. Small nesting areas may go undetected and therefore be predated less frequently. On the flip side, if small sites are found, they may be predated more efficiently. Multiple sites of various sizes within the island footprint are probably better than one large sand pad specifically designed for nesting. Long linear nesting areas can be predated more efficiently. Therefore, irregularly shaped and contoured nesting areas within the island may reduce overall predation rates.

Island Elevation. It is highly desirable to create nesting areas at or above the 10-year flood frequency. Eggs submerged in flood waters for more than 1 hour are rendered unviable. The higher portions of islands, as currently designed for the HREP program, are therefore the more likely areas for successful nesting and should be managed for terrestrial vegetation as described below.

Terrestrial Vegetation. A mosaic of diverse vegetation cover types and open areas, distributed over the higher portions of the constructed islands, would be conducive to turtle nesting success. To the degree necessary, ground cover should be encouraged to insure island stability. However, vegetation too dense may limit turtle access, over shade nests and root-bind hatchlings in the nest. Over story should be limited in some areas on the islands to increase habitat complexity and assist gravid turtles in visually locating appropriate island nesting sites. Breaks in the willow plantings and topsoil placement at irregular intervals, say every 100 to 300 feet, may be required to create the vegetation/opening mosaic required to allow nesting turtles better access to the island interior. Some of the openings should be large enough so that in 15 to 20 years they will still receive 8 to12 hours of sun a day to meet the thermal requirements to produce female offspring.

Island Nesting Substrate. Islands should have some flat areas rather than just steep or expansive slopes. Nesting substrates would ideally consist of fine sand to medium sand size particles to allow for adequate drainage. Fine-grained particles (silts and clays) placed as topsoil to promote vegetative growth and help stabilize the island, should be incorporated into the underlying sand and not allowed to form a hard, thick, impermeable crust. Again, it may be desirable to leave some portions of the island shoreline and interior topsoil free.