Habitat Rehabilitation and Enhancement Projects

4

Wood duck taking flight.

INTRODUCTION

Habitat Rehabilitation and Enhancement Projects (HREPs) are effectively preserving and improving fish and wildlife habitat on the UMRS. Since 1987, 24 HREPs have been implemented, affecting 28,000 acres of river and floodplain habitat. When the 14 HREPs currently under construction are completed, this area will more than double to nearly 68,000 acres. It is expected to increase to 97,000 acres with construction of the 12 projects now in various stages of general design (see Figure 4-1). HREPs are providing new information regarding river-ecology and physical processes. Project planning, engineering, construction, and monitoring approaches have evolved with the program, resulting in improved habitat benefits-to-project costs ratios.

The HREP program has fostered interdisciplinary and collaborative planning for habitat restoration, preservation, and enhancement previously unknown on any other river system in the United States. Three U.S. Army Corps of Engineers District offices, St. Paul, Rock Island, and St. Louis, manage HREP design and construction. The Corps Districts work directly with the five states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin and the U.S. Fish and Wildlife Service (USFWS) throughout all stages of individual habitat project development. Several other Federal agencies, as well as non-government entities and individual citizens, also regularly participate in the development of HREPs.

Although the UMRS supports a variety of aquatic, wetland, and terrestrial species, numerous studies have documented declines in habitat quantity, quality, and diversity. In Chapter 2, river health was discussed in terms of six relatively complex criteria. For purposes of more easily relating the HREPs to system ecological needs, these criteria have been simplified to

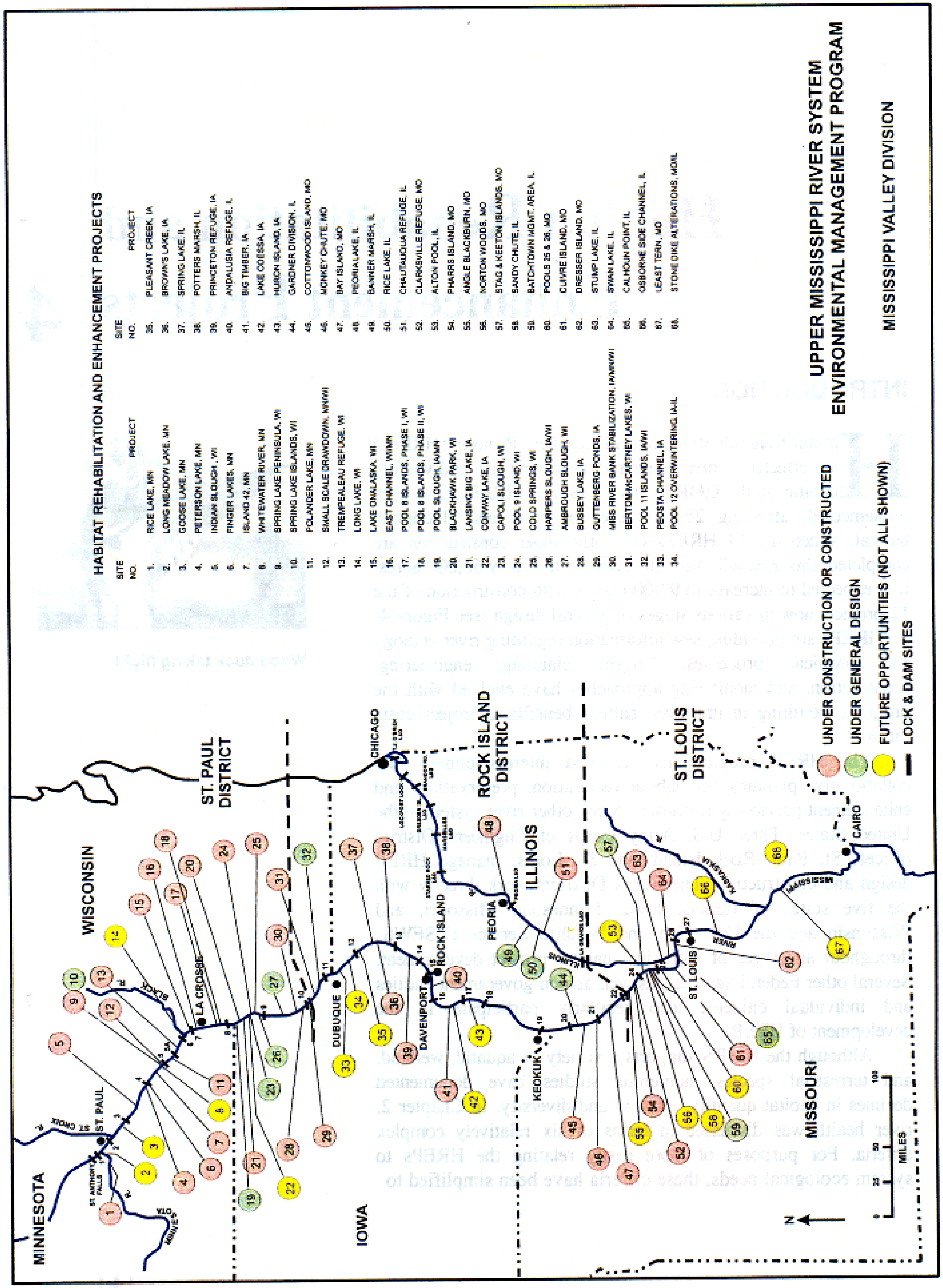

Figure 4-1. UMRS-EMP Habitat Rehabilitation and Enhancement Projects.

four areas of concern and associated trends (see Table 4-1).

Programs and policies exist to manage trends in tributaries and in water/sediment quality and quantity. For example, best management practices for agricultural activities reduce sediment, nutrient, and toxics transport. Point source pollution reductions have improved water and sediment quality as well. However, the HREP program is the only initiative that focuses on floodplain structure and hydrology. Sediment transport, river-floodplain connectivity, or water levels are altered to improve habitat by dredging sediments; stabilizing shorelines; or constructing islands, dikes, and other structures.

PROJECT DEVELOPMENT

Project Identification and Selection

Habitat projects are nominated for inclusion in the EMP by the respective State natural resource agencies and/or the USFWS based on agency management objectives; documented habitat needs; professional judgment; funding availability; and, at times, social considerations. For example, in the project formulation process in the Rock Island District, State and Federal field biologists known as the Fish and Wildlife Interagency Committee (FWIC) convened a series of meetings starting in 1986 to consider critical habitat needs on a pool-by-pool basis. These analyses revealed deficiencies (such as feeding, resting, and loafing areas for migratory waterfowl and absence of deep water off the main channel for diving ducks and fish), as well as types of habitat in abundant supply (e.g., mature bottomland hardwood). With this information, projects being considered reflected broader regional needs in addition to representing the best site-specific choices. The St. Paul and St. Louis Districts utilized similar committees and processes to screen and prioritize potential HREPs. Priority projects are then recommended to the Corps district for initiation of planning activities. Table 4-2 lists eligible project types and their associated purpose(s) or goal(s).

Project Planning, Engineering, and Approval

When funds are received for detailed planning and design on a proposed project, a multidisciplinary team of Corps planners, engineers, scientists, and technicians is assembled to initiate detailed project planning. This team works closely with an interagency team of biologists and natural resource managers to identify site-specific resource problems, constraints, and project goals and objectives. This process is described in detail in Appendix B.3, Planning and Design Tools. Public input on resource problems and desired outputs is solicited at this early stage in the planning process by conducting a public meeting.

Coincident with the formulation of goals and objectives is the identification of potential project features. For early HREPs, pre-project monitoring data was often limited, and performance data for similar projects was not available for comparison or refinement of design parameters; so the interagency project team worked together to develop project designs using the following general criteria to identify and assess alternative project features:

General Criteria Used for Designing HREPs
1. Locate and construct features consistent with EMP directives and guidance and best planning and design practices
2. Construct features consistent with Federal, State and local laws
3. Establish goals and objectives that can be monitored
4. Design features for a 50-year life, while minimizing operation and maintenance requirements

TABLE 4-1: River Health Areas of Concern and Trends	
Area of Concern	**Trends**
Tributary Effects	Increased Flood Inflows Sediment/Nutrient/Toxics Transport
Decreased Floodplain Structural Diversity	Island Erosion Sediment Deposition Training Structure Effects Floodplain Sequestering by Levees
Altered Hydrology	Flood Zone Reduction Water Level Alterations River-Floodplain Connectivity
Water/Sediment Quality	Increased: Suspended Sediment Nutrients Toxics

TABLE 4-2: Eligible Project Types, Purpose, or Goals	
Eligible Project Type	**Purpose or Goals**
Backwater Dredging	Create or restore overwintering fish habitat and depth diversity
Water Level Management (Dikes and Water Control Systems)	Reduce sediment deposition in backwater and wetland areas and manipulate water levels to promote aquatic plant and invertebrate production, and restore waterfowl resting and feeding habitat
Islands	Restore aquatic and migratory waterfowl habitat by providing physical conditions necessary for the re-establishment of aquatic plant growth and reduce wind and wave action
Shoreline Stabilization	Prevent shoreline erosion and create fish habitat
Secondary Channel Modifications	Preserve aquatic habitat by reducing sedimentation in backwater areas
Aeration	Restore aquatic habitat by improving water quality
Other (e.g., notched wing dams, potholes, land acquisition)	Complement to one of the other project types

As interagency teams planned individual projects, HREP design was further refined based on the following factors:

Factors Considered for HREP Design

1. Project goals and objectives
2. Hydraulic, geotechnical, structural engineering factors
3. Economics (habitat benefits versus project costs)
4. Constructibility
5. Aesthetics
6. Acceptable level of risk

While these criteria and factors continue to be used, project design has evolved because of lessons learned on earlier projects, input from researchers, and evolving natural resource management philosophies. In addition, mathematical and analytical modeling of flow, wind effects, and sediment transport has advanced since the program's beginnings and is used extensively in project design. Essentially, HREP engineering and design developed as the program developed, resulting in enhanced habitat benefits and reductions in most project implementation costs.

Engineering Advances

HREP construction, monitoring results, and improved technological tools have all contributed to advances in HREP design. Through the use of GIS and 2-dimensional numerical hydrodynamic models, the outcome resulting from construction of certain HREP features can be more reliably predicted. Design standards have been adjusted to promote innovation and reduce project costs. Project successes have become the basis for development of design standards for various types of HREPs.

For project planning purposes, evaluation of alternatives is accomplished through the application of a numerical habitat assessment methodology. Habitat evaluation procedures are used to assess existing and future without-project conditions in the study area, and to evaluate the anticipated habitat outputs of alternatives.

Quantifying HREP Outputs

To quantify the outputs of HREPs, the Aquatic Habitat Appraisal Guide (AHAG) was developed. This methodology for quantifying ecological outputs was developed because a dynamic, flexible model was not available to predict and quantify aquatic variables for large rivers, such as the Upper Mississippi and Illinois Rivers. AHAG is used to numerically rate habitat quality for individual species of fish under different life stages and varying conditions, and to document benefits of various habitat restoration, protection, and enhancement measures (e.g., creation of slack-water habitat and construction of weirs) proposed in the project design. AHAG is now available for use in evaluating other Corps actions as well as HREPs. EMP planning requirements also led to the development of habitat evaluation models for mussels and diving ducks.

Incremental analysis is also used to evaluate what enhancement features should be built based on determination of the most cost-effective combinations of features to provide habitat benefit outputs that meet the goals and objectives of the project. Incremental analysis is basically a three-step procedure: (1) calculate the environmental outputs of each feature; (2) estimate the cost of each feature; and (3) combine the features to develop the best overall project alternative based on habitat benefits and cost. Habitat evaluation procedures and incremental analysis are further described in Appendix B.3, Planning and Design Tools.

Following completion of these analyses, the interagency team selects the combination of enhancement features that best serves the needs of the resource, while being cost effective. Also, less conservative, experimental designs are considered and, if feasible, incorporated into project design. Examples of this include dike and island construction using available sediments, and shoreline stabilization using vegetation rather than rock. In some cases, planning and negotiating design options takes several years, but more typically takes two. Project design involves individuals from State and Federal agencies, as well as non-governmental organizations and the general public.

The results of the analyses and investigations described above are documented in a Definite Project Report (DPR) prepared by the Corps with input from the States and USFWS. The DPR also evaluates the selected plan for potential impacts to the human environment in accordance with applicable State and Federal environmental laws and regulations. Real estate requirements are identified, operation and maintenance requirements are evaluated, and a detailed project cost estimate is developed. The DPR is coordinated with the other involved Federal and State agencies and resource interests, and made available for general public review. The DPR is forwarded to the Corps higher authority with a recommendation for project implementa-tion approval.[1]

After approval of the project, the responsible Corps district prepares detailed project plans and specifications with input from the project sponsor. For habitat projects on land not managed as a National Refuge, the Corps of Engineers and the non-Federal project sponsor sign and execute a Project Cooperation Agreement (PCA) detailing the obligations and responsibilities of both parties. For these projects, the State natural resource agency normally assumes the responsibility of the non-Federal sponsor. Following completion of these two actions, the construction contract is advertised and awarded, and construction begins.

Project Construction, Operation and Maintenance

HREPs have provided new opportunities to test construction techniques and project design in the river floodplain environment. One of the greatest challenges in project construction can be site conditions, as projects are often located in remote areas of the floodplain. To meet this challenge, more recently constructed HREPs have featured contracts with shorter construction seasons to reduce the risk of flooding, utilized materials such as sheet pile to cut dewatering costs, or staged construction to facilitate access to the site. Construction modifications and unforeseen costs of early HREPs emphasized the importance of sound engineering investigations during design, including collection of sufficient geotechnical, hydraulic, and surveying data.

Operation and maintenance of a completed HREP is the responsibility of the Federal or State agency that has management responsibility for the respective project lands. That agency agrees to assume the project operation and maintenance (O&M) responsibility in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580. These functions are further specified in the Project Operation and Maintenance Manual that is provided to the sponsor prior to final acceptance of the project.

O&M costs vary by project type, as shown in Table 4-3. Water level management projects have the highest O&M costs because their features are more susceptible to damage from high water events; the higher level of active management required for successful project operation; and the more structurally complex features (e.g., pumps, wells) involved. In contrast, side channel modifications and islands are passively managed and typically have minimal maintenance requirements.

Project Monitoring

Physical and biological response monitoring of HREPs has added significantly to the wealth of information available on the river. Ongoing monitoring of projects will produce data necessary to develop physical and biological response models for use in refining future project designs. Table 4-4 summarizes the types of monitoring that are done on HREPs.

[1] In December 1993, Headquarters, U.S. Army Corps of Engineers delegated project approval authority to the Division level for most HREPs that have a total construction cost of less than $2 million.

TABLE 4-3: HREP O&M Costs

Project Name	Estimated Annual O&M Cost	O&M Responsibility	Project Status (as of Nov 97)	Features
Banner Marsh	$49,500	ILDNR	DPR complete	Water Level Management, Other
Batchtown	$90,000	ILDNR	DPR complete	Water Level Management, Other
Calhoun Point	$41,700	ILDNR	DPR complete	Water Level Management, Backwater Dredging
Bank Stabilization	$4,900	USFWS	Under construction	Shoreline Stabilization
Chautauqua Refuge	$29,800	USFWS	Under construction	Water Level Management
Cottonwood Island	$6,000	MDOC	Under construction	Backwater Dredging, Other
Cuivre Island	$14,700	MDOC	Under construction	Water Level Management, Secondary Channel Modifications, Other
East Channel	$5,100	USFWS	Under construction	Shoreline Stabilization
Peoria Lake	$19,800	ILDNR	Under construction	Water Level Management, Islands, Secondary Channel Modifications, Other
Polander Lake	$3,900	USFWS	Under construction	Islands, Shoreline Stabilization
Pool 8 Islands - Phase II	$4,000	USFWS	Under construction	Backwater Dredging, Islands, Shoreline Stabilization
Princeton Refuge	$26,600	IADNR	Under construction	Water Level Management, Other
Rice Lake	$2,900	USFWS	Under construction	Water Level Management, Other
Spring Lake	$33,100	USFWS	Under construction	Water Level Management, Aeration
Stump Lake	$33,700	ILDNR	Under construction	Backwater Dredging, Water Level Management,
Swan Lake	$60,000	ILDNR	Under construction	Water Level Management, Islands, Other
Trempealeau Refuge	$21,700	USFWS	Under construction	Water Level management, Shoreline Stabilization
Andalusia Refuge	$11,400	ILDNR	Constructed	Water Level Management, Backwater Dredging, Islands, Aeration
Bay Island	$9,400	MDOC	Constructed	Water Level Management, Other
Bertom and McCartney	$5,500	USFWS	Constructed	Backwater Dredging, Islands, Shoreline Stabilization, Secondary Channel Modifications, Other
Big Timber	$7,500	USFWS	Constructed	Backwater Dredging, Other
Blackhawk Park	$3,000	WDNR	Constructed	Secondary Channel Modifications, Aeration
Brown's Lake	$11,300	USFWS	Constructed	Backwater Dredging, Water Level Management, Aeration, Other
Bussey Lake	$4,500	USFWS/ IADNR	Constructed	Backwater Dredging, Water Level Management, Islands
Cold Springs	$900	USFWS	Constructed	Aeration
Dresser Island	$16,400	MDOC	Constructed	Backwater Dredging, Water Level Management
Finger Lakes	$10,500	USFWS	Constructed	Aeration
Guttenberg Ponds	$2,000	USFWS	Constructed	Water Level Management
Indian Slough	$500	USFWS	Constructed	Secondary Channel Modifications, Backwater Dredging, Other
Lake Onalaska	$3,000	USFWS	Constructed	Backwater Dredging, Islands, Shoreline Stabilization, Aeration
Lansing Big Lake	$2,500	USFWS	Constructed	Secondary Channel Modifications
Monkey Chute	$0	MDOC	Constructed	Backwater Dredging
Peterson Lake	$3,100	USFWS	Constructed	Shoreline Stabilization, Secondary Channel Modifications
Pharrs Island - Phase I	$5,500	MDOC	Constructed	Other
Pool 8 Islands - Phase I	$3,200	USFWS	Constructed	Backwater Dredging, Islands, Shoreline Stabilization
Pool 9 Island	$1,500	USFWS	Constructed	Islands
Potters Marsh	$6,100	USFWS	Constructed	Backwater Dredging, Water Level Management, Other
Small Scale Drawdown	$0	USFWS/ WDNR	Constructed	Other
Spring Lake Peninsula	$1,000	USFWS	Constructed	Shoreline Stabilization, Secondary Channel Modifications
Clarksville Refuge	$1,800	MDOC	Constructed	Water Level Management
Island 42	$400	USFWS	Constructed	Secondary Channel Modifications, Aeration

TABLE 4-4: HREP Monitoring	
Type of HREP Monitoring	**Typical Parameters Monitored**
Physical Response Monitoring	Flow distribution Flow velocity Water levels
	Water quality (e.g., dissolved oxygen, temperature)
	Sediment transport
Biological Response Monitoring	Plant growth, fish and wildlife response
Performance Evaluation Reports	Project performance as measured by physical and biological response monitoring Operation & maintenance Engineering design Monitoring plan
Natural Resource Managers' Reports	Project success Engineering design

Pre-project physical and biological monitoring is done to quantify resource problems such as low dissolved oxygen levels, island erosion, and backwater sedimentation. Post-project monitoring allows specific measurement of physical and biological variables affected by projects and provides data for use in future project development. Intensive biological response monitoring is ongoing at six HREPs.

The physical effects of HREPs on water movement are well understood. While many of the physical and chemical responses to a project (e.g., changes in dissolved oxygen, water temperature, or water velocity) can usually be determined shortly after construction, several years of monitoring may be required to determine certain selected physical and biological responses to the project (e.g., changes in sediment deposition, fish populations, invertebrates, and vegetation composition). The initial response to project construction may be much different than what happens over the life of a project.

Much of the intensive monitoring of biological response to HREPs has been accomplished using HREP funds. The decision to limit biological response monitoring was made early in the program because the individual and cumulative cost of pursuing detailed, quantitative assessments of the biological effects of every HREP constructed would be high and would reduce available funds for HREP design and construction. For example, biological response monitoring efforts accomplished in 1997 alone at two of the six sites (Peoria Lake and Lake Chautauqua) totaled $111,605 in contracted surveys, not including in-house Corps of Engineers costs. Where detailed monitoring has been completed, the results have generally supported management's evaluations of habitat problems. Biological response monitoring is complete at one of the six HREPs; however, information obtained at all six sites has already resulted in modifications of design and operation at many HREPs to further enhance benefits for riverine fish and wildlife species.

Because an HREP project provides benefits within a larger surrounding system, the need for and success of the project must be assessed in this broader context. Fish abundance estimates conducted at an HREP site may only indicate how the site functions as a fish attractor at the time of sampling or how vulnerable the fish are to capture at that site. The actual benefit of the project may lead to population improvements off site that are undetectable by short-term, site-specific sampling. Because of this, the species specific range of action is important (e.g., fish that can move 8-10 miles can utilize more widely dispersed habitat than one limited to a couple of miles). To this end, input from natural resource managers, scientists, and resource users (i.e., anglers, hunters, and other recreationists) is extremely valuable.

Performance Evaluations
Performance Evaluation Reports provide a comprehensive discussion of individual project post-construction operation and monitoring results to date. The reports summarize performance of the specific project as related to project goals and objectives, review the monitoring plan for possible revision, describe project operation and maintenance efforts, and review engineering performance criteria to aid in the design of future projects.

PROJECT COMPONENTS, EFFECTIVENESS, AND LESSONS LEARNED

HREP locations are shown on Figure 4-1 on page 4-2. Detailed project descriptions and other information can be found in Appendix B or via the Internet at http://www.emtc.gov/hrep.html.

Most HREP projects consist of one or more of six general components (see Table 4-5). Many projects combine components in order to address more than one resource problem. These project components alter river hydrodynamics and floodplain structure (i.e., topography), subsequently affecting water quality parameters such as temperature, dissolved oxygen, and suspended sediment, and ultimately improving fish and wildlife habitat. Many projects also include other innovative components to improve habitat and provide secondary benefits beyond the target species and project area. Examples of this include: hillside sediment control; wing and closing dam modifications; seed islands, waterfowl nesting cover establishment; vegetation, fish habitat structures; and pothole excavation.

HREP projects have diversified and improved habitat conditions throughout the UMRS. Many HREPs are well on their way to achieving their objectives. The following sections describe and evaluate the effectiveness, strengths, and weaknesses (i.e., lessons learned) of the six primary components and some of the innovative techniques that comprise HREPs.

Backwater Dredging

Dredged channels, Potters Marsh, Illinois (Mississippi River Pool 13) HREP.

Backwater Dredging	**Objectives**
	1. Alter flow patterns and velocity 2. Improve floodplain structural diversity 3. Increase deep water fish habitat (especially winter habitat) 4. Provide access for fish movement 5. Provide dredged material for topsoil or construction of other project features

Dredging is a component of many HREPs in the UMRS. It restores aquatic habitat by removing sediment from backwater areas; reduces plant abundance; provides deep water fish habitat; and provides the ancillary benefit of increasing depth diversity, primarily for fisheries. Dredging has effectively restored year-round habitat access to many backwater areas, boosted dissolved oxygen levels, and increased overwintering habitat. Dredging projects are often combined with other components such as water control structures, dikes, islands, and secondary channel closures. Experience with early dredging projects has provided significant information on the relationship between fish distribution, flow, water temperature, and oxygen concentrations.

TABLE 4-5: Project Components and Associated HREPs	
Backwater Dredging	Andalusia Refuge, Bertom and McCartney Lakes, Big Timber, Brown's Lake, Bussey Lake, Calhoun Point, Cold Springs, Dresser Island, Indian Slough, Island 42, Lake Onalaska, Monkey Chute, Peterson Lake, Pool 8 Islands, Potters Marsh, Rice Lake, Spring Lake Peninsula, Stump Lake, Swan Lake, Trempealeau National Wildlife Refuge
Water Level Management (Dikes and Water Control Systems)	Andalusia Refuge, Banner Marsh, Batchtown, Bay Island, Bussey Lake, Brown's Lake (dike only), Calhoun Point, Clarksville, Cuivre Island, Dresser Island, Guttenberg Ponds, Lake Chautauqua, Peoria Lake, Princeton, Rice Lake, Spring Lake, Stump Lake, Swan Lake, Trempealeau National Wildlife Refuge
Islands	Andalusia Refuge, Bertom and McCartney Lakes, Bussey Lake, Lake Onalaska, Peoria Lake, Polander Lake, Pool 8, Pool 9, Swan Lake
Shoreline Stabilization	Bank Stabilization, Bertom and McCartney Lakes, East Channel, Lake Onalaska Islands, Peterson Lake, Polander Lake, Pool 8 Islands, Rice Lake, Spring Lake Peninsula, Trempealeau
Secondary Channel Modifications	Bertom and McCartney Lakes, Blackhawk Park, Cuivre Island, Indian Slough, Island 42, Lansing Big Lake, Peterson Lake, Peoria Lake, Polander Lake, Spring Lake Peninsula
Aeration	Andalusia Refuge, Blackhawk Park, Brown's Lake, Cold Springs, Finger Lakes, Island 42, Lake Onalaska, Spring Lake
Other	Banner Marsh (littoral zone grading, warm season grasses), Batchtown (upland sediment control), Bay Island (mast trees), Bertom and McCartney Lakes (mussel bed), Big Timber (mast trees, potholes), Brown's Lake (mast trees), Cottonwood (timber sale, mast trees, notch wing dams, potholes), Cuivre Island (mast trees, rock hard points, breakwater), Indian Slough (rock riffle, tree groins, oak savanna), Island 42 (willow and grass planting), Peoria Lake (herbaceous vegetation), Pharrs Island (bullnose dike), Pool 8 (willow and grass planting), Potters Marsh (prairie grass, potholes), Princeton (mast trees), Rice Lake (woody vegetation), Small Scale Drawdown (drawdown), Swan Lake (upland sediment control)

Dredging widths, lengths, and depths vary, depending on project size and scope. Dredging depths range from shallow (less than 4 feet) to deep (depths greater than 6 feet). Pool fluctuation and sediment deposition over the 50-year life of the project are also considered when determining project dredging depths. Consequently, the as-constructed depth may be several feet deeper than the anticipated depth at 50 years to account for sediment accumulation over the life of the project. Both hydraulic and mechanical dredges are used to excavate channels and create deeper water areas.

Overdepth dredging increases the life of dredge cuts, since these areas tend to act like sediment traps. An additional environmental benefit is the creation of deep water off-channel habitat. This type of habitat provides critical requirements (e.g., lower flows, higher temperatures, and dissolved oxygen levels) for overwinter survival of fish and has been documented to be declining on the UMRS.

The Lake Onalaska dredge cuts positively impacted water quality as shown in Figure 4-2. Since project completion, dissolved oxygen levels in the dredged channels have remained above the target water quality standard during the critical winter months.

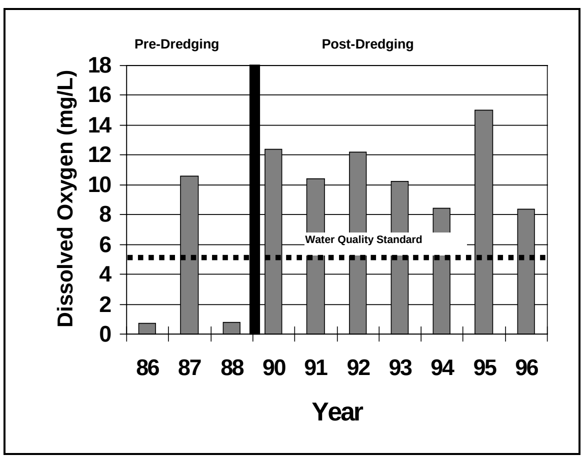

Figure 4-2. Lake Onalaska Islands, Wisconsin HREP. Average surface dissolved oxygen for sites 4 and 5 combined, during late January and February. (Source: Wisconsin Department of Natural Resources)

Fish response to dredged channels has been very good. Demonstrable reductions in winter fish kills have been realized at several HREPs. At the Brown's Lake, Iowa HREP (Pool 13), increases in post-construction fish use have been documented through movement of radio-tagged largemouth bass and creel statistics.

(Photo not included in this version.)

Bass chasing minnow.

Long Distance Project Impacts

The ability to introduce oxygenated water into a backwater complex during periods of low dissolved oxygen concentrations is a key element in providing year-round habitat for native fisheries. A study prepared for the USFWS by the IA DNR documented movements of radio-tagged largemouth bass within the Browns Lake, Iowa (Pool 13) HREP. This study correlated use of the dredged channels with dissolved oxygen concentrations. The radio-tagged bass exited the complex concurrent with oxygen declines and returned when the water control structure was opened and oxygen concentrations increased. Some radio-tagged bass moved as much as 4 miles under ice to return to the complex.

At the Bussey Lake, Iowa HREP (Pool 10), preliminary fish sampling indicates heavy fish use of the dredged areas. An increase in fish use of the dredged areas has also been documented for the Bertom and McCartney, Wisconsin (Pool 11) HREP, as illustrated in Figure 4-3.

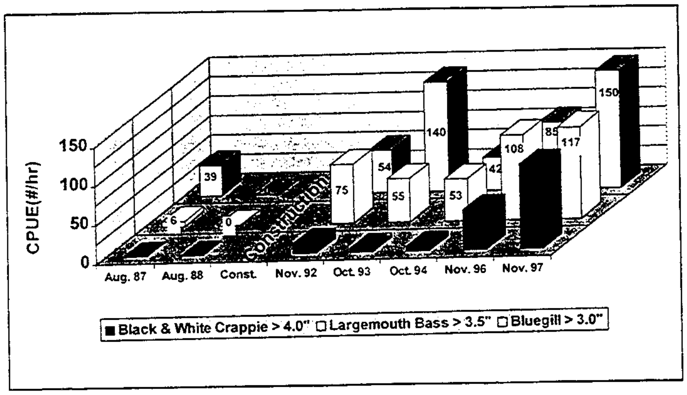

Figure 4-3. Bertom and McCartney, Wisconsin HREP. Electro-fishing Catch-Per-Unit Effort (CPUE) of target species of fish ≥ 1+ years of age in dredged pockets reference stations. (Source: Wisconsin Department of Natural Resources)

Dredging projects are extremely popular with recreational users of the river due to the immediate benefits of deeper water. Hunters and anglers benefit from the tendency of fish to concentrate in deep water areas and, sometimes, from improved boat access.

Dredged material placement has been one of the biggest challenges of HREP dredging projects. To provide for a 50-year project life, large containment areas are needed to accommodate the dredged material or provide room for maintenance dredging over the life of the project. Dredged material has been effectively used for island construction, dike construction to deflect sediment from a project area or create moist soil units, and reforestation efforts. Dredged material has raised existing ground elevations for planting of mast trees, decreasing mortality due to inundation during high water events.

Island created from dredged material, Bussey Lake, Iowa (Mississippi River Pool 10) HREP.

Beneficial Use of Dredged Material

Beneficial use of dredged material from HREP project construction has assumed many forms. Fine sediments have been placed on old sand dredged material or power plant ash piles to promote revegetation or accommodate the planting of grasses and forbs. Dredged material has been used to create island and wetland habitat. Sidecast material has been used to raise existing elevations to improve mast tree survivability. Dredged material has also been used for highway embankment fill, preserving upland borrow sources that would have been utilized if dredged material had not been available.

An innovative alternative to backwater dredging is currently under way at the Cuivre Island, Missouri (Pool 26) HREP. Tow propwash is being directed up the lower end of Turkey Chute. This will resuspend sediment, increasing channel depths from 2 feet to 4 feet. The success of this project will demonstrate a potentially more cost-effective option for deepening secluded backwater HREP side channels and sloughs.

Water Level Management (Dikes and Water Control Systems)

Andalusia Refuge, Illinois (Mississippi River Pool 16) HREP.

Water Level Management (Dikes & Water Control Systems)	Objectives
	1. Restore natural hydrologic cycles 2. Improve aquatic plant and invertebrate production that provides cover and food for numerous fish and wildlife species 3. Reduce backwater sediment loads 4. Consolidate bottom sediments 5. Control rough fish

Water level management is a tool for restoring some of the river's natural processes. Biologists have long recognized the value of water level management, especially drawdowns. For the past 50 years, wildlife managers have used dikes and levees and some type of water control system as key features of water level or moist soil management projects. Moist soil management involves manipulation of water levels to promote conditions suitable for the production of aquatic plants and invertebrates. Water levels are drawn down in late spring and throughout the summer to allow natural plant colonization or to permit seeding. Drawdowns also consolidate substrates and improve water quality. The project area is then flooded in the fall to make food available for the waterfowl migration.

Water level management has become an increasingly important component of HREPs. The loss of more than 200,000 acres of wetlands on the Illinois River and more than 400,000 acres of wetlands on the Upper Mississippi River, primarily between Rock Island and Cairo, Illinois, has drastically reduced the quantity and quality of natural aquatic and floodplain vegetation. These losses, mainly due to large-scale conversion of the floodplain to agriculture, have eliminated or degraded important habitat for migrating birds and spawning and nursery areas for fish. Water level management projects can help enhance these floodplain wetlands.

Water level management projects typically include construction of low dikes (2- to 5-year flooding recurrence interval) or rehabilitation of existing dikes and construction of water control systems such as pump stations, wells, and gated or stoplog structures. Besides retaining water, the dikes can be used to keep silt-laden water out of backwater areas. The water control system is used to drain and flood the moist soil units.

In general, water level management projects have been the most challenging to implement due to the planning and engineering complexity of project features and the impacts of natural events. Some water level management projects have experienced construction delays, damage during floods, and problems with pumps and gates. This is in part because water level management projects have mostly been located in the lower reaches of the Mississippi River and the Illinois River, which have experienced substantial flooding during 3 of the last 4 years. The Lake

Chautauqua, Illinois HREP has been particularly plagued with construction delays due to flooding, culminating with the loss of a pre-existing water control structure in 1996. However, construction of a replacement structure is under way (see text box below), and the project is scheduled for completion in 1999.

Although water level management projects impact less than 1% of the UMRS floodplain, concerns exist over the potential for isolating backwaters from the river. Levees and associated water control features may limit fish movement between the river and backwaters. If gates are not manipulated to provide access during critical spawning and overwintering periods, or if fish do not move through water control structures, available fish habitat could be reduced and fishery resources could decline. However, experience with the Andalusia, Illinois (Pool 16) HREP suggests that water level management projects could potentially provide significant benefits to fish as well. Monitoring of the project by the Illinois DNR in 1995 indicated that substantial numbers of larval fish, including species such as largemouth bass and crappie, were produced in the moist soil management area and returned to the Mississippi River. The results of this initial survey prompted the initiation of larval fish production and escapement surveys as part of bioresponse monitoring for the Lake Chautauqua, Illinois HREP.

To further address this issue, fish movement through the water control structures at the Swan Lake, Illinois HREP will also be monitored. Additionally, the proposed Rice Lake, Illinois HREP project features include two water control structures devoted solely to fish ingress and egress.

Swan Lake, Illinois (Mississippi River Pool 26) HREP.

Many HREPs use existing structures to reduce project costs. When existing structures are not an option, lessons learned are put to use, resulting in innovative new designs and cheaper structures.

Reduce, Reuse, Recycle

The low bid for the Swan Lake, IL, Phase II HREP was substantially higher than the Government estimate. A constructibility review and economical analysis was undertaken to propose recommendations that would reduce costs and maintain functionality. In regard to the water control structure, alternate design concept recommendations included minimizing the use of cast-in-place concrete, open cut excavation, and dewatering requirements, and using precast concrete and soldier piles to provide a braced type excavation. To further minimize costs, the concept design was improved to consist of a cellular structure utilizing sheet pile left over from the construction of Mel Price Lock and Dam.

A similar cellular structure is under construction to replace the radial gate structure at the Lake Chautauqua, IL, HREP project. This structure also will utilize sheet pile left over from the construction of Mel Price Lock and Dam.

Pump design has also evolved. As early HREPs with water level management components became operational, it was apparent that several projects had unnecessarily large pumps. In some instances, the pump stations were designed based on the resource managers' preferences; and in others, a 50-year life was used to reduce operation and maintenance costs. More simple pump systems are now being designed, and consideration is being given to pump replacement over the life of the project, or using well systems rather than pumping from the river to flood moist soil units.

Many aspects of water level management projects have been successful. Sedimentation at water level management HREPs has been substantially reduced. At the Stump Lake, Illinois HREP, local managers have reported one foot of accumulated sediment on the exterior of the levee and only trace amounts (one inch) on the interior of the levee. At the Clarksville Refuge, Missouri HREP, post-project sediment surveys estimated sedimentation decreased 67% between 1990 to 1994.

Drawdowns have been used to consolidate substrates, improve water quality, and increase or control aquatic and terrestrial vegetation for the benefit of fish and wildlife. Plant response to seasonal drawdowns has been favorable, with many native plant species growing from residual seed banks or aerial seed dispersal. At the Andalusia, Illinois (Pool 17) HREP, water level control successfully promoted the growth of natural waterfowl food sources such as smartweeds, wild millet, pigweeds, and nutsedges in the first year of operation. There is evidence of positive waterfowl response as well. In 1994, the Chautauqua Refuge recorded the highest fall peak migration of ducks and geese (375,300 and 60,000, respectively) since 1955. These numbers are attributable to the ample food supply generated by enhanced vegetation, along with a very mild winter and a higher overall continental population. At the Clarksville Refuge, Missouri (Pool 24) HREP, the ability to control water levels has encouraged plant production, which has drawn increasing numbers of waterfowl to the project area.

Islands

Pool 8 Islands, Wisconsin (Mississippi River Pool 8) HREP.

Islands	Objectives
	1. Alter flow patterns and sediment transport regime 2. Reduce wave action 3. Improve aquatic plant growth 4. Improve floodplain structural diversity 5. Provide nesting, loafing, and brood habitat for waterfowl, turtles, etc.

Islands create an area downstream or downwind from themselves that is sheltered from waves and currents, promoting conditions better suited to the establishment of aquatic vegetation. Islands also alter flow patterns by providing partial or complete barriers that prevent flow into backwater areas, increase floodplain topographic diversity, and provide terrestrial habitat and additional nesting and loafing habitat for waterfowl and turtles. Experience with island projects has yielded significant information on the influence of island orientation, shape, and physical dimensions, as well as on aquatic plant and animal response to island construction.

HREP islands can be grouped into three

categories based on project objectives and physical/biological effects, i.e., barrier islands, nesting islands, and seed islands.

Barrier islands are the most common type of island constructed. These islands, which are typically one-half mile in length or longer, segregate low energy areas from high energy areas by redirecting river currents or reducing wave action. This alters sediment transport and distribution of sediment types in the vicinity of the islands, subsequently influencing floodplain structural diversity as well as aquatic vegetation (e.g., cattails and bulrush) and benthic invertebrates (e.g., aquatic worms, and insect larvae). Barrier islands are constructed of dredged material or rock. Dredged material is typically obtained from the main channel or from within the backwater to be protected, thereby creating further depth diversity. A combination of rock and vegetative plantings, such as willows and prairie grasses, is used to stabilize dredged material. Rock/vegetation combinations decrease project costs and increase shoreline diversity, resulting in habitat for a variety of aquatic and terrestrial species.

Nesting islands are usually less than 2.5 acres in size and are located at least a quarter mile from the nearest significant land mass to minimize disturbance by terrestrial predators, such as fox, raccoon, and skunk. Because of their small size and remote location, construction costs often outweigh benefits. To date, only one nesting island (Pool 8, Phase I) has been constructed; however, future HREPs will evaluate less costly construction techniques.

The seed island concept is a direct product of the HREP program, being based on observations of river managers and engineers working on HREP teams. Seed islands are obstructions in flowing water where coarse sediment transport is occurring. The desired result is the formation of a low elevation island (less than 3 feet above average water level) due to deposition and creation of a channel in the erosion zone adjacent to the island. Enhanced topographic diversity and the island habitat are two benefits of seed islands. Although these methods may not produce islands with much elevation, seed islands protect areas from wave action and river currents and represent a means of restoring floodplain structural diversity.

In addition to these three specific categories of islands, several islands have been created as part of dredged material placement associated with backwater dredging projects. Examples of this type of island include the Bertom and McCartney Island and Willow Island in Pool 10.

22-acre island created from dredged material placement, Bertom and McCartney, Wisconsin (Mississippi River Pool 11) HREP.

Perched Wetland

Although not originally identified as a feature of the subject project, a perched wetland was created following placement of dredged material in the project's confined placement site. This wetland sits atop the island that was created as part of this project. It is sufficiently isolated from nearby land masses so as to provide valuable wetland habitat inaccessible to predators. This project feature has been identified by the USFWS as one of the outstanding benefits of the overall project even though it was not part of the original design.

A combination of engineering techniques is used in island design, including field reconnaissance; data analysis; and computer modeling to predict flow patterns, wind effects, and sometimes sediment transport. Island position and layout are generally based on the following factors:

Factors Affecting Island Position

- Existing floodplain configuration
- Construction equipment access
- Existing flow patterns and prevailing wind direction
- Desired habitat

Historic island locations are attractive because of better foundation conditions and shallower water depths, which reduce construction cost and result in a more stable shoreline. If natural floodplain features do not lead to an obvious island layout, islands are usually designed based on existing flow patterns and predominant wind direction.

Islands are effective management tools for the rehabilitation of floodplain structure and its associated physical and biological attributes. The physical responses are generally very rapid (i.e., they are a direct result of the island's presence) and highly predictable (i.e., they are the result of well known physical forces). The Lake Onalaska islands biological response study (see below) indicates that the expected biological responses such as duck nesting, invertebrate colonization, aquatic vegetation, and fish usage do occur.

- **Biological Response Study, Lake Onalaska Islands**

Lake Onalaska Barrier Islands (Mississippi River Pool 7).

Arrowhead Island, which is part of the Lake Onalaska, Wisconsin HREP, was chosen as the site for a biological response study to quantify the physical and biological effects of islands. This study included extensive monitoring of physical and biological parameters and computer modeling to simulate flow patterns in Lake Onalaska. The computer model predicted that the islands would create areas of increased velocities on either side of the island and areas of reduced velocities (or a sheltered area) both upstream and downstream of the island. Measurement of velocities near the islands and aerial photography confirm these flow patterns. Monitoring indicates that while sediment transport is driven by hydrometeorological conditions (i.e., high flows, high winds), sediment deposition and the characteristics of bed sediments are correlated with the observed flow patterns. Sediment accumula-tion was identified downstream of Arrowhead Island, in the sheltered area, and sediment erosion and transport predominate in the areas adjacent to the island, where higher flow velocities and wave heights exist.

Vegetation surveys indicate islands can provide suitable habitat and offer protection to macrophytes if water depths are 3 feet or less and flows are at a suitable level throughout the growing season. Vegetation sampling at Lake Onalaska's Arrowhead Island in 1997 documented the presence of extensive aquatic vegetation beds in the "shallow zone" of the Island (Figure 4-4).

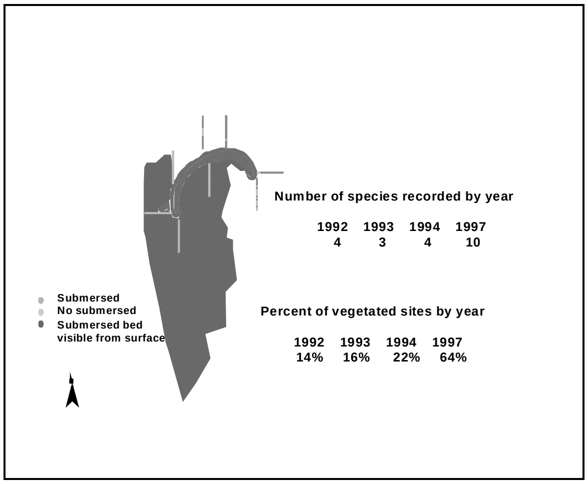

Figure 4-4. Occurrence of submersed vegetation around Arrowhead Island, 1997, Pool 7, UMRS. (Source: Wisconsin Department of Natural Resources)

Fish data suggest that the islands are being used as nursery areas by many of the same fish species typically found in natural off-channel areas. Fingernail clam density and distribution was associated with flow velocity, water depth, and distance from the island, further suggesting that flow patterns created by the islands may be affecting biota.

Waterfowl use of the islands is also significant. Nesting and hatchling success on the islands has exceeded expectations, as shown in Figure 4-5. Average hatching success over 6 years was 73%.

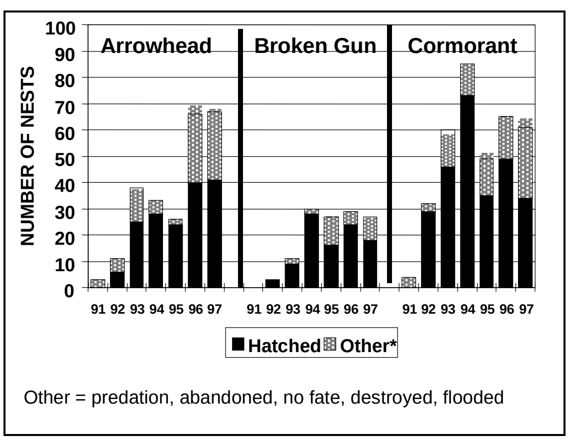

Figure 4-5. Lake Onalaska Islands, Wisconsin HREP. Waterfowl nesting success on the Onalaska HREP islands, 1991-1997. [Note: Broken Gun Island experiences significantly more human disturbance than the other islands. (Source: Wisconsin Department of Natural Resources)]

The large concentrations of fingernail clams found around these islands provide food resources for 60,000 to 80,000 diving ducks (e.g., lesser scaup and canvasback) during fall migration. Early fall migrants (e.g., mallards and blue-wing teal) also use the islands as feeding and loafing areas.

Shoreline Stabilization

Groins and willows used to stabilize island shoreline, Mississippi River Pool 8.

Shoreline Stabilization	Objectives
	1. Prevent erosion of terrestrial habitat 2. Maintain existing floodplain structural and habitat diversity 3. Create desirable substrate for fish 4. Reduce sediment loads to backwater areas

Erosion of natural island shorelines and river banks is occurring throughout the UMRS due to river currents, wave action, and ice movement. This results in the loss of terrestrial habitat and, if a secondary channel gets larger or a new breach forms, increases water and sediment inflows to backwaters. Shoreline stabilization is one option for reversing this trend. Constructed HREP features such as islands or dikes often incorporate shoreline stabilization to prevent erosion. These designs continually evolve based on observations of previously constructed islands and shorelines.

Shoreline stabilization designs currently used include riprap, rock groins, offshore rock mounds, rock wedge, biotechnical (vegetation), and rock/berm/biotechnical combinations. Several engineering and constructibility factors are considered in choosing a design. The primary design factors are the erosion process (river currents and/or waves), nearshore bathymetry (deep or shallow), and whether the site is accessible by construction equipment. In addition, every attempt is made to make the stabilization job as aesthetically pleasing as possible. For example, vegetative stabilization is chosen over rock when site conditions allow, and more innovative rock designs such as offshore rock mounds or groins are chosen over riprap blankets.

Unlike other types of HREPs, the impacts of shoreline stabilization are self evident. If rock is placed on a shoreline, the shoreline, whether it is natural or artificial, is stable and the habitat associated with the shoreline is preserved or enhanced. Openings between the rock used in shoreline stabilization projects promote invertebrate colonization, which encourages fish foraging. In many cases, the most feasible project is preservation of existing habitat.

Secondary Channel Modifications

Indian Slough Closure Structure, Mississippi River Pool 4.

Secondary Channel Modifications	Objectives
	1. Improve fish habitat and water quality by altering inflows (increasing or decreasing) 2. Stabilize eroding channel 3. Reduce sediment load to backwaters by reducing flow velocities 4. Maintaining water temperature and providing rock substrate 5. Improve water quality

Secondary channels connect backwater areas to the main channel. Modifying secondary channels alters backwater flow patterns, sediment transport, and water quality, improving habitat for a variety of species. For example, if sediment transport into the backwater is reduced, the conversion of aquatic habitat to terrestrial habitat is slowed.

For projects with channel closure components, a low rock structure (i.e., lower than adjacent river banks) is usually designed, since the rock structure will be overtopped first, thereby reducing erosive forces on adjacent river banks. An artificial logjam made by anchoring fallen trees was used at Pool 10 as part of the Mississippi River Bank Stabilization, Iowa, Minnesota, and Wisconsin (Pools 6-10) HREP to create a low cost, aesthetically appropriate, closure structure. Sand was used to construct closures at the Lansing Big Lake, Iowa (Pool 9) and Peterson Lake, Minnesota (Pool 4) HREPs. These structures experienced severe erosion as a result of the 1995-96 floods and were replaced with rock structures. Consequently, rock structures are now used in most riverine situations where erosive forces are high. Submerged closure structures can be a hazard for recreational boaters, so safety factors are also considered in their design.

The physical and chemical regime that results from secondary channel modifications is complex, and developing the proper flow balance is critical. For example, opening a secondary channel can improve fish habitat by introducing flow to a backwater and thereby boosting dissolved oxygen levels. However, the subsequent increase in flow velocity and decrease in water temperature also can be detrimental to fish. Similarly, constructing a partial closure structure reduces the flow of water and sediment to a backwater area. However, the sediment that does enter the backwater area is more likely to deposit there because the water is moving more slowly. The rock structures themselves provide excellent habitat for fish.

Secondary channel closure structures have been successful at preventing the entrance of sediments to backwaters and in altering backwater water quality to benefit centrarchids (e.g., bluegill, bass, and crappie). Limiting the entrance of bedload sediments is slowing the conversion of traditional aquatic habitat to terrestrial habitat and improving water quality and overwintering habitat.

- **Physical Response Study, Pool 9 HREPs**

River-floodplain connectivity is a parameter used to describe how connected the main channel of the river is to its floodplain.[2] A common way of defining river-floodplain connectivity is that it is equal to the percentage of the total river water that flows through backwater areas.

Important processes are affected by river-floodplain connectivity. Physically, high river-floodplain connectivity results in high water discharge and mass transport (sediment, nutrients, etc.) through backwater areas. Both positive and negative biological responses can result. For instance, high river-floodplain connectivity has the positive effect of increased migration routes to habitat for fish and various animals. However, negative effects such as degraded winter habitat for fish (due to high flow velocities) or decreased aquatic vegetation growth (due to turbidity or sediment deposition) also result. Optimal levels of river-floodplain connectivity vary depending on the species of interest. On any river reach, it is probably desirable to have a variety of conditions.

HREP physical response monitoring has made river-floodplain connectivity quantification possible in Pools 1-10 of the UMRS. River-floodplain connectivity in Pool 9 of the UMRS is presented here as an example. Three important conclusions regarding river-floodplain connectivity were established from physical response monitoring done in Pool 9.

1. For normal flow conditions, Pool 9 can be divided into three distinct reaches with significantly different river-floodplain connectivity (see table below).

Reach	River-Floodplain Connectivity (Percent)	Reach Type
Upper 8 Miles	0 - 20	Riverine
Middle 12 Miles	10 - 60	Transitional
Lower 11 Miles	50 - 75	Impounded

2. By comparing flow data from two different time periods, a trend of increasing river-floodplain connectivity for normal flow conditions was established in the middle transitional reach.

3. In all three instances, the annual flood increases river-floodplain connectivity. For instance, at one location in the middle reach of Pool 9, river-floodplain connectivity increased from 15% for normal flow conditions to 55% during flood conditions.

This type of information can be used to develop future river management strategies. For instance, in the middle transitional reach of Pool 9, where river-floodplain

[2] This river characteristic is used as an important descriptor in defining the health of large floodplain river systems. Refer to Chapter 2, Criterion 5, of this report for additional explanation.

connectivity for normal flow conditions is increasing, and where natural resource managers have observed degraded winter fish habitat, river management might focus on secondary channel closure projects, such as the Lansing Big Lake HREP, to stabilize river-floodplain connectivity. In the lower reach where river-floodplain connectivity is high, river management should focus on barrier island construction, such as the Pool 9 Islands HREP, to reduce river-floodplain connectivity in specific areas and diversify river-floodplain connectivity over the entire lower reach.

Aeration

Finger Lakes, Minnesota (Mississippi River Pool 5) HREP.

AERATION	Objective
	Improve fish habitat and water quality by introducing water

Aeration projects are designed to improve fish habitat conditions for lentic (quiet water) species such as bass and bluegills (centrarchids) and, in some cases, riverine species such as walleyes and catfish. This is achieved by installation of gated culverts or weirs at the entrance to the project area to control inflows. By introducing small quantities of flow to a project area in the winter, dissolved oxygen levels, water temperature, and current velocity can be manipulated to restore fish habitat. Larger quantities of flow can be introduced during the summer months to attract riverine species. The physical and chemical regime that results from aeration projects often involves trade-offs among habitat parameters (e.g., increased dissolved oxygen versus decreased water temperature), and the biological response to these altered conditions is complex.

Early HREP aeration projects were designed to provide a wide range of flows. This resulted in projects that were responsive to seasonal changes in required discharge (e.g., summer discharges may be ten times greater than winter discharges), accommodated operational changes based on biological research, and resulted in greater capability to flush debris out of the structures for O&M purposes. The main problem encountered with these structures has been when operating the structures at low discharges in the winter. The small gate openings required are more susceptible to blockage from small debris and ice, increasing operation and maintenance requirements and costs. Experience such as this and biological response monitoring results have and will continue to be incorporated into the design of subsequent HREP projects to reduce construction and O&M costs.

Brown's Lake, Iowa (Mississippi River Pool 13) HREP.

- **Biological Response Study, Brown's Lake Aeration**

The Brown's Lake HREP (Pool 13) is a combination aeration/dredging/dike project. A water control structure provides water with high dissolved oxygen concentrations to a network of dredged channel cuts located in the backwater complex. During the critical winter months, dissolved oxygen levels have remained above the target level throughout most of the lake, a key element in providing year-round habitat for native fisheries. Movement of radio-tagged largemouth bass in response to changing oxygen concentrations, and creel statistics both indicate increased use of the area following project construction. Important information on the amount of flow needed to provide optimal fish habitat was provided by this study.

Design Adjustments

Desired water inflow for the Brown's Lake water control structure was determined during the design phase. An oxygen balance analysis indicated that four 5-foot by 5-foot gated box culverts were required to ensure adequate dissolved oxygen in order to prevent winter fish kills. Post-construction water quality monitoring has shown that the water control structure is more than adequate to supply oxygenated water throughout the Brown's Lake complex. Typically, a single gate is opened 10 inches. Because of the Brown's Lake post-construction monitoring results, the water control structure for the Spring Lake, Illinois HREP project (currently under construction) was designed utilizing less conservative values. The Spring Lake water control structure is half the size of the Brown's Lake water control structure and should oxygenate nearly twice the area.

OTHER PROJECT COMPONENTS

Pothole, Cottonwood Island, Missouri (Mississippi River Pool 21) HREP.

Other Project Components	Objectives
Large Scale Water Level Management	Simulate historic summer low flow levels; increase winter water depth
Upland Sediment Control	Reduce sedimentation
Land Acquisition	Preserve existing habitats; make additional lands available for habitat rehabilitation and enhancement
Anchor tree clumps	Restore fish habitat diversity
Create riffle pools	Restore fish habitat diversity
Potholes	Increase habitat for wildlife
Notch wing dams	Provide flowing water habitat diversity for fish.
Vegetative plantings	Increase food and cover for birds and mammals

Other HREP components are often unique to a reach of the UMRS and include many experimental features, such as several of those listed in the above table. Successful experimental features and approaches are incorporated into subsequent projects where appropriate. For example, an experimental pre-construction timber sale at the Bay Island, Missouri (Pool 17) HREP led to a similar sale at the Cottonwood Island, Missouri (Pool 21) HREP.

Pre-Construction Timber Sales

A timber sale to clear areas for excavated material placement, potholes, and mast-producing tree planting sites was implemented prior to construction of the Cottonwood Island, Missouri (Pool 21) HREP. Project construction costs were reduced by $30,000 because clearing and removal of timber as a bid item was accomplished by selling the timber to a logging contractor.

The positive ecological effects produced by water level management and an interest in more holistic management of river resources have prompted attention to opportunities for larger-scale water level management actions. Opportunity may exist to modify river regulation to improve habitat conditions without serious disruption to commercial navigation and other uses. The St. Louis District made minor modification to river regulation in Pools 24, 25, and 26 to simulate summer low-flow water levels, which stimulated growth of moist-soil vegetation (annual plants) without any disruption to navigation. St. Paul and Rock Island Districts terminated long-standing practices of drawing the pools down a quarter foot in the winter. By keeping the pools slightly higher, the volume of water in backwaters is increased, which reduces the chance of dissolved oxygen depletion in the winter. A recently completed problem appraisal report in the St. Paul District indicates that 1- to 3-foot drawdowns of Pool 8 could be feasible without significant interruption of commercial navigation if advance dredging is done. The Rock Island District is investigating environmental water level management for Pool 13 and the Illinois River. A major objective of pool-scale water level management is to restore aquatic macrophytes (cattails, lotus, coontail and other perennial plants) in areas where they no longer occur. This may require multi-year water level management strategies.

One of the potential challenges to large-scale water level management may be the existing requirements of law regarding cost-sharing and OMRR&R. Those provisions may be difficult to accommodate when land is under multiple-party ownership and management.

Bullnose dike, Pharrs Island, Missouri (Mississippi River Pool 24).

Flood-Induced Habitat Developments

During the flood of 1993, high water overtopped the Pharr's Island, Missouri (Pool 24) HREP bullnose dike by 6 to 8 feet, and sediment was deposited between the dike and island. Sedimentation also led to loss of depth in one interior channel, and an overall increase in the amount of shallow water within the project area. Depth was regained during the 1995 flood in the area between the dike and island by the creation of a 12-foot-deep trench. The shallow water areas have become highly productive moist soil units under the pool's current water level management program.

Erosion in site-specific upland areas can have a significant effect on a project's floodplain and aquatic areas as the resultant sediment is deposited and accumulated in critical habitats. Yet, HREPs involving upland sediment control measures have not generally been pursued under the EMP. Upland sediment controls may be recommended for implementation if they are determined by an engineering analysis to be the most cost-effective way of preventing or reducing sedimentation in a project area that is within the UMRS floodplain. Additionally, project documentation must include verification that other Federal, State, and local sources of upland sediment control funding were evaluated and found to be unavailable to the project area in a timeframe consistent with the project timetable. While not expressly precluded under the EMP authorization, Corps policy has generally regarded such features as beyond its purview and as the responsibility of other agencies.

Nevertheless, two HREPs with upland features (Swan Lake and Batchtown) have been advanced as a result of specific Congressional directives. In both instances, the upland sediment control features were the most cost-effective way of protecting habitat in the project area. These features include hillside retention ponds, terracing, and other measures to reduce sediment delivery to the specific project area, but do not extend to land conservation practices throughout the watershed.

The original EMP authorization was silent regarding the subject of acquiring lands and easements for habitat projects. Consequently, the subject was addressed through a series of Corps of Engineers policy statements. The initial policy limited habitat projects to areas with existing Federal and State land holdings. Current policy includes land acquisition from willing sellers as an additional technique for habitat enhancement and restoration within certain parameters (e.g., the acquisition must be cost efficient and include active construction and/or operation and management). Land acquisition alternatives for the Rice Lake, Illinois HREP (Illinois River, La Grange Pool) are currently being evaluated. However, due to the lack of publicly owned land on the middle Mississippi River below St. Louis, no HREPs have been constructed in this reach. Due to the substantial lead time required to accomplish land acquisition, the current policy is only relevant to those HREPs that are still in the early design stage.

Local anglers have reported the rock riffle pools (rock placed so as to change flow and create scour holes) and tree groins (log snags) at the Indian Slough, Wisconsin (Pool 4) HREP are providing habitat for smallmouth bass and other game fish. The mussel bed (a channel lined with varying sizes of rock) and fish habitat structures at the Bertom and McCartney Lakes, Wisconsin (Pool 11) HREP are also favorite spots for local anglers.

While most HREPs focus on benefiting certain target species such as migratory waterfowl or centrarchids, some HREP project components, such as potholes, are designed to provide ancillary benefits to non-target species such as frogs, salamanders, and small mammals (e.g., raccoon and beaver). Potholes are shallow, water-filled depressions created by mechanical excavation or explosives. Potholes at the Big Timber, Iowa (Pool 17) and Potters Marsh, Illinois (Pool 13) HREPs have seen great response by beaver, deer, muskrats, turtles, raccoons, and small fish. The Potters Marsh potholes are particularly attractive to migrating ducks during windy spring days because they are protected from the winds, providing calm water and isolation. Potholes at the Cottonwood Island, Missouri (Pool 21) HREP were being used by deer, herons, frogs, and tadpoles less than a week after completion of construction.

Wing dam notching was also recently completed at the Cottonwood Island HREP. Initial flow measurements in the vicinity of the notches indicate increased velocities and formation of scour holes, confirming design assumptions.

Vegetative features, such as the planting of prairie/grasslands on dredged material at Potters Marsh, Illinois (Pool 13) and Indian Slough, Wisconsin (Pool 4) HREPs, have been very successful. Vegetation has also been used in combination with riprap to stabilize shorelines, providing shade for fish and cover for wildlife. At the Bay Island, Missouri (Pool 17) HREP, an experimental planting of hard mast (nut-bearing) trees as seeds, seedlings, and large stock (i.e., 4-foot-tall trees) led to the selection of large stock trees for a similar mast planting at the Cottonwood Island, Missouri (Pool 21) HREP.

Mast Trees

Natural regeneration of mast producing trees in a free flowing large river system such as the Mississippi River is an infrequent event. Planting of hard mast producing trees such as oak and pecan provides a long term wildlife benefit by "jump starting" natural processes.

At the Bay Island HREP, mast producing trees (pin oak) were planted as acorns, seedlings and large stock. Acorn survival after the first growing season was 45%, seedling survival was 85%, and large stock was 99%. Survival after the second growing season for acorns had dropped to 10%, seedling survival was 84%, and large stock survival was 94%. All sites suffered from high water inundation and annual weed competition. The additional height of the large stock trees undoubtedly contributes to the higher survival rates.

FINDINGS AND CONCLUSIONS

Habitat Rehabilitation and Enhancement Projects (HREPs) are the most effective management measure that is currently available for restoring and improving Upper Mississippi River fish and wildlife habitat. While other programs and policies exist to address tributary and point source pollution, the HREP program is the only one to focus on the quantity, quality, and diversity of floodplain and aquatic habitat. The HREP planning and implementation process has fostered a previously unknown level of cooperation among the river community—an important tool for future river management.

Significant achievements have been made through this program since authorization. Construction has been initiated or completed on 38 projects, directly benefiting more than 68,000 acres of habitat. As anticipated in original EMP planning documents, experience with projects completed early in the life of the program is fostering new ideas regarding habitat restoration, protection, and enhancement on the UMRS. As the HREP program evolved, and as resource management philosophies began incorporating ecosystem principles, the diversity of species for which projects were being designed increased and project features changed accordingly. The resulting multiple component projects address habitat needs for many species, often providing secondary benefits to an even broader array of aquatic and terrestrial species than initially planned.

In general, public response to HREPs has been extremely positive. River stewardship is strong among river users, and with every river reach comes a group of concerned citizens that know the river well and have observed it change. Their input on resource problems and desired outputs is solicited early in the HREP planning process. Public involvement during early planning stages of HREPs has directly resulted in environmentally beneficial and cost-effective design changes of habitat projects. Current island design was directly influenced by citizens who demanded that more backwater sediments be used to construct islands. Other citizens influenced the shape, size, and location of potholes at the Potters Marsh, Illinois, and Cottonwood Island, Missouri HREPs. The public has also requested Performance Evaluation Reports and aerial photography of completed HREPs, in addition to requests for presentations to local bass clubs and other conservation organizations.

Better, more effective planning and design tools have been developed to improve the HREP formulation process (see Appendix B). Planning and engineering for habitat projects in large riverine floodplains was in its infancy when the EMP began in 1986. Essentially, the manual on how to plan and design an HREP was written as the program evolved, building upon new information gained through experience with constructed projects, findings reported by LTRMP, and studies and management techniques conducted by various other agencies.

Involvement and interaction among engineers, biologists, and managers in HREP planning, design, and implementation has increased interdisciplinary understanding of river ecosystem needs and engineering limitations. The result of this collaborative inter- and intra-agency planning and design of HREPs is more innovative and effective habitat projects. However, there is a variety of project planning requirements that are now being recognized as potential constraints to pursuing such innovative projects. For example, the planning guidance for HREPs to meet a 50-year project life, and the requirement for the project sponsor to accept O&M responsibility for 50 years, can restrict the use of innovative techniques or measures. Additionally, no simple mechanism is available for expending HREP funds economically and efficiently to modify innovative features if they are not meeting expectations. In addition, cost-sharing requirements effectively preclude projects on Federal lands unless they meet the provisions of Section 906(e) of Water Resources Development Act of 1986. On a river system such as the UMRS that has a patchwork of land ownership and management responsibilities, this can be a major limitation, particularly for large-scale projects.

Knowledge and experience gained from HREPs has enabled all partner agencies to pursue additional habitat management projects on the UMRS independent of EMP (e.g., USFWS and Wisconsin DNR sponsored seed islands in Pool 8). The partnerships and dialogue fostered by EMP have opened discussions regarding the feasibility of pool scale water level management as a cost-effective large scale vegetation and habitat management tool. Information about habitat enhancement and restoration techniques developed and implemented as part of EMP has been requested from many regions in the United States and abroad, indicative of the need for wide-spread sharing of biological and technical information relative to habitat/ecosystem design.

Learning from Experience

An October 1996 Workshop for Engineering and Design of EMP HREPs provided the first opportunity to bring together 32 design and construction personnel from the three Corps districts involved in the EMP. The workshop included presentations on the design and construction techniques utilized by the three districts, followed by a round table discussion of technical aspects of project features, performance, and lessons learned. Recommendations for the future were formulated. Nearly 150 copies of the workshop proceedings have been distributed to date.

HREP physical, chemical, and biological monitoring has added significantly to the wealth of hydrodynamic, sediment transport, water quality, and habitat information available on the UMRS. Natural resource managers provide valuable observations on project success, in terms of habitat gains and engineering. Continuing improvements in habitat quantification and analysis procedures are also resulting in better designs and increased habitat benefits. Review and monitoring of completed projects has resulted in improved design of subsequent projects to obtain greater environmental benefits at reduced costs, and reduced operation and maintenance costs.

Evaluation of the biological response to HREPs at times can be both complex and costly. However, biological response monitoring of selected HREPs and post-construction monitoring of all projects has provided valuable information for designing subsequent projects. Continued monitoring of projects will assure a sound scientific framework to guide design and predict HREP effects. The idea is not to gauge in detail the physical and biological performance of every project, but rather to develop the science by monitoring a representative sample of HREPs.

The six primary project components discussed in this chapter form the backbone of the HREPs. HREPs, although primarily designed to address site-specific problems and needs, taken as a whole and combined with other habitat restoration and management measures, contribute to a healthier river ecosystem.