Report to Congress

An Evaluation of the Upper Mississippi River System Environmental Management Program

U.S. Army Corps of Engineers
Rock Island District
December 1997

UMRS-EMP

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
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REPLY TO
ATTENTION OF:

December 18, 1997

DIVISION ENGINEER'S PUBLIC NOTICE

Upper Mississippi River System - Environmental Management Program (UMRS-EMP) Report to Congress

COMPLETION OF REPORT

Notice is hereby given that the District and Division Commanders have completed a final report for the Upper Mississippi River System - Environmental Management Program. The report was prepared in response to Section 1103(e)(2) of the Water Resources Development Act of 1986, Public Law 99-662, as amended, by Section 405 of the Water Resources Development Act of 1990, Public Law 101-640, and Section 107 of the Water Resources Development Act of 1992, Public Law 102-580, and provides response to the requirements of Senate Report 105-44, page 41, accompanying the Energy and Water Development Act of 1998.

CONCLUSIONS, MODIFICATIONS, AND RECOMMENDATIONS

The report contained:

a. Overarching conclusions drawn with respect to the Upper Mississippi River System-Environmental Management Program (UMRS-EMP) outputs, strengths, and weaknesses and the future needs of the Upper Mississippi River System are summarized as follows:

1. The UMRS-EMP currently is the single most important and successful program authorized by the Federal government for the purposes of understanding the ecology of the UMRS and sustaining its significant environmental resources.

2. The degradation and loss of UMRS aquatic, wetland, and floodplain habitat can be substantially offset by the application of habitat restoration, protection, and enhancement measures. Such measures must be based upon quantitative and qualitative goals that recognize the multiple purpose use of this national resource.

3. A habitat needs assessment should be accomplished to establish a technically sound, consensus-based management framework "blue print" for the restoration, protection, and enhancement of the UMR ecosystem. This assessment would begin to

identify at the system, pool, and reach levels, the long-term habitat requirements. It would also serve to better focus future system monitoring and research activities.

4. Increasingly effective management of regulated river systems, such as the UMRS, is dependent upon long-term monitoring to detect system changes and applied research to understand system dynamics and relationships.

5. Implementing the EMP has resulted in an unprecedented level of communication and cooperation among the Federal and state partner agencies responsible for UMRS management. However, greater public involvement, outreach, and education also are needed.

b. Long Term Resource Monitoring Program (LTRMP)[1] program-element specific conclusions are as follows:

1. The LTRMP is making significant contributions to our understanding of the ecology of the UMRS. Resource managers and decision makers are increasingly using LTRMP biological, physical, chemical, and land use/cover data to accomplish better river system management decisions.

2. LTRMP data and analysis are providing meaningful characterization of system conditions and identification of long-term trends. This enables better prediction of the impacts of human and natural actions and allows the Corps and others to design, construct, operate, and maintain their UMRS projects in a more environmentally sustainable fashion.

3. The LTRMP has established the institutional framework (e.g., sampling protocols, centralized database) and infrastructure (e.g., field stations, equipment) necessary for conducting systemic monitoring and applied research at a level that was previously not possible.

4. The LTRMP is increasing the accessibility of UMRS data and information to resource managers and the public.

5. The LTRMP must continue to adapt to evolving management data and information needs of management and advancements in ecological science and technology. This adaptation will require infrastructure modifications, monitoring program changes, and reprioritization of research efforts.

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1 LTRMP has come to refer to both the LTRM and Computerized Inventory and Analysis (CIA) program elements identitided in the EMP’s authorizing legislation.

6. The LTRMP plays an important role in the planning and implementation of habitat rehabilitation and enhancement projects. An expanded LTRMP would allow for a much greater level of involvement by the program's science staff in the identification, formulation, monitoring, and assessment of habitat rehabiliation and enhancement projects.

7. The LTRMP's acquisition of additional key spatial data coverages (e.g., water depths and velocities, habitat types and distributions, substrate qualities, land ownership) is essential to its ability to support successful river resource planning and management.

c. The Habitats Rehabilitation and Enhancement Project Conclusions are as follows:

1. Habitat rehabilitation and enhancement projects constructed to date have directly restored, protected, or enhanced over 28,000 acres of critical UMRS fish and wildlife habitat. When the 14 HREP's 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 that are now in various stages of general design.

2. Important system-level ecological benefits are known to accrue from the site-specific improvements (e.g., awning habitat, food resources, nesting opportunities, shelter, etc.) provided by individual HREPs.

3. The HREPs have made significant contributions to the science of habitat and ecosystem restoration by developing new and increasingly effective planning tools, engineering designs, and evaluation methods.

4. The challenge for the future is to better couple HREP evaluation data, LTRMP systemic data, and decision support tools now available with the experience gained in the design and implementation of HREPs over the past 10 years to shape system-wide habitat restoration, protection, and enhancement strategies.

5. Most HREP implementation costs have declined as a result of evolving HREP planning, design, and construction approaches.

6. Corps of Engineers Districts now have over 10 years of experience with HREPs. Further delegation of project approval authority would streamline project implementation and thereby reduce program costs.

7. HREPs implemented to date have been essentially confined to lands already under public ownership. On the lower two-thirds of the UMRS, limited public land ownership has restricted options for restoring, protecting, and enhancing habitat.

8. Sediment delivery from uplands immediately adjacent to HREP project sites needs to be simultaneously addressed to maximize project life and outputs.

9. Most HREPs have met, and in many cases exceeded, their physical and chemical design objectives. Quantitative verification of biological outputs is more difficult to accomplish. Performance (physical, chemical, and biological) monitoring of habitat projects, although costly, is expanding our understanding of habitat requirements of UMRS species. EMP partners have used these performance monitoring results to design more cost-effective projects as the program has evolved.

10. Collaborative planning and design of HREPs have identified a number of experimental and innovative project opportunities such as seed islands, small scale drawdowns, wing dam notching, and pool-level management.

d. Additional general conclusions are as follows:

1. Charters for the EMP-CC and LTRMP Analysis Team reflecting greater involvement and stronger empowerment of the EMP partner agencies need to be established. These charters would further clarify roles, responsibilities, and expectations of program partners; assure clear lines of communications; and strengthen partnership linkages.

2. The EMP would benefit from greater participation by all river constituencies.

The most important recommendation made by the reporting officer in the report is that the Upper Mississippi River System-Environmental Management Program should be reauthorized. This recommendation was strongly supported by the Upper Mississippi River Basin Association and the Environmental Management Program Coordination Committee. In addition, the report identified modifications which could be implemented under the authority of the St. Louis, Rock Island, and St. Paul District Commanders,

Mississippi Valley Division Commander, and the Chief of Engineers. However, the report also contains recommendations which require additional legislative authorization. These modifications and recommendations are summarized as follows:

a. St. Paul, Rock Island, and St. Louis District Commanders approval:

1. Physical, chemical, and biological monitoring of pre- and post-project conditions should continue. Integration of project-specific monitoring with the systemic monitoring activities of the LTRMP should be enhanced. Biological response monitoring of selected habitat restoration, protection, and enhancement measures is essential to evaluating the ecological and cost effectiveness of the HREP program element and should continue to be supported.

2. Future efforts to restore, protect, and enhance UMRS habitat should include an appropriate mix of large-scale actions, such as pool-scale watershed management modifications, which are compatible with other river system purposes, and smaller projects affecting limited areas. Increased emphasis should be placed on using natural river processes and innovative measures in the design and construction of habitat projects.

3. Increase the level of public involvement in the planning and implementation of the UMRS-EMP. Efforts should be taken to inform the public about habitat project purposes (resource management goals and objectives), expected outputs, and actual performance. In addition, opportunities to support public education of programs that increase general understanding of the UMRS ecosystem and management challenges should be pursued.

b. Mississippi Valley Division Commander approval:

1. The Corps of Engineers should assure that a comprehensive habitat needs assessment for those parts of the floodplain directly associated with the river is accomplished. Over the past decade our understanding of regulated rivers has grown, the availability of comprehensive data sets and spatial coverages has increased, and technologies (e.g., GIS, remote sensing, GPS, modeling tools, etc.) have evolved. All of these changes make refinement of the existing system goals and objectives and development of a more comprehensive “blueprint” for future habitat needs more feasible. This blueprint also would include improved metrics for evaluating future program implementation efforts.

2. To reduce HREP review and approval time and therefore implementation costs, approval authority for those projects with an estimated total construction cost of less than $1 million should be delegated to the district level.

3. The Corps of Engineers should facilitate development of charters within the constraints imposed by Federal law for the EMP-CC and LTRMP Analysis Team.

c. Chief of Engineers approval:

1. The Corps of Engineers should review and, if necessary, modify current policies and guidance to ensure that HREPs can include obtaining real estate interests from willing sellers when and where such actions are determined to be consistent with and supportive of program goals and objectives. Any new or revised policy and guidance should include a provision to reimburse the local sponsor for all lands, easements, rights-of-way, relocations, and disposal sites (LERRD) costs in excess of 25 percent of the total project cost.

2. The Corps of Engineers should modify EMP policies and guidance to allow the inclusion of upland sediment controls as part of HREPs in cases where sediment from the local watershed is directly affecting the project area and sediment control is the most cost-effective measure for achieving project objectives.

3. A concerted effort should be undertaken to identify factors (e.g., 50-year project life design requirement, definition of project failure, experimental design) that may currently be limiting program innovation. Subsequently, any potentially constraining policies and guidance should be reviewed and, if necessary, modified.

4. To gain additional project implementation efficiencies, approval authority for those projects with an estimated total construction cost of $5 million or less should be delegated to the Mississippi Valley Division Commander.

d. Recommendations requiring Congressional authority:

1. Congress further amend Section 1103 of the Water Resources Development Act (WRDA) of 1986, as previously amended, to provide for the continuing authorization of a program for the implementation and evaluation of measures for fish and wildlife habitat restoration, protection, enhancement, and for resource monitoring and research.

2. The annual amount authorized to be appropriated for the program for the implementation and evaluation of Habitat Rehabilitation and Enhancement Projects (HREPs) be increased to $22,750,000.

3. Current program authorization language specifying separate LTRM and CIA program elements be rewritten to identify a single long-term resource monitoring, data analysis, and applied research element, herein referred to as the LTRMP.

4. The annual amount authorized to be appropriated for the LTRMP, which is 100 percent Federally funded, be increased to $10,420,000.

5. The Secretary of the Army, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, be required to submit a report to Congress every six years describing the accomplishments of the programs; providing updates of a systemic habitat needs assessment; and identifying any needed adjustments (e.g., funding level, program scope, etc.) in the authorization. Submittal of this report is to be timed so as to allow consideration as part of a comprehensive Water Resources Development Act.

6. Cost sharing for EMP projects be continued as prescribed by Section 906(e) of the Water Resources Development Act of 1986, under which implementation costs of projects “on lands managed as national wildlife refuge” are 100 percent Federal, and implementation costs of all other projects are shared 75 percent Federal/25 percent non-Federal, providing the following:

(a) Up to 80 percent of the 25 percent non-Federal cost share of a habitat Rehabilitation and Enhancement Project may be in the form of in-kind services, including a facility, supply, or service or lands (LERRDS credits) that is necessary to carry out the project. This would be similar to other habitat

restoration programs such as Section 1135 of the Water Resources Development Act of 1986, Project Modifications for the Improvement of the Environment, as amended by Section 204(d) of the Water Resources Development Act of 1996.

(b) Subject to availability of funds, non-Federal interests may be reimbursed for the Federal share, without interest, of studies, design documents, and implementation costs of approved Habitat Rehabilitation and Enhancement Projects.

Alternatives Considered for the Environmental Management Program

a. No Action Alternative - End Environmental Management Program

For this alternative the EMP authorization would expire at the end of FY 2002. No UMRS-specific program authority would replace it. After 2002, UMRS habitat restoration, protection, or enhancement would be accomplished under other existing authorities. Monitoring, data analysis, and research would be limited to those sites and parameters of greatest interest to individual state or Federal agencies. No action, other than annual appropriations through

FY 2002, would be required of Congress. HREP planning and design work would be discontinued unless project construction could be completed prior to 2002 or implementation could be funded under another authority, such as Section 1135. Projects currently under construction would be accelerated, if necessary, to realize completion by FY 2002. The Environmental Management Technical Center’s LTRMP responsibilities would be dismantled with data and equipment transferred to the Corps of Engineers or other appropriate agencies.

b. Continue Existing Environmental Management Program

Under this alternative the budget and structure of the current EMP would continue unchanged after FY 2002. The types of projects undertaken would conform to existing Corps policy. The pace of project implementation would decrease as the effects of inflation over time reduce actual purchasing power. LTRMP monitoring design would need to be regularly revised and data analysis and research efforts reprioritized to meet funding

limitations. Congressional action would be required to extend authorization beyond FY 2002. Partner agencies would help restructure and down scale the habitat program and LTRMP due to the effects of inflation.

c. Continue and Modify Environmental Management Program

1. With this alternative, continuing the authority and increased funding level would be provided to continue and enhance two program components, HREP and LTRMP. A habitat needs assessment would be conducted to help guide the selection and design of HREPs and provide a basis for project performance measurement. HREP measures would be expanded to include a wider variety of restoration, protection, and enhancement techniques, including upland sediment control of local watersheds directly affecting riverine habitat; land and easement acquisition from willing sellers; and more innovative measures. The LTRMP would continue with an emphasis on: a) improving monitoring design; b) applied research to provide information needed for river management; c) an expanded array of components monitored, including wildlife, mussels, and enhanced water quality parameters; and d) expansion of spatial scale to include more widely distributed sampling locations within the floodplain and analysis at multiple scales. In addition, LTRMP responsibilities would be expanded to include broader responsibilities for HREP monitoring and support for the habitat needs assessment (HNA).

2. As an early effort in FY 98 or FY 99 the previously mentioned HNA would be conducted to identify objectives and opportunities for habitat protection, restoration, and enhancement. In general, the assessment would include a description of historical and existing habitat conditions, as well as an identification of objectives for future habitat conditions. Such an assessment would help guide the selection and design of HREPs by defining habitat needs at system-wide, river reach, and pool scales. It would address a variety of habitat requirements, including physical, chemical, and biological parameter. Six-year updates would provide a basis for recommending future changes to Corps policies and to the EMP authorizing legislation, including funding. Every six years, a Report to Congress would be provided. Given that the EMP would be authorized as a continuing program, it is recognized that periodic adjustments may be needed. The Report to Congress would describe program accomplishments, including progress toward meeting the needs identified in the Habitat Needs Assessment, and recommend program modifications, if necessary, to achieve habitat restoration and protection objectives. Congressional action

would be required to amend Section 1103 to provide continuing authority subject to the Report to Congress every six years and subsequent Congressional reauthorization. This Congressional reauthorization would increase the authorized funding level and institutionalize further reporting to Congress on a six-year schedule. Corps of Engineers policies including those related to acquisition of real estate interest, upland sediment control, 50-year project life, and demonstration projects would also be clarified or revised.

COORDINATION

The Rock Island District Corps of Engineers was responsible for preparing and coordinating this report, consolidating information from other agencies and interested parties, formulating the alternatives, and finalizing the conclusions and associated recommendations. During the course of the report preparation, there was active and extensive participation and input from the Upper Mississippi River Basin Association and the Environmental Management Program-Coordination Committee. Both these organization have representatives from the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The Environmental Management Program-Coordination Committee also has representatives from the Fish and Wildlife Service, the Geological Survey, the Environmental Protection Agency, the Department of Agriculture, and Department of Transportation. The District also coordinated this report with numerous other Federal, state, and local agencies and groups.

PUBLIC INVOLVEMENT

The draft report had extensive review by members of the general public and governmental and non-governmental organizations. The reporting officers distributed approximately 400 copies of the report. In addition, a Notice of Availability and Public Meeting Announcement were sent to over 9,000 addresses. The reporting officer conducted five public meetings. Every effort was made by the reporting officer to ensure all concerned parties had an opportunity to comment on the draft report.

REVIEW AND AUTHORIZATION PROCESS

Prior to forwarding the Upper Mississippi River System-Environmental Management Program report to Congress, the report will be reviewed by the Chief of Engineers and Assistant Secretary of the Army for Civil Works. A coordinated review, including states and other Federal agencies, will also be accomplished at that time. Upon completion of his review the Chief of Engineers will forward the report with his recommendations to the Secretary of the Army.

If the Chief of Engineer's recommendations are significantly different from the program modifications, and recommendations coordinated with state and Federal agencies, interested parties will be afforded an opportunity to comment further prior to submission of the Chief's report to the Secretary. The Assistant Secretary of the Army, in consultation with the Office of Management and Budget, then establishes the Administration position on whether the proposal should be recommended to Congress for reauthorization.

VIEWS OF INTERESTED PARTIES

Interested parties may present written views on the report to the Chief of Engineers and the Secretary of the Army, through the Headquarters of the U.S. Army Corps of Engineers. Such communications should be mailed and received by the U.S. Army Corps of Engineers, Attn: CECW-PC, 20 Massachusetts Ave., Washington, DC 20314-1000, within 30 days from the date of this notice. Copies of information received by mail will be regarded as public information unless the correspondent requests otherwise. Such a request will limit the usefulness of the information because of the need for full public disclosure of all factors relevant to the decision.

FINAL ACTION BY THE CHIEF OF ENGINEERS

The Chief of Engineers will not submit a recommendation to the Secretary on the report until after the expiration of this notice or any extension thereof that may be granted and full consideration of all information submitted in response thereto.

REPORT INFORMATION

Further information may be obtained from the District Commander, U.S. Army Engineer District, Rock Island, P.O. Box 2004, Rock Island, Illinois 61204-2004. Interested Parties may obtain copies of the URMS-EMP report from the District Engineer free of charge as long as copies are available. Additional copies of the report will also be on file and available for public review at libraries throughout the study area. Please pass along a copy of this public notice to anyone who may be interested in the report and who has not received a copy.

Phillip R. Anderson

PHILLIP R. ANDERSON
Major General, USA
Commanding

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT. CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P.O. BOX 2004
ROCK ISLAND. ILLINOIS 61204-2004

REPLY TO
ATTENTION OF:

December 23, 1997

Planning Division

SEE REPORT DISTRIBUTION LIST

The enclosed final Upper Mississippi River System - Environmental Management Program (UMRS-EMP) Report to Congress (RTC1-F), with appendices, is provided for your information (Enclosure 1). This document, including the conclusions, proposed program implementation modifications, and recommendations to Congress stated therein, was developed in consultation with the program partners (U.S. Fish and Wildlife Service, U.S. Geological Survey, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin). Other Federal and State agencies and non-governmental organizations, as well as members of the general public also participated in the report formulation process.

The Habitat Rehabilitation and Enhancement Project (HREP) and Long Term Resource Monitoring Program (LTRMP) appendices are provided in 3-ring binders so that updated or additional information about those program elements may be added in the future.

This Report to Congress, including the appendices, will be available electronically via the Internet (see enclosed document for addresses) by late January 1998. For this reason, and because of the prohibitive cost of hard copy color reproduction, much of the enclosed document was reproduced in black and white.

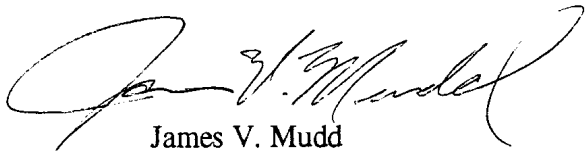
The Division Engineer's Public Notice, Upper Mississippi River System - Environmental Management Program (UMRS-EMP) Report to Congress, dated December 18, 1997, was mailed to 110 congressional offices (see pages 1-8 of report distribution list [Attachment 7 of Enclosure 1]) and the offices of the 5 State Governors (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) on December 19, 1997. A copy of this notice is provided as Enclosure 2.

Concurrent review of this report at Headquarters, U.S. Army Corps of Engineers and the Mississippi Valley Division is underway. This review process will culminate with the distribution of the U.S. Army Corps of Engineers' draft Chief of Engineers report for State and agency review, currently scheduled to occur on February 1, 1998.

Comments on the draft Chief's report will be given careful consideration in the Corps of Engineers' preparation of the final Chief's report. That final Chief's report, along with the enclosed reporting documents, will ultimately be submitted to Congress for their consideration in preparing a 1998 Water Resources Development Act.

Please direct any questions or comments you may have regarding this document or the future processing of the UMRS-EMP Report to Congress to Mr. Jerry Skalak, Report to Congress Project Manager. You may reach Mr. Skalak by telephoning 309/794-5605, by FAX at 309/794-5710, or by electronic mail at: **Jerry.A.Skalak@usace.army.mil**

Sincerely,



James V. Mudd
Colonel, U.S. Army
District Engineer
Rock Island District

Enclosure

Executive Summary

The Upper Mississippi River System (UMRS), is defined as the reach of the Upper Mississippi River between Minneapolis, Minnesota, and Cairo, Illinois; the entire length of the Illinois River; and the navigable portions of the Minnesota, St. Croix, Black, and Kaskaskia Rivers. The UMRS encompasses one of the world's few large river-floodplain ecosystems. Its complex mosaic of flowing main and side channels, floodplain lakes and forests, backwaters, and wetlands provides all or part of the food and habitat requirements of over 485 species of fish, mussels, birds, mammals, amphibians, and reptiles. Over 10% of these species are classified as rare, threatened, or endangered in one or more of the five UMR basin States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), and nine species are federally listed as threatened or endangered. More than 40% of North America's migratory waterfowl and shorebirds depend upon the food resources and other life requisites (shelter, nesting habitat, etc.) that the UMRS provides. This diversity and abundance of species is supported in part by an extensive system of State and Federal land holdings that are managed for natural resource purposes. The U.S. Fish and Wildlife Service manages the Upper Mississippi and Illinois River National Wildlife and Fish Refuges and the Mark Twain, Trempealeau, and Minnesota Valley National Wildlife Refuges, which together encompass approximately 310,000 acres. The States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin manage over 190,000 acres for fish and wildlife purposes at more than 80 sites along the UMRS.

The UMRS supports many economic activities of regional and national importance. In 1995, shippers transported approximately 126.3 million tons of cargo on the system's 1,300 commercially navigable miles. Grain, petroleum products, and coal are the leading commodities shipped, with farm products accounting for approximately half of the total tonnage. Millions of visitors annually come to the river to: pursue boating, swimming, camping, hunting, and fishing opportunities; visit its many historic towns and archeological sites; or just enjoy its natural beauty. Many of the region's more than 24 million residents rely on the Upper Mississippi and its tributaries for municipal and industrial water supplies, power generation and power plant cooling, and waste water assimilation. The river system also provides opportunities for extractive industries such as commercial harvesting of fish and mussels and sand and gravel mining operations.

In the 1986 Water Resources Development Act, Congress clearly recognized the uniqueness of the UMRS by declaring it to be "a nationally significant ecosystem and a nationally significant commercial navigation system." Consistent with that recognition and as part of the same legislation, Congress authorized both the construction of the second lock at Locks and Dam 26 and a multiple element program that has come to be known as the Upper Mississippi River System - Environmental Management Program (UMRS-EMP). The development and submittal of this Report to Congress was specifically mandated in the EMP's authorizing legislation.

Implementation of the EMP is providing many important outputs, including:

- Restoration, protection and enhancement of critical aquatic, wetland, and floodplain habitat types throughout the UMRS.
- Systemic resource monitoring, data analysis, and applied research resulting in an increased understanding of both the regulated and open reaches of the UMRS.
- Improved communications and expanded partnership among the many UMRS management agencies, interest groups, and the general public.
- A model program applicable to other river systems and water resources.

The EMP is truly a unique, multi-participant program consisting of three major elements (Habitat Rehabilitation and Enhancement Projects [HREPs], Long Term Resource Monitoring [LTRM], and Computerized Inventory and Analysis [CIA] [note: the LTRM and CIA have come to be jointly referred to as the LTRMP]) dedicated to the study and restoration of the natural resources of the UMRS. To date, HREP construction has resulted in over 28,000 acres of aquatic, wetland, and floodplain habitat being restored, protected, or enhanced. When the 14 HREPs currently under construction are completed, this area will more than double to nearly 68,000 acres. It will increase to over 97,000 acres upon implementation of the 12 projects currently being designed. The LTRMP monitoring and research activities are providing invaluable information about the UMRS. New levels of partnership among the many river constituencies are being realized. The EMP is fundamental to successful comprehensive management of the system.

This report was developed in consultation with the many Federal and State agencies and non-governmental organizations that participate in the implementation of the UMRS-EMP. It presents the cumulative results of an extensive program review and evaluation process. Program outputs, specifically benefits accrued to the nation as a result of the planning, design, construction, and evaluation of multiple habitat rehabilitation and enhancement projects and the accomplishment of system-wide resource monitoring and applied research activities, are identified and assessed.

The following five overarching conclusions about the UMRS and the EMP were reached during the development of this report:

- The EMP has come to be the single most important and successful program authorized by the Federal government for the purposes of understanding the ecology of the UMRS and sustaining its significant fish and wildlife resources.

- The degradation and loss of UMRS aquatic, wetland, and floodplain habitat can be substantially offset by the application of habitat restoration, protection, and enhancement measures. Such measures must be based upon quantitative and qualitative goals that are compatible with the multiple purpose use of the resource.

- A habitat needs assessment (HNA) should be completed to establish a technically sound, consensus-based management framework or “blue print” for the restoration, protection, and enhancement of the UMR ecosystem. This assessment would begin to identify, at system, pool, and reach levels, long term habitat requirements. It would also serve to refine the focus of future system monitoring and research activities.

- Increasingly effective management of regulated river systems, such as the UMRS, is dependent upon long term monitoring to detect system changes and applied research to understand system dynamics and relationships.

- Implementing the EMP has resulted in an unprecedented level of communication and cooperation among the Federal and State partner agencies responsible for UMRS management; however, greater public involvement, outreach, and education also are needed.

Conclusions reached specific to the LTRMP and HREP program elements include:

The Long Term Resource Monitoring Program (LTRMP) …

- Is providing meaningful characterization of system conditions and identification of long term resource trends.

- Has established and is maintaining the institutional framework and infrastructure necessary to conduct systemic monitoring and applied research at levels not previously possible.

- Is increasing accessibility of UMRS data and information.

- Has and is continuing to adapt to evolving management data and information needs and advancements in ecological science and technology.

- Is playing an increasing role in the planning, design, and evaluation of UMRS habitat restoration, protection, and enhancement projects.

The Habitat Rehabilitation and Enhancement Projects (HREPs) …

- Have directly restored, protected, or enhanced over 28,000 acres of critical UMRS fish and wildlife habitat. By completing implementation of the 26 projects currently being designed or constructed, the number of acres of habitat improved will increase to over 97,000.

- Are providing unique opportunities to demonstrate experimental and innovative approaches to habitat restoration.

- Have met, if not exceeded in most cases, their physical, chemical, and biological design objectives.

- Have become increasingly cost-effective as evolving approaches to their planning, design, and construction are applied.

- Are site-specific improvements that provide important system-level ecological benefits.

- Have been, to date, essentially confined to lands already under public ownership.

- In many cases, are adversely affected by sediment delivery from immediately adjacent uplands.

Additional programmatic conclusions included:

- Charters for the EMPCC and LTRMP Analysis Team, reflecting greater involvement and stronger empowerment of the EMP partner agencies, need to be established.

- The EMP would benefit from increased participation by all river constituencies.

The EMP authorization also contained three minor program elements—recreation projects, economic impacts of recreation, and traffic monitoring. These elements have either been successfully completed or are now being carried out under other authorities.

Three program alternatives are considered in this report. They were formulated and assessed utilizing a multi-participant approach. The Program's partner agencies, other Federal and State governmental agencies, and several interested non-governmental organizations all contributed to the process of defining and evaluating these alternatives:

1. **End EMP.** No action to extend or otherwise change the existing program authorization would be taken, nor would any significant modifications of existing program implementation procedures be pursued. The current program authorization would be allowed to end as of fiscal year 2002. Ramping down of the program would be initiated immediately to allow completion of habitat rehabilitation and enhancement projects already in advanced stages of design or awaiting construction. Activities of the Long Term Resource Monitoring Program would be increasingly directed towards data analysis in preparation for program termination.

2. **Continue EMP.** The program, as currently authorized, would be reauthorized for an additional 15 years (2003-2018). Program funding levels and implementation roles and responsibilities would remain unchanged. Program capabilities and annual outputs would continue to decline over time as the erosive effects of inflation on the Program's fixed funding level are realized.

3. **Continue and Modify EMP.** The EMP would be reauthorized as a continuing authority with a requirement for formal Congressional reviews of the program (Reports to Congress) on a 6-year cycle. Currently authorized Program funding levels for the LTRMP and HREP program elements would be increased by a factor of 1.75 to offset the effects of inflation since program inception. The Program would be periodically re-examined based upon future program evaluations and habitat needs assessments. Under this alternative, additional habitat projects would be implemented and an expanded program of monitoring and research carried out.

Alternative 3, **Continue and Modify EMP**, is the preferred alternative. It includes the following proposed program implementation modifications and recommendations to Congress:

Proposed Program Implementation Modifications

- Complete a habitat needs assessment for the UMRS.
- Delegate to the District level of the U.S. Army Corps of Engineers approval authority for habit projects costing $1 million or less.
- Delegate to the Division level of the U.S. Army Corps of Engineers approval authority for habitat projects costing $5 million or less.
- Review and possibly revise policies and guidance addressing acquisition of real estate interests (fee title or easement) from willing sellers.
- Review and possibly revise policies and guidance addressing upland sediment controls.

- Continue the important pre- and post-habitat project monitoring and evaluation efforts.
- Continue to implement a mix of small- and large-scale habitat projects with increasing emphasis on the use of natural river processes and innovative measures.
- Identify factors that may be limiting program innovation and review and revise any potentially constraining policies and guidance.
- Facilitate development of charters for the EMPCC and Analysis Team.
- Increase the level of public involvement in program planning and implementation.

Recommendations to the United States Congress

1. Establish a continuing authority for the UMRS-EMP with a requirement for Reports to Congress every 6 years (to coincide with Water Resources Development Act legislation).

2. Review the current authorization so as to formally merge the Long Term Resource Monitoring and Computerized Inventory and Analysis elements of the program into a single element called the Long Term Resource Monitoring Program.

3. Reauthorize the program at a total annual Federal funding level of $33.17 million.

    - $22.75 million/year for the protection, restoration, and improvement of Upper Mississippi River System aquatic, wetland, and floodplain habitats (habitat rehabilitation and enhancement projects).
    - $10.42 million/year for monitoring, data analysis, and applied research (long term resource monitoring program).

4. Continue program cost-sharing requirements as described in the Water Resources Development Act of 1986

    - 100% Federal funding of HREPs “on lands managed as a national wildlife refuge”; 75% Federal/25% non-Federal cost sharing of all other HREPs

    and recommended in this report

    - Allow up to 80% of the 25% non-Federal share of cost-shared HREPs to be in the form of in-kind services.
    - Allow non-Federal interests to be reimbursed, subject to the availability of funds, for the Federal share, without interest, of studies, design documents, and implementation costs of approved HREPs.

This report and its appendices provide, both quantitatively and qualitatively, the data, information, professional judgments, and determinations necessary to reach prudent, defensible decisions as to the strengths and weaknesses of the current UMRS-EMP and its future.

The conclusions, proposed program implementation modifications, and recommendations to Congress presented in this report were developed in consultation with the program's partners, other appropriate government agencies, various non-governmental organizations, and the general public. The preferred alternative, as identified, for the future of the UMRS-EMP is broadly supported by the UMRS' many stakeholders. Its full implementation will assure that the future EMP is of the magnitude, standing, and duration necessary to: meet the long term data and information needs of river managers and users; offset the continuing degradation and loss of UMRS aquatic, wetland, and floodplain habitats; support emerging efforts to more comprehensively manage the UMRS and its basin; and ultimately, fulfill public expectations of a healthy, sustainable UMR ecosystem capable of accommodating equally important recreational and economic uses.

Report to Congress

An Evaluation of the Upper Mississippi River System Environmental Management Program

Main Report

December 1997

US Army Corps of Engineers
Rock Island District

Cover Photos (from upper left)
- Aquatic Vegetation Sampling
- Multi-Agency Habitat Project Planning Meeting
- New, Off-Channel Aquatic Habitat (Potters Marsh, Illinois)

(RTC1-F)

The Mississippi River at Guttenberg, Iowa.

Foreword

The Upper Mississippi River System (UMRS) has a long history of providing many social and economic needs and supporting a tremendous diversity and abundance of fauna and flora. It is the only river system in the United States formally recognized by Congress both as a nationally significant ecosystem and commercial navigation system. This designation underscores the great importance that we, as a nation, place upon the economic and ecological values of this magnificent resource.

The effects of river regulation and modifications to the system's watersheds, floodplains, and tributaries present constant challenges to the ecological integrity of the Upper Mississippi and Illinois Rivers. To meet these challenges, better information and knowledge must be pursued, habitat protection, restoration and enhancement must be accomplished, and increasingly effective partnerships must be nurtured and maintained. Only then may our common goal, to assure a healthy, sustainable Upper Mississippi River ecosystem for future generations while accommodating the vital economic and recreational functions it provides and society expects, be realized.

The Upper Mississippi River System - Environmental Management Program (EMP) was established to help maintain the multiple use character of the river. In the eyes of many individuals, the program has since evolved into a national model for the management of large floodplain river ecosystems. The EMP's extensive monitoring and focused research activities are significantly advancing our understanding of the complex physical, chemical, and biological interrelationships that define and determine the Upper Mississippi River ecosystem. Many of the habitat projects being constructed as part of the EMP represent real progress toward regional, national, and international ecological objectives, while others demonstrate innovative measures that bring us closer to realizing ecosystem sustainability.

Finally, everyone involved in implementing the EMP acknowledges that it has brought a new level of partnership to the UMRS. This is one of the program's truly invaluable outputs. The Corps, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and the five UMRS States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) have formed a partnership to collectively implement the EMP. This partnership is fundamental to our successfully maintaining and enhancing all of the river system's environmental and economic values into the 21st century.

James V. Mudd
Colonel, U.S. Army
District Engineer
Rock Island District

Acknowledgments

The U.S. Army Corps of Engineers would like to take this opportunity to express its appreciation to the representatives and other staff members of the following Federal and State agencies and non-governmental organizations who participated in the many workshops and meetings requisite to the development of this report and accomplished the extensive coordination and document reviews its preparation necessitated. Although many other individuals should be recognized here, only the names of the principal point(s)-of-contact are identified.

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Minnesota/Wisconsin Boundary Area Commission
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Upper Mississippi River Conservation Committee
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United States Fish and Wildlife Service
Mr. John Blankenship and Mr. Keith Beseke
United States Geological Survey
Mr. Robert Delaney and Dr. Ken Lubinski
United States Environmental Protection Agency
Mr. Bill Franz
Natural Resources Conservation Service
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Sierra Club
Mr. Jonathan Ela
Mississippi Area River Coalition 2000
Mr. Chris Brescia
American Rivers
Mr. Scott Faber and Mr. Steve Ellis

Abbreviations and Acronyms

AHAG	Aquatic Habitat Appraisal Guide
ASA(CW)	Assistant Secretary of the Army (Civil Works)
A-Team	Analysis Team
BEST	Biomonitoring of Environmental Status and Trends
BRD	Biological Resources Division
CAR	Coordination Act Report
cfs	cubic feet per second
CIA	Computerized Inventory and Analysis
CPUE	Catch-Per-Unit Effort
DO	Dissolved Oxygen
DOC	Department of Conservation
DPR	Definite Project Report
EMP	Environmental Management Program
EMPCC	Environmental Management Program Coordinating Committee
EMTC	Environmental Management Technical Center
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FY	Fiscal Year
GEM	General Equilibrium Model
GIS	Geographic Information Systems
GPS	Global Positioning Systems
GREAT	Great River Environmental Action Team
HEP	Habitat Evaluation Procedures
HNA	Habitat Needs Assessment
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HREP	Habitat Rehabilitation and Enhancement Project
HSI	Habitat Suitability Index
HU	Habitat Unit
IA DNR	Iowa Department of Natural Resources
IL DNR	Illinois Department of Natural Resources
IRC	Issues Resolution Conference
LAN	Local Area Network
LERRD	Lands, Easements, Rights-of-Way, Relocations, and Disposal Sites
LTRM	Long Term Resource Monitoring
LTRMP	Long Term Resource Monitoring Program
MDOC	Missouri Department of Conservation
MRC	Management Review Committee
MSC	Major Subordinate Command
MTNWR	Mark Twain National Wildlife Refuge
MVD	Mississippi Valley Division, U.S. Army Corps of Engineers
MVP	St. Paul District, U.S. Army Corps of Engineers
MVR	Rock Island District, U.S. Army Corps of Engineers
MVS	St. Louis District, U.S. Army Corps of Engineers
NBII	National Biological Information Infrastructure
NED	National Economic Development
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
NSSC	Navigation System Support Center
O&M	Operation and Maintenance
OMRR&R	Operation, Maintenance, Repair, Rehabilitation and Replacement
PCA	Project Cooperation Agreement
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PL	Public Law
PMS	Performance Monitoring System
POS	Plan of Study
SAST	Scientific Assessment and Strategy Team
SAV	Submerged Aquatic Vegetation
SRC	Science Review Committee
GAP	Gap Analysis Project
UMR	Upper Mississippi River

UMRBA	Upper Mississippi River Basin Association
UMRBC	Upper Mississippi River Basin Commission
UMRNWFR	Upper Mississippi River National Wildlife and Fish Refuge
UMRS	Upper Mississippi River System
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WDNR	Wisconsin Department of Natural Resources
WEEM	Waterway Economic Efficiency Model
WES	Waterways Experiment Station
WHAG	Wildlife Habitat Appraisal Guide
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WWW	World Wide Web

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APPENDIX A Long Term Resource Monitoring Program

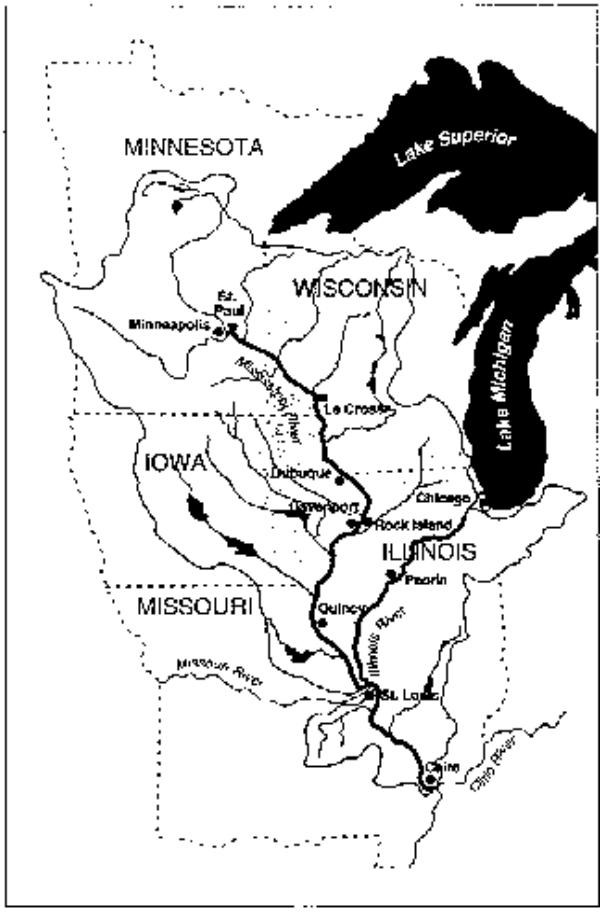
APPENDIX B Habitat Rehabilitation and Enhancement Projects

Introduction

In Section 1103 of the 1986 Water Resources Development Act,[1] Congress authorized a multi-element program designed to protect, restore, and balance the resources of the Upper Mississippi River System (UMRS). This program, which has come to be known as the Environmental Management Program, or EMP, consists of five program elements:

- Habitat Rehabilitation and Enhancement Projects (HREP)
- Long Term Resource Monitoring (LTRM) and Computerized Inventory and Analysis (CIA) [Note: These program elements have come to be jointly referred to as the Long Term Resource Monitoring Program (LTRMP)]
- Recreation Projects
- Economic Impacts of Recreation Study
- Navigation Traffic Monitoring

This report is presented to Congress in fulfillment of Section 1103(e)(2) of that same Act, which directs the Secretary of the Army, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin to:



The Upper Mississippi River System and its Basin.

[1] See Attachment 1.

> *…conduct an evaluation of [the HREP, LTRM, and CIA] programs and submit a report on the results of such evaluation to Congress. Such evaluation shall determine each such program's effectiveness, strengths, and weaknesses and contain recommendations for the modification and continuance or termination of such program.*

Chapter 1 of this report describes the program's origin and presents its funding and implementation history and current management framework. The ecological state of the UMRS is discussed and presented in Chapter 2. Chapters 3 and 4 provide a description and evaluation of the program's two major elements,[2] the LTRMP and HREP, respectively.

The public's perspectives on river resources and public involvement in the implementation of the EMP are presented in Chapter 5. This chapter includes the results of a major public survey completed in 1996 on river resource values and expectations. Chapter 6 lays out the program options and alternatives considered and presents preferences for the program's future based on evaluations of those options and alternatives. Chapter 7 provides over-arching program conclusions and proposed program implementation modifications. Recommendations to the Congress are presented in Chapter 8.

The recommendations, as well as the proposed program implementation modifications identified in this report, were developed in consultation with the program partners, the five Upper Mississippi River basin states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), the U.S. Fish and Wildlife Service, and the U.S Geological Survey. Also, several other governmental agencies and non-governmental organiza-tions actively participated in the formulation of the recommendations and proposed program implementation modifications presented in this document.

Two separately bound appendices containing extensive documentation on the LTRMP (Appendix A) and the HREPs (Appendix B) have been developed and distributed. These appendices, along with this report and its attachments, are available electronically. They may be reached via either of the following Internet addresses: **www.mvr.usace.army.mil**. or **www.emtc.usgs.gov**. Additional hard copies of this document and its appendices may be obtained by writing the U.S. Army Corps of Engineers, Rock Island District, ATTN: Planning Division, Clock Tower Building, P.O. Box 2004, Rock Island, Illinois 61204-2004.

[2] The program authorizing legislation that mandated the development of this report did not specifically request evaluation of the three other program elements (recreation projects, Economic Impacts of Recreation Study, and navigation traffic monitoring). Attachment 3 of this report was developed to provide, for reasons of report completeness, a summary of these other program elements.

History and Background 1

PROGRAM ORIGINS

In the 1970s, a proposal to replace Lock and Dam 26 near Alton, Illinois, and increase its navigation capacity, sparked considerable debate and protracted litigation. Environmental groups and Midwestern railroads were particularly opposed to proposed construction of twin 1,200-foot locks. Seeking to balance this concern with the navigation system needs, Congress, in 1978, authorized construction of a new dam with a single, 1,200-foot lock and directed the Upper Mississippi River Basin Commission to conduct studies and make recommendations related to further navigation capacity expansion and its ecological impacts. The Commission presented its findings and recommendations in a landmark document, the *Comprehensive Master Plan for the Management of the Upper Mississippi River System.*[1]

Melvin Price Locks and Dam (L&D 26), Alton, Illinois.

The Master Plan

The Master Plan recommended that Congress authorize: a second lock, 600 feet in length, at Lock and Dam 26; a habitat rehabilitation and enhancement program; a long term resource monitoring program; a computerized inventory and analysis system; recreation projects; and a study of the economic impacts of recreation. In addition, the Commission proposed actions to reduce erosion rates, increase the capacity of other locks through non-structural and minor structural measures, monitor traffic movements, continue dredged material placement practices, promote beneficial uses of dredged material, and coordinate State water resources management activities.

The Commission emphasized three factors that were foundational to its strategy and fundamental to the philosophy upon which the Master Plan was built:

[1] Upper Mississippi River Basin Commission. 1982. *Comprehensive Master Plan for the Management of the Upper Mississippi River System.* Upper Mississippi River Basin Commission, Minneapolis, Minnesota. 193 pp.

- **Multi-purpose use**—Recognizing that the river is both a nationally significant ecosystem and a nationally significant commercial navigation system, the Commission urged that a commitment be made "to maintain and enhance all aspects" and that the Master Plan recommendations be given "equal weight."

Tows passing through the Upper Mississippi River National Wildlife and Fish Refuge.

- **Immediate action**—The Commission recognized that the urgent needs associated with commercial navigation growth and deteriorating environmental conditions could not be met with the authorities and programs in existence at that time.

- **Inconclusive data**—Despite the numerous studies conducted as part of the Master Plan, the Commission recognized that inadequate data and dynamic economic and environmental conditions could render long term investment decisions tenuous.

Moving from the Plan to Legislation

During the two years immediately following publication of the Master Plan, four bills were introduced, each of which contained the keystone elements of what is now called the Environmental Management Program, or EMP. In addition, each recognized the need to evaluate the program after some specified initial implementation period so that the program could be adjusted based upon experience gained and changes in river conditions. This concern for adaptive opportunities ultimately resulted in the directive that a Report to Congress be submitted prior to the end of the program's authorization period.

Upper Mississippi River legislation proposals were first integrated into a national Water Resources Development Act (WRDA) in 1983. Although the WRDA was not passed until 1986, the effect of using this national legislation as a vehicle to authorize the Upper Mississippi River programs was twofold. First, the authority for implementing all the Upper Mississippi River program elements was vested in the U.S. Army Corps of Engineers.[2] Secondly, cost-sharing for EMP habitat projects was mandated. Although the Upper Mississippi River Basin states were actively involved in negotiating both of those provisions, neither was originally conceived by the Commission that authored the Master Plan recommendations.

1985 Supplemental Appropriations

Prior to passage of the 1986 WRDA, Congress used the 1985 Supplemental Appropriations Act (Public Law 99-88) to initiate a number of water projects by directing that the Corps of Engineers proceed with construction and providing the funds necessary to do so. Among the 41 projects advanced in this way was the second lock at Locks and Dam 26, "including environmental management along the Upper Mississippi River Basin." This "early action" phase of the EMP resulted in total funding of $2,527,000 in fiscal years 1985-1987.

[2] Originally, the Master Plan had recommended that the U.S. Department of the Interior be given lead responsibility for implementing the plan's environmental recommendations.

The conference committee report accompanying the 1985 supplemental appropriations measure also set forth the basic framework for what was later to be called the Environmental Management Program. In the absence of more elaborate statutory provisions, the conferees directed that funds equal to those provided for advanced engineering and design of the second lock be used for "initial activities related to programs for long term resource monitoring, habitat rehabilitation and enhancement, recreation improvements and studies, traffic monitoring, and computerized inventory and analysis."

1986 Water Resources Development Act

Section 1103 of the 1986 Water Resources Development Act (Public Law 99-662) included provisions authorizing both construction of a second lock at Locks and Dam 26 and a variety of environmental initiatives on the Upper Mississippi River. That section was entitled the Upper Mississippi River Management Act of 1986. It is the statutory basis for the EMP, though the law does not confer that name upon the program.

The provisions of Section 1103 that constitute the programmatic elements (see Table 1-1) of the EMP are those that authorize:

- a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement,
- a long term resource monitoring program,
- a computerized inventory and analysis system,
- a program of recreational projects,
- an assessment of the economic benefits generated by recreational activities, and
- monitoring of traffic movements.

Other provisions of Section 1103 provide both context and statutory direction regarding implementation of the EMP. Of particular note are the provisions that:

- express Congress' desire "to ensure the coordinated development and enhancement of the Upper Mississippi River System";
- declare that the river is a "nationally significant ecosystem and a nationally significant commercial navigation system";
- declare that the system should be administered and regulated in recognition of its several purposes;
- define the Upper Mississippi River System as the commercially navigable portions of the Mississippi River north of Cairo, Illinois, and the Minnesota, Black, Saint Croix, Illinois, and Kaskaskia Rivers;
- provide Congressional consent for the basin states to establish interstate agreements or agencies;
- provide for transfer of funds to agencies of the Department of Interior;
- designate the Upper Mississippi River Basin Association as "caretaker" of the Master Plan;
- establish the applicability of cost-share formulas and clarify that none of the appropriations for the habitat, monitoring, or computerized information and analysis programs shall be considered chargeable to navigation;

TABLE 1-1: EMP Element Summary

Element	Description	Lead Agency	Cost Sharing	Authorized Funding
Habitat Projects	Planning, design, construction, and monitoring of projects to rehabilitate or enhance fish and wildlife habitat. Examples include side channel modifications, island creation, water level and flow control, and dredging.	Corps of Engineers	Construction costs are 75% Federal / 25% non-Federal, except for projects on lands managed as a national refuge, which are 100% Federal. Operation and maintenance costs are responsibility of agency that manages land (either Fish and Wildlife Service or State conservation agency).	$13,000,000/year
Long Term Resource Monitoring	Standardized monitoring of water quality, fisheries, vegetation, and other river resources. Related research activities in support of partner agencies' river management roles. Administered as integrated program with computerized inventory and analysis system.	U.S. Geological Survey 1/	100% Federal funding	$5,080,000/year
Computerized Inventory and Analysis System	Integration, analysis, and storage of data from the Long Term Resource Monitoring element. Extensive capabilities to perform spatial and statistical analysis and to provide access to data. Administered as integrated program with long term resource monitoring.	U.S. Geological Survey	100% Federal funding	$875,000/year
Recreation Projects	Authorization to construct river-based recreation projects. No funds have been allocated to construct recreation projects to date.	Corps of Engineers	Construction costs are 50% Federal / 50% non-Federal Operation and maintenance costs are 100% non-Federal	$500,000/year
Economic Impacts of Recreation Study	Assessment of economic impacts of recreation expenditures on the UMRS. Study completed in 1993.	Corps of Engineers	No cost-share provisions	$750,000 in total
Traffic Monitoring	Monitor traffic movements to determine need for capacity expansion of navigation system. Authority has not been used since fiscal year 1990. Further analysis of system's capacity needs is being done under Corps of Engineers' navigation feasibility study.	Corps of Engineers	No cost-share provisions	"Such sum as may be necessary"

1/ The USFWS was the agency originally given responsibility for management and implementation of the LTRMP. Subsequent DOI consolidation of its biological research facilities into a biological resources division under the USGS resulted in this responsibility transferring to that DOI agency in October 1996.

- provide general authority to determine the need for environmental improvements on the Upper Mississippi River System;
- direct dredged material to be disposed of in accordance with recommendations of the Great River Environmental Action Team (GREAT) studies of the 1970s;
- authorize a program to facilitate productive uses of dredged material; and
- authorize construction of a second lock at Locks and Dam 26.

The identification of these provisions and, ultimately, authorization of the UMRS-EMP were the result of hard work by a body of organizations and individuals dedicated to achieving balance among the system's many values.

Legislative Amendments

The original EMP authorizing legislation in Section 1103 of the 1986 WRDA has been amended twice since its enactment. The 1990 WRDA extended the original EMP authorization period an additional 5 years to FY 2002. This action recognized the need for a period of ramping up for the program.

The 1992 WRDA amended the original EMP authorization in two additional ways. First, a provision was added allowing some limited flexibility in how funds are allocated between the habitat projects program and the long term resource monitoring program. Secondly, the EMP cost-sharing provisions were amended to assign sole responsibility for operation and maintenance of habitat projects to the agency that manages the lands on which the project is located.

EVOLUTION OF IMPLEMENTATION

Shaping the Program

The 1986 WRDA authorized the individual components of the EMP without defining them in detail. The statute does, however, prescribe cost-sharing arrangements, geographic scope, annual funding levels, and the States and Federal agencies with whom the Corps of Engineers is to coordinate. Similar to other Corps project authorizations, other implementation parameters were left to the Corps' discretion and guidance.

In contrast to other Corps projects, for which reconnaissance and feasibility studies precede construction authorization, the EMP had no prior Corps of Engineers planning documents. The Master Plan prepared by the Upper Mississippi River Basin Commission was the foundation of the EMP authorization, but was relatively conceptual in nature. Thus, project planning became as much a part of the EMP as project construction.

To guide implementation, in January 1986 the Corps of Engineers published an initial foundational document entitled the *General Plan*. That document was followed by six Annual Addendums, each of which provided programmatic and policy updates, individual project status reports, and recommendations for out-year funding and schedules. In August 1992, the Corps prepared a *Midterm Evaluation Report*[3] that set forth program accomplishments and recommended continued funding.

The Partnership

As the primary implementing Federal agency, the Corps of Engineers is accountable for management and execution of the EMP. Vesting this responsibility in the Corps means that the EMP has been shaped in many ways by Corps policies and procedures. Yet in the early years of the EMP, the Corps had few, if any, precedents for this type of regional, multi-faceted, partnership program. Ensuring that the implementation of the EMP is consistent with national policy, yet responsive to the needs and expectations of the program's other partner agencies, has been the common goal.

[3] See Attachment 4, Summaries of Key Related Reports.

Technical specialists from the USFWS, the Corps of Engineers, and the Illinois Department of Natural Resources participate in an on-site planning meeting for the Gardner Division, Illinois HREP.

Partnership and shared responsibility have always been and continue to be critical to successful program implementation. This fact can be traced not only to the EMP's origins in a Commission structure, but also to the EMP authorizing legislation, which directed the Corps to undertake the program "in consultation with" the Department of the Interior and the five basin states. The region has a rich tradition of interagency partnership, and many of the long-standing interagency organizations have provided convenient forums for coordinating many aspects of the EMP.

For the specific purpose of providing interagency coordination of EMP implementation, the Corps of Engineers established the EMP Coordinating Committee (EMPCC) in 1987. The EMPCC is the primary consultative body used to discuss and, whenever possible, seek consensus on EMP budgetary and policy issues. The Corps of Engineers and the U.S. Fish and Wildlife Service co-chair the Committee. Membership consists of representatives from the U.S. Geological Survey, each of the five State conservation agencies, and a variety of Federal agencies[4] that have an interest in the EMP even though they have no specific implementation responsibilities.

To provide more detailed guidance on implementation of the Long Term Resource Monitoring Program (LTRMP), which combines the authorized monitoring and computerized information and analysis elements, another interagency committee called the Analysis Team, or "A-Team," was formed. This team provides science and management advice and recommendations to the U.S. Geological Survey on LTRMP work priorities, annual work plans, and research activities. It also plays an invaluable interagency program coordination role.

The EMP authorizing legislation designates the Upper Mississippi River Basin Association as the "caretaker" of the Master Plan. As such, major EMP policy, budgetary, and other non-technical issues are addressed in this forum.

Roles and Responsibilities

In addition to the various interagency consultative and coordination bodies associated with the EMP, individual Federal and State agencies have specific EMP implementation responsibilities.

- ***U.S. Army Corps of Engineers.*** The Mississippi Valley Division[5] has overall program management responsibility and receives policy guidance from the Headquarters office of the U.S. Army Corps of Engineers. The St. Paul, Rock Island, and St. Louis Districts are responsible for the planning, design, construction, and monitoring of habitat projects.

- ***U.S. Fish and Wildlife Service.*** The Region 3 office has lead coordination responsibility. Personnel from the refuges and environmental services field offices participate in all phases[6] of HREP implementation, both on and off refuge lands. The Service is also responsible for operation and maintenance of projects on lands it manages and for satisfying

[4] U.S. EPA, U.S. Department of Agriculture (NRCS), U.S. Department of Transportation (Maritime Administration).

[5] All program implementation responsibilities were transferred to the U.S. Army Corps of Engineers' Mississippi Valley Division from its former North Central Division as a result of the 1997 Corps of Engineers division restructuring action.

[6] Identification, planning, design, construction, monitoring, and evaluation.

requirements of the Fish and Wildlife Coordination Act with respect to all habitat projects.

Prior to 1993, the Service also had lead responsibility for implementing the LTRMP. That responsibility was assumed in 1993 by the National Biological Service, which was subsequently merged into the U.S. Geological Survey.

- ***U.S. Geological Survey.*** The U.S. Geological Survey (USGS) has managed and executed the LTRMP since October 1996. Funds are transferred from the Corps of Engineers to the USGS to support the LTRMP work carried out by the Environmental Management Technical Center (EMTC) and its six field stations.

LTRMP field station staff and remote sensing specialists from the U.S. Army Corps of Engineers Cold Regions Research Laboratory apply GPS technology to UMRS field data collection efforts.

- ***Other Federal Agencies.*** The Environmental Protection Agency, Natural Resources Conservation Service, and Maritime Administration serve as members of various interagency advisory bodies to the EMP.

- ***States.*** Each State conservation agency is actively involved in the identification, selection, planning, and design of habitat projects in its jurisdiction. Also, they often participate in the planning of projects in adjoining states. Each State funds 25% of the total costs of any project within its borders that is not on lands managed as a national refuge. Upon completion of construction, the respective State is responsible for 100% of the operation and maintenance of projects on lands that it manages.

In addition, the LTRMP field stations are staffed and operated by the States.

Funding

Section 1103 of the 1986 WRDA specifies annual authorized appropriations for each of the individual program components of the EMP. Annual authorized amounts for some of the individual components fluctuated in the first few years to accommodate what were anticipated to be variable start-up costs. However, annual authorizations (see Table 1-2) were fixed for the last 12 years of the program at $13 million for habitat projects, $6 million for long term resource monitoring, and $500,000 for recreation projects.

Congress appropriates funds for the EMP as a single line item (see Table 1-3). From the annual programmatic appropriation, sums are allocated for overall program management costs as well as the individual program elements. Table 1-4 summarizes how funds provided in the first 10 years of the EMP have been allocated among the program elements, including program management.

From the EMP's "pre-authorization" years through FY 1998, Congress has appropriated a total of $176,497,000 for the EMP, of which $160,614,000 has actually been allocated. Table 1-2 details the EMP's funding history.

TABLE 1-2: Annual Authorized Appropriations ($ Millions)

	FY 88	FY 89	FY 90	FY 91 - FY 02
Habitat Projects [1/]	8.2	12.4	13.0	13.0
Long Term Resource Monitoring	7.72	5.36	6.3	5.955
Recreation Projects	0.5	0.5	0.5	0.5
Economic Impacts of Recreation Study	0.3	0.3	0.15	0.0
Traffic Monitoring		("Sums as may be necessary")		
TOTAL	16.72	18.56	19.95	19.455

TABLE 1-3: Funding History ($1,000)

Fiscal Year	Authorization	President's Budget Request	Appropriation	Allocation
1985	---	---	Unspecified	30
1986 Early	---	---	Unspecified	814
1987 action	---	1,000	2,000	1,683
1988	16,720	4,168	5,168	5,911
1989	18,560	7,000	7,500	7,364
1990	19,950	14,860	14,860	15,334
1991	19,455	14,900	17,000	15,177
1992	19,455	19,455	19,455	13,672
1993	19,455	19,455	19,455	13,852
1994	19,455	19,455	19,455	20,501
1995	19,455	19,455	19,455	15,498
1996	19,455	19,455	19,455	17,842
1997	19,455	15,694	16,694	17,909
1998	19,455	14,000	16,000	15,027[a]
Total to Date	210,870	168,897	176,497	160,614

[a] As of 30 Nov 97.
Note: Annual allocations may vary from appropriated amounts as a result of savings and slippage, fiscal performance, and other factors.

TABLE 1-4: Actual Allocations ($1,000)

	Early Action													
	FY86[a]	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98[b]	Total
Habitat Projects	401	529	2,964	3,251	7,880	9,196	6,839	6,451	13,256	8,313	11,005	10,958	9,242	90,280
Long Term Resource Monitoring [1/]	110	734	2,316	3,264	6,327	4,662	5,170	5,946	5,955	5,955	5,955	5,912	5,038	57,344
Recreation Projects	9	0	0	0	0	0	0	0	0	0	0	0	0	9
Economic Impacts of Rec. Study	20	59	107	194	118	159	83	10	0	0	0	0	0	750
Traffic Monitoring	5	6	14	66	115	0	0	0	0	0	0	0	0	206
Report to Congress											327	346	100	773
Program Management	299	355	510	589	894	1,160	1,580	1,445	1,290	1,230	555	695	647	11,249
TOTAL	844	1,683	5,911	7,364	15,334	15,177	13,672	13,852	20,501	15,498	17,842	17,909	15,027	160,614

[a] Includes $30,000 from FY 1985 supplemental appropriations.
[b] Allocations as of 30 Nov 97.
1/ Includes amounts authorized and allocated for the Computerized Inventory and Analysis (CIA).

While the annual Federal EMP appropriations to the Corps of Engineers fund the largest portion of the costs of the program, that amount does not fully reflect the investment that has been made.

The U.S. Fish and Wildlife Service accomplishes its EMP-related roles and responsibilities with its own funding and staff. In addition, the Service is responsible for the costs of operating and maintaining EMP habitat projects on lands that it manages.[7] Through FY 1997, the U.S. Fish and Wildlife Service has expended approximately $1,030,000 on EMP coordination and projects.

State Cost-Shared Habitat Rehabilitation and Enhancement Project (Peoria Lake, Woodford State Fish and Wildlife Area, Woodford County, Illinois).

The five basin states have also made substantial investments in the EMP. In the first 12 years of the EMP, the States have spent $10,522,093 in support of the program. Of this amount, $1,430,093 has been expended to meet the 25% non-Federal cost-share for habitat projects on non-refuge lands in Illinois, Iowa, and Wisconsin.[8] The States have spent approximately $137,000 to operate and maintain projects on lands they manage. The remaining $8,955,000 has supported State involvement in planning, coordinating, and implementing all components of the EMP.

The vast majority of EMP resources have been and will continue to be devoted to the construction of HREPs and the accomplishment of the LTRMP. The report chapters that follow are dedicated to the evaluation of these two program elements, the evaluation of future alternatives, and presentation of conclusions and recommendations.

[7] In the past, the Corps provided up to $200,000 annually to the Regional USFWS office to support certain programmatic activities, primarily HREP coordination. The FY 95 House of Representatives Report directed the Corps of Engineers to terminate provision of these funds beginning in FY 96. Funds are still transferred to USFWS environmental services offices for accomplishment of HREP Coordination Act Report (CAR) requirements.

[8] See Appendix B, HREP, Section B.2, HREP database for information as to habitat projects where a non-Federal cost-sharing requirement has been met and the specific cost-sharing amounts provided.

The Ecological State of the UMRS 2

INTRODUCTION

The purpose of this chapter is to describe the ecological state of the UMRS.[1] In the context of the EMP, this description is necessary to evaluate the current program's monitoring, research, and habitat restoration activities, as well as the identification of future system needs. From a broader perspective, an assessment of the UMR ecosystem should inform the river community, in a scientifically objective and responsible way, about the system's condition.

Describing the river's ecological status requires a scientific understanding of how the river should function as an ecosystem and as a part of its basin. This understanding helps to select a working set of ecosystem features or criteria that function like "subjects" on a student's report card.

The process requires consistent observations of the river's habitats and species, how they vary over time, and how they are impacted by natural processes and human activity. The following description is heavily dependent on results of the LTRMP, although other relevant data also have been used in its development.

The river reaches of the UMRS and their basins have been extensively altered by human use (Yin *et al*., 1997; Nelson *et al*., 1994; Yin and Nelson, 1996). As a result, none of the reaches support the same species or habitats, in the same proportions that they did in their natural state (Theiling, 1996; Duyvejonck, 1996). Defining the status or "health" of such altered systems is made more difficult by the fact that different river users value different ecosystem related conditions.

[1] Due to its significantly modified condition, the highly urbanized upper reach of the Illinois River is not considered in the context of this report chapter.

At least one of the major alterations, impoundment for navigation, increased aquatic habitats and habitat diversity that were and still are considered from certain perspectives to be beneficial. In the eyes of many river users, the first few decades after impoundment represented an optimal river state that now should be used as a gage against which to measure river health. Altered geomorphic conditions resulting from impoundment, however, prevent this "optimal river state" from being maintained.

Much of the upper impounded river reach of the Mississippi River still retains many important river species and habitats and, for the time being, is considered to be ecologically healthy. However, conditions at even the most healthy sites within the UMRS are at least partially artificial, non-sustainable, and in a recognized state of degradation. Continued and progressively increasing human energy and resources will be needed to maintain current or restore past levels of ecological health to "acceptable" levels. Ultimately, the river community collectively defines what an acceptable level of ecological health is, relative to the commercial, recreational, and cultural river uses that the community also values.

RIVER REACHES OF THE UMRS

The Illinois River and Upper Mississippi River make up about 94% (by linear mile) of the UMRS.[2] We refer to separate reaches of the rivers because of their distinctive floodplain structures and because the ecological health of each reach has been impacted differently by human activities. One defining river modification, alignment and maintenance of the navigation channel, has been uniform along the entire length of the Illinois and Upper Mississippi Rivers. The fluvial dynamics once responsible for channel migration across the floodplain, for alternating terrestrial and aquatic phases on the floodplain surface, and for sustaining a diverse array of aquatic habitat types and alluvial forest successional stages have been largely arrested along the entire length of the two rivers. Three reaches of the UMR and the Lower Reach of the Illinois will be the focus of this chapter (Figure 2-1).

The Upper Impounded Reach of the UMR extends from Minneapolis, Minnesota, through Pool 13 at Clinton, Iowa. It is characterized by a narrow floodplain terminating at steep bluffs. Variable floodplain topography created by hydraulic, glacial, and geologic processes, combined with seasonal flooding and dam impacts, create many off-channel permanent and ephemeral aquatic habitats. A unique feature of this reach is that approximately 50% of the floodplain environment is contained within the Upper Mississippi River National Wildlife and Fish Refuge. Land-cover analyses (Laustrup and Lowenberg, 1994) indicate this reach supports higher proportions of non-channel aquatic and marsh area and lower proportions of agriculture and channel area than the two lower reaches. Less than 3% of the floodplain has been isolated by levees.

The Lower Impounded Reach of the UMR lies between Clinton, Iowa, and Pool 26 at Alton, Illinois. Between Clarksville, Missouri, and Alton, Illinois, the average width of the valley floor is 5.6 miles with an average slope of 0.5 foot/mile. Floodplain land use is diverse, including urban areas, conservation lands, and agricultural fields that are protected from moderate floods by levees. Smaller percentages of marsh and backwater habitats occur in this reach. Fifty-three percent of the floodplain has been isolated by levees.

The Unimpounded Reach of the UMR between St. Louis and the river's confluence with the Ohio is structurally different from the upper reaches as a result of both natural and human activities. Missouri River flows have historically contributed significant water and sediment inputs that, before levee construction, sculpted a more dynamic floodplain physiography. In this reach, except for Lock and Dam 27 which includes a diversion canal and a submerged rock weir

[2] See Attachment 1, Water Resources Development Act of 1986, Section 1103(b)(1) for the definition of the UMRS.

at the Chain-of-Rocks Rapids, the 9-foot navigation channel is maintained entirely with channel training structures, side channel closures, and dredging. Much of this reach is isolated (82%) from the river by agricultural levees. Unlike upstream reaches, there is virtually no land contained in the National Refuge System in the Unimpounded Reach.

The Illinois River can also be divided into floodplain reaches based on geomorphic and ecological criteria. The Upper Illinois Reach lies above Starved Rock Lock and Dam. This reach has a steep gradient, narrow floodplain, and is mostly urbanized. It has been greatly impacted by industrial and municipal pollution following the diversion of water from Lake Michigan. Opportunities for habitat rehabilitation along this reach are limited.

The Lower Illinois River reach extends downstream from Starved Rock Lock and Dam to its confluence with the Mississippi River. The Lower Reach is more characteristic of floodplain ecosystems in both form and function than is the Upper reach. The Lower Illinois has a shallow gradient and a wide floodplain. Before recent glacial processes changed the course of the Mississippi River, the Lower Reach of the Illinois River carried the flow of the Mississippi River. Over 60% of the floodplain has been isolated behind levees.

WHAT IS RIVER ECOLOGICAL HEALTH?

Scientists have only recently begun to bridge the gap between the concept of ecosystem "health" and its application to practical natural resource management. Three general ecosystem features, or criteria, have most commonly been recognized for their value in characterizing ecosystem health (Cairns, 1977; Rapport, 1989; Grumbine 1994):

1. The presence of habitats and viable, native animal and plant populations that the ecosystem, if undisturbed, would support;

2. The ability of the ecosystem to return to its pre-existing condition after a disturbance (whether natural or human-induced); and

3. The ability of the ecosystem to sustain itself.

A meaningful discussion of ecological integrity or "health" must be tempered by the realization that the concept does not exist outside of human value judgment. Measurements of integrity or health by scientific means are therefore limited to criteria that are subjectively selected (Serafin and Steedman, 1991). Unique features and processes of floodplain river ecosystems can also be used as criteria for evaluating the health of the UMRS reaches. The following reach-specific ecosystem health criteria were synthesized by a team of river scientists at an LTRMP-sponsored international conference on river ecology in 1994:

4. The reach's capacity to function as part of a healthy basin;

5. The degree to which the annual flood pulse "connects" the main channel to its floodplain; and

6. The ability of infrequent natural events (floods and droughts) to maintain ecological structure and processes within the reach.

The sixth criterion may seem to be at odds with the second. The second refers to an innate ability of a healthy ecosystem to adjust to external factors without permanently changing its overall character. The sixth refers to the presence of infrequent but important external factors that help structure an ecosystem's character over a long period of time. This criterion is less related to the ecosystem *per se* than it is to the external factors that affect the ecosystem.

RIVER REACH ECOLOGICAL HEALTH

This section synthesizes ecological status and trend information from the UMRS according to the six criteria listed above. By far the greatest amount of available information relates to the first criterion, presence of native species and habitats.

Criterion 1. The presence of habitats and viable, native animal and plant populations that the ecosystem, if undisturbed, would support.

Habitats

The development of the commercial navigation system and the construction of agricultural levees represent two river and floodplain modifications that have extensively altered aquatic and terrestrial floodplain habitats within the UMRS. These activities have had varying impacts among the different river reaches.

- **Navigation Channel Training Structures and Impoundments.** Prior to engineering improvements, the floodplains of the UMR were dominated by terrestrial habitats, primarily bottomland forests intersected with braided channels (Figure 2-7). Channel training structures built to create and maintain the 4.5-foot (in 1878) and the 6-foot (in 1907) navigation channel, while not changing the position of the main channel (Chen and Simons, 1986), reduced the river's ability to reshape itself, a dynamic process that, in part, kept its bottomland forests in early successional stages. Closing structures in the Unimpounded Reach of the UMR have substantially reduced available side channel habitat which, while still providing most of the off-channel habitat, now represents less than 5% of the total aquatic area (Figure 2-8).

After the navigation dams were built, low-lying floodplain areas were permanently inundated (Figure 2-2). Floodplains in the lower reaches of the pools were transformed to wide, open water areas in which higher points of land remained as islands. The middle sections of the pools were not as deeply flooded. Old channels and floodplain depressions were flooded to form networks of interconnected side channels and backwaters. Depth diversity resulted in the formation of wetland communities that range from deep water to emergent marsh and floodplain forest communities.

Impoundment initially resulted in an increase in aquatic productivity and species diversity. Aquatic plant species and backwater fisheries flourished. In much of the Upper Impounded Reach of the UMR, these conditions still persist and are indicators of ecological health. However, long term, persistent river forces are changing these conditions.

Two of the most important structural indicators of what is referred to as the "aging pool" response are sedimentation and island loss. Impounded areas and backwaters contiguous with the river have been subject to the effects of impoundment and sedimentation. Physical consequences of these processes include the loss of water depth, island surface area, sediment quality, and bathymetric diversity (Figure 2-3).

Additional studies have suggested that sedimentation rates are lower now than they were immediately after impoundment. The process of sedimentation will continue in impounded areas until they reach a state of sediment equilibrium. As a result of sedimentation analyses, the life spans of many backwaters, critical to the productivity and diversity of the post-impoundment UMRS floodplain ecosystems, have been estimated at less than 100-200 years (Belrose *et al*., 1983; Chen and Simons, 1986).

Post-impoundment river forces have impacted terrestrial habitats within the floodplain. Many islands were created by impoundment, especially in the Upper Impounded Reach of the UMR. Over time, these islands have eroded away. For instance, 624 acres of islands existed in the middle section of Pool 8 in 1939, two years after impoundment. In 1995, only 129 acres remained (Figure 2-3). Such island loss impacts hydrological patterns within the pool, allows wind to resuspend bottom

sediments, and reduces the diversity of habitats available for a variety of wildlife species.

In the Unimpounded Reach of the UMR, the required navigation channel depth has been maintained by dredging and the construction of wing dams that have reduced flows into side channels. The latter was accomplished by constructing closing dams across 23 side channels. An example of the long term habitat change associated with one of these closures is shown in Figure 2-4 **.**

▪ **Levee Construction and Ecological Consequences.** Levee construction began in the UMRS in the late 1800s, first by individual farmers, cooperative levee districts, and local governments. Federal levee construction began on a large scale after World War II. Now, approximately 530,000 acres (53% of the total floodplain) in the lower impounded reach and 543,000 acres (82% of total floodplain) in the Unimpounded Reach of the UMR are located behind the levees. Figure 2-5 provides an example of long term land cover change associated with floodplain agricultural development in the Unimpounded Reach of the UMR. Levee construction along the Lower Illinois River reach sequestered more than 61% (334,000 acres) of the floodplain (Laustrup and Lowenberg, 1994; Figure 2-6).

Agriculture use of the floodplain reduces available bottomland forest and wet meadow habitat; and the levees effectively reduce the flow cross-sectional area (i.e., width of a river reach's flood zone), thereby increasing the heights of flood stages.

▪ **Water and Sediment Quality.** Physical and chemical conditions of UMRS water are generally good now, but there have been periods in which the rivers, especially the Illinois River, were severely degraded by municipal and industrial waste. Recognition of the pollution problem and risk to human health led to interventions by local governments in the early 1900s which continue today under Federal guidelines. Gross pollution by domestic organic waste has been almost entirely eliminated since passage of the Federal Water Pollution Control Act of 1972[3] that limited the quantity or concentration of all sewage effluent discharges. However, the rivers continue to receive a host of agricultural, industrial, and municipal contaminants that threaten their biota.

Concentrations of toxic heavy metals dissolved in river water are well below U.S. EPA guidelines for human consumption and aquatic life (Garbarino *et al.*, 1995). However, concentrations in suspended and deposited sediments often exceed pollution guidelines, and contaminants accumulated in the river's sediments will be a potential problem for decades. Lake Pepin, a natural river lake impounded by alluvial deposits from the Chippewa River, traps sediment, contaminants, and nutrients, and thus reduces the downstream levels of pollutants such as polychlorinated biphenyls, or PCBs, and cadmium. It appears that rates of deposition of toxic metals (e.g., cadmium) to lower Lake Pepin have not diminished. The fine-grained sediments deposited during the past century in Lake Pepin, and presumably into other depositional sites nearer the Twin Cities, are a reservoir of potentially toxic metals, posing a continuing hazard to riverine biota. In the Illinois River, there is evidence that some of the more toxic sediments deposited in the past are being buried by cleaner sediments deposited more recently (Sparks, 1984).

Nutrient enrichment of the river results from soil and fertilizer runoff and sewage discharge. Moderate levels of nutrients are required for normal system function, but excessive levels can be detrimental. For example, high levels of nitrate can be toxic to humans, and ammonia from the decomposition of organic waste can be hazardous to aquatic biota. High ammonia concentrations have been implicated in the loss of most of the benthic community in upper and middle reaches of the Illinois River during the 1950s (Sparks, 1984). Nutrients exported to the Gulf of Mexico are also considered a likely causal factor contributing to the Hypoxic Zone in the Gulf of Mexico. Prudent agricultural practices have reduced the use of fertilizer and

[3] This statute is also referred to as the Clean Water Act.

pesticides in recent years, but it is unknown if these reductions will have a widespread or lasting effect on the water quality of the UMRS.

Native Plant and Animal Species

▪ **Submersed Aquatic Vascular Plants (SAV).** Before the lock and dam system was built, submersed aquatic vegetation (SAV) was present in the UMR, but not greatly abundant (Green, 1960). SAV was never very common in the Open River reach. Because of its lower gradient and more numerous backwaters, the Lower Reach of the Illinois River supported an abundance of SAV. SAV is an important indicator of the health of the now impounded river reaches of the UMRS because it provides food and structure for invertebrates, fish and waterfowl. Its presence suggests that physical conditions have not declined past viable ecological levels.

Pollution and sediment-related factors caused a dramatic decline in SAV in the Lower Reach of the Illinois River during the mid-1950s. Subsequent impacts to the river's fish and waterfowl have been extensively reported. SAV on the Lower Illinois River is currently restricted to isolated waterfowl management areas, but it is now common in the upper reach.

In the late 1980s, declines in the abundance of SAV were observed in the Upper Impounded Reach of the Mississippi River (Rogers *et al.*, 1995). The observations, supported by Landsat images[4] consistently suggested that the declines occurred primarily during a drought period between 1987 and 1989. The great Midwestern flood of 1993 also triggered declines in SAV. However, SAV in the Upper Impounded Reach is slowly recovering from both the drought and the flood.

There is little quantifiable information on aquatic plant communities south of Pool 19, but anecdotal information suggests that plants were initially abundant in shallow lakes created by the dams. Through time, sediment accumulation, reduced water clarity, and greater water level fluctuations led to reduced plant abundance in most pools in the Lower Impounded Reach of the Mississippi River. Currently, SAV is not abundant in aquatic areas connected to the river in this reach, but sometimes flourishes in isolated backwaters managed as waterfowl refuges and hunting areas.

▪ **Forests.** Modern UMRS forests represent only a small portion of the presettlement floodplain forests. For example, floodplain forests covered 56% of the landscape at the confluence of the Illinois and Mississippi Rivers in 1817 but they were reduced to 35% of the landscape by 1975 (Nelson *et al.*, 1994). Floodplain forests covered 71.4% of the landscape in a 102-km stretch in the Unimpounded Reach of the Mississippi in 1809, but their cover was reduced to 18.3% of the landscape by 1989 (Yin *et al.*, 1997). Mast producing oaks, hickories, beech, and walnuts have been drastically reduced in much of the Lower Impounded Reach and the Lower Reach of the Illinois River, and these species have virtually disappeared from the unleveed portions of the Unimpounded Reach of the UMRS. Land clearing for agriculture, steamboat fuel wood cutting, and lumber production was responsible for most of the changes to the forests, although modified hydrology may also be impacting forest community structure and species composition.

Large portions of the floodplain forests in the UMRS, especially in the lower impounded and unimpounded reaches, were impacted by the major disturbance caused by the flood of 1993. Floodplain forests are capable of enduring brief inundation; however, prolonged inundation during the growing season can be deadly to many tree species. Although the flood only slightly affected the floodplain forests above Pool 13, its impact increased sharply in the downstream reaches. In Pool 26, 37.2% of

[4] Landsat is a satellite-based, passive remote sensing system that provides medium resolution land use/land cover information.

the trees 10 cm or greater in diameter and 80% of the trees between 2.2 and 9.9 cm in diameter were killed. Mortality rates were positively correlated with flood duration and negatively correlated with the diameter of the trees. Hackberry and pin oak were two of the most severely impacted species (Yin *et al*., 1994).

▪ **Macroinvertebrates.** Fingernail clams and mayflies are important food sources for many species of waterfowl and fishes. They are widely distributed throughout the UMRS. Shifts in diving duck migration patterns and fish condition (Sparks, 1984) have been linked to the decline of fingernail clams and mayflies along the middle and lower reaches of the Illinois River in the 1950s.

Fingernail clam collections in the Impounded Reaches of the UMR have produced mixed results. In Mississippi River Pool 19, population densities of fingernail clams exceeding 100,000/m^2 were observed in the late 1960s. Their numbers gradually declined until none were found in the early 1990s. However, the Pool 19 population appears to have fluctuated with flood and drought years, and the community has recovered since the flood of 1993. Several site-specific studies conducted in Mississippi River Pools 2-9 documented declines in fingernail clam populations. A variety of potential causes was investigated, but the decline was ultimately attributed to pollution from the Twin Cities. Metal contaminated sediments and ammonia were suspected causal agents. A different study in Pool 9 found substantial population increases and densities more typical of the mid-1970s.

LTRMP data collected between 1992 and 1995 revealed patchy distributions of fingernail clams. Pool 13, the lowermost pool in the Upper Impounded Reach, has consistently supported the highest densities of fingernail clams among the six LTRMP trend analysis reaches. The LTRMP data suggest that low densities of fingernail clams are common in the river, and that high densities are rare. Non-channel (primarily impounded) habitats typically support higher densities of fingernail clams than channels. These spatial patterns may explain, in part, some of the mixed results of previous studies.

Mayflies are subject to many of the same perturbations as fingernail clams. Among the LTRMP trend analysis areas, they presently occur in the greatest abundance in Pools 4, 8, and 13. In Pool 19, the population appears stable since 1984 after increasing from lower earlier levels. In the Pool 2 to 4 reach, mayflies were eradicated between 1957 and 1976 due to pollution from the Twin Cities. Sampling conducted in 1986 and observations of mass emergences revealed a strong recovery in response to improved sewage treatment. This recovery has been faster than that of fingernail clams, possibly because mayflies filter more surface water while fingernail clams filter more heavily contaminated sediment pore water (Wilson *et al.,* 1995).

▪ **Fishes.** Long Term Resource Monitoring Program standardized monitoring has documented the existence of 127 fish species in the UMRS during its first five years. River wide, there is no evidence that the number of fish species has declined since the construction of the locks and dams. Fish species richness tends to be greater in the northern reaches of the UMR than in the more southerly reaches. The greater physical complexity of the northern-most reaches may explain their higher species richness.

Dam 19 blocks fish migrations because it is a high head dam of 38 feet and its main purpose is hydropower. However, this effect was at least temporarily reduced during the flood of 1993. The other dams are low head and their main purpose is navigation. Although these dams restrict upriver fish movements, they do not completely block it. For example, skipjack herring returned to the uppermost pools of the Mississippi River during the flood. The migration blocking effect of the dam therefore is not permanent. Species can recolonize upstream reaches given the appropriate opportunity.

Many fish species of the UMRS, like black basses, crappies and sunfishes, are ecologically and economically important and generally known to be dependent on healthy

backwaters. Backwaters provide suitable conditions for aquatic vegetation, and thus refuge from predation for these species and substrates for invertebrate food sources. Backwaters also provide spawning areas and refuges necessary for overwinter survival.

Local variables have traditionally made it difficult to quantify the relationship between habitat and fish community structure. Centrarchids (bluegills, sunfishes, crappies, etc.) exemplify backwater species. Differences in their abundance among the six LTRMP study reaches are now beginning to reveal "how much habitat is enough." Centrarchid relative abundance in the open river study reach is typically less than one-third of its value in other study reaches. These results suggest that the abundance of centrarchids in some areas of the UMR may presently be limited by the availability of suitable backwater habitat. They also provide initial estimates of how much backwater habitat may be needed in a given reach to achieve target management levels.

- **Mussels.** Under natural conditions, the river reaches of the UMRS supported one of the most diverse and abundant mussel faunas of the world. Consistent, long term mussel monitoring has not been conducted within the UMRS, but multiple study results from a variety of sites indicate that the number of mussels species has declined from 48 to 37 (a 23% decline), and from 45 to 25 (a 44% decline) in the Upper Mississippi and Illinois Rivers, respectively. Starrett (1971) documented widespread declines in both species and their abundance on the Illinois River. These declines have been variously attributed to high substrate ammonia concentrations, sedimentation, impoundment, and commercial navigation. Fuller (1974) attributed many of the effects of impoundment on UMR mussels to alterations in fish faunas that follow impoundment, further underscoring the interaction between native mussel reproduction and human alterations of habitat. Tucker *et al*. (1996) suggested that impoundment of backwaters reduced mussel diversity by interfering with energy transfer from the river to the backwater.

Mussel diversity consists of two components. The first is the actual number of native mussel species that occur in an area such as the UMRS (species richness). The second and equally important factor is the relative abundance of each native mussel species (species evenness). Maximum mussel diversity results when many native mussel species that are all fairly abundant occur in a particular region. This is important because changes in mussel diversity in native mussel faunas of the UMRS are only in part due to loss of species richness. Other species have become rare though they still occur at reduced population levels. Hornbach *et al*. (1992) compared surveys from 1930 and 1977 to those they conducted. They found three fewer species than the 36 species that had been previously reported. However, they found a significant increase in the abundance of the threeridge mussel (a species tolerant of impounded conditions) with a concomitant decrease in abundance of other species less tolerant of the habitat conditions created by dam construction.

The introduction of the exotic zebra mussel significantly complicates conservation of mussel faunas in the UMRS. Zebra mussels can form dense aggregations on native mussels. These aggregations lead to decreased native mussel density and have even been blamed for the complete extirpation of native mussel faunas in some portions of the Great Lakes. Initial surveys in Pool 26 suggest that the absolute number of native mussels decreases where zebra mussels become and remain abundant. At one location in Pool 26, the mussel fauna contained 18 species with three co-dominant species and a density of 18.6 mussels per square meter in 1993 (Tucker, 1994). However, one year later, a survey at this same site which was heavily colonized by zebra mussels, found 10 species, and densities were reduced to 6.6 mussels per square meter.

- **Birds.** The ecological value of the Mississippi and Illinois Rivers as migration

corridors for waterfowl has historically been great. On Pool 19, fall waterfowl censuses during 1948-1984 made by the Illinois Natural History Survey revealed a yearly mean peak of 345,000 diving ducks. A maximum of 875,000 divers was reported for Pool 19 in 1969. The percent composition of peak numbers was lesser scaup 71%; canvasback 18%; and ring-necked ducks 10%. Peak population counts of these three species on Pool 19 have been much lower during the past 10 years (S. Havera and M. Georgi, Illinois Natural History Survey, unpubl. data). During the 1978-1994 period, a peak of 195,000 canvasbacks was observed on Pools 7, 8, and 9 (C. E. Korschgen *et al*., 1989 and unpubl. data); significant numbers of ring-necked ducks and lesser scaup used these pools during this time period.

Waterfowl use of the Illinois River has declined dramatically (Mills *et al.*, 1966; Havera and Bellrose, 1985). Dabbling duck populations have declined steadily since the late 1940s, when annual fall surveys indicated that peak mallard numbers during the fall migration exceeded 1.5 million birds on the Illinois River alone. Environmental degradation and subsequent loss of food resources on the Illinois River caused a shift in migration routes of both dabblers and divers from the Illinois River to the central portion of the Upper Mississippi River (Pools 19-26). The populations converged after 1960 due to increased use of Mississippi River habitats and declining use of Illinois River habitats. Today, the combined populations barely exceed 500,000 birds, a full two-thirds reduction from pre-1950 counts from the Illinois River alone.

Bald eagle numbers began to decline nation-wide due to loss of prey and habitat prior to 1940, when the Bald Eagle Protection Act was passed (USFWS, 1996). While they were in a recovery stage, the use of DDT as an insecticide expanded. Its breakdown product (DDE) caused reproductive failure in bald eagles and other predatory birds. After DDT was banned in 1973, eagle populations began to recover (USFWS, 1996). Numbers of breeding bald eagles along the UMR have increased from 2 to 5 pairs in the 1970s to 43 to 44 pairs in 1993 and 1994.

Populations of great blue heron, great egret, and double-crested cormorant appear to have declined in the Upper Impounded Reach of the UMR (Graber *et al*., 1978; Thompson, 1977 and 1978; Upper Mississippi River National Wildlife and Fish Refuge, unpublished data; Kirsch in review). The Illinois Department of Natural Resources aerial surveys of Illinois rookeries since 1983 revealed a substantial increase in the number of active heron nests on the Mississippi River bordering Illinois, from 2,111 nests in 21 colonies in 1987 to 5,045 nests in 20 colonies in 1991. Active egret nests also increased, from 351 nests in 14 colonies in 1987 to 1,099 nests in 18 colonies in 1991. Ground surveys of colonies in Pool 26 indicated that both species occur mostly in tall cottonwood and sycamore trees on islands (Browning-Hayden *et al*., 1994). They select live trees and thus may have been impacted by tree mortality resulting from the flood in 1993. Colonies in the Upper Mississippi River National Wildlife and Fish Refuge have decreased from 31 in 1977 to 18 in 1992.

Double-crested cormorants were common breeders and abundant migrants on the UMR from St. Paul, Minnesota, to St. Louis, Missouri, during the 1940s and 1950s. Their numbers declined from about 40,000 in the 1940s to almost none in the 1960s and 1970s due to effects of contaminants and human disturbance on productivity. Populations have been increasing within the last decade. Populations of endangered least terns, which occur on the lower portion of the Mississippi River, appear to be increasing (Rumancik, 1985-1995).

Swan use on the UMR has increased in recent years, principally on Pools 7, 8, and 9 where counts during 1992-1993 were an order of magnitude higher than those observed in the early 1980s.

Criterion 2. The ability of the ecosystem to return to its pre-existing condition after a disturbance (whether natural or human-induced).

Although it is not yet possible to directly measure or model the ability of an ecosystem to return to its pre-existing condition after a disturbance, we can evaluate recent events on the UMRS and retroactively observe how the river reaches have responded.

The Lower Reach of the Illinois River has yet to recover from the combination of factors that caused widespread declines in its aquatic plant and invertebrate communities. This observation is a clear indication that these reaches are ecologically unhealthy.

In the Upper Impounded Reach of UMR, aquatic plants have recently shown the capacity to recover from both a drought and a flood. Mayflies have recovered from earlier declines that were related to pollution from the Twin Cities. Both observations suggest that this river reach meets this criterion of health.

The trends of succession before and after the 1993 flood indicate different futures for early-successional willow and cottonwood communities in the impounded and unimpounded reaches. Willow and cottonwood seedlings abundantly occurred after the flood in the open river reach. Patches of willow and cottonwood seedlings are colonizing the openings created by the flood and show rapid growth. In response to the flood disturbance in 1993, the aerial extent of willow and cottonwood communities is not expected to decrease in the next 50 years in the unimpounded river reach. The observations suggest that this component of the unimpounded reach ecosystem has shown the healthy ability to recover after a disturbance.

In contrast, in the Lower Impounded Reach where water levels are regulated by navigation dams, the 1993 flood did not change the trend of a willow and cottonwood decline, because willow and cottonwood did not regenerate vigorously in the aftermath of the flood. It is unclear why willow and cottonwood regenerated well in the Unimpounded Reach of the Mississippi River, but poorly in Pool 26, despite the fact that both reaches were equally disturbed by the flood. It is clear, however, that willow and cottonwood in the impounded reaches will continue an unhealthy decline in the future unless other management actions are taken.

Criterion 3. The ability of the ecosystem to sustain itself.

Two important long term trends within the reaches of the UMRS suggest that current conditions are non-sustainable. These trends relate to the pool aging and sedimentation processes that are occurring within impounded reaches, and changes in river discharges and elevations in the Unimpounded Reach of the UMR.

- **Pool Aging and Sedimentation.** Sedimentation is one of the most critical resource problems affecting impounded areas within the UMRS. As the navigation pools age, sedimentation will continue to degrade the quantity and quality of non-channel aquatic habitats. Sediments originating from both basin and floodplain sources settle in the deepest portions of the off-channel impounded river first (Bellrose *et al.*, 1983; Robert Gaugush, USGS-BRD, personal communication). The result will be a transformation of the diverse impounded aquatic habitats toward pre-impoundment geometry, which was primarily channel habitat.

Studies indicate sediment accumulation in aquatic areas is probably slower now than it was in the earlier years following dam construction. This pattern is consistent with other perturbed systems; change is greatest following the initial disturbance (i.e., impoundment) and tapers off as a new equilibrium is approached.

The rate of sediment delivery from the basin and erosion of floodplain soils will affect the time it takes to achieve equilibrium. A complicating factor is the considerable amount of sediment stored in tributary streams. DeMissie, *et al*. (1993) predicted that it would take more than 100 years for sediments in Illinois River

tributaries to be flushed if all basin runoff were eliminated. Stored sediments may also be delivered at different rates than sediments associated with runoff. Sediments stored in tributary valleys may mobilize more slowly to the main stem rivers of the UMRS and may be deposited in different spatial patterns than sediment originating in upland areas of the basin. Improvements to land-use practices and reduced soil erosion rates will likely slow the pool aging process, but the impacts of these measures will be dependent on climate and runoff patterns.

Anticipated ecological responses to pool aging include poorer water quality (i.e., more frequent dissolved oxygen problems, higher turbidity levels), poorer substrate quality, reductions of submerged aquatic plants and benthic invertebrates, shifts in fish communities to less desirable species, and fewer areas that are able to support migratory waterfowl.

Some of these responses have already been observed on the Lower Reach of the Illinois River (Starrett, 1972; Sparks, 1984; Sparks *et al.*, 1990). However, the Illinois River has been subjected to a much higher level of municipal and industrial pollution and greater loads of sediment runoff than the reaches of the UMR and, therefore, comparisons between the two rivers, especially rates of expected change, should be made cautiously.

There appear to be certain thresholds of environmental conditions that determine biotic community development in the UMRS. Changes were rapid on the Illinois River in the mid-1950s. Because many of the pools of the UMR receive less sediment and other pollutants than those of the middle and lower Illinois River, future changes on the UMR may well be more gradual than those observed on the Illinois River.

Perhaps the most important point to be made about the navigation pools is that they are still responding to the effects of impoundment and are changing toward a less diverse mix of habitats that will resemble pre-impoundment conditions. In order to maintain the ecosystem quality that currently exists in the navigation pools, or to reduce its rate of decline, active management, such as habitat restoration, is necessary.

▪ **Discharge and Elevation in the Unimpounded Reach of the UMR.** Water surface elevation and discharge data, measured daily, are available for over 130 years at St. Louis, Missouri, and for over 60 years at Chester and Thebes, Illinois. Analyses of data from these three stations show a disturbing trend. At equivalent low discharges, water surface elevations are now lower than they were in the past. At equivalent high discharges, water surface elevations are now significantly higher than they were in the past. Thus, at low river discharges, habitats that were previously aquatic are now significantly dried, while at high discharges greater land areas that previously would have been dry are now inundated during floods.

The number of days an area is above flood stage is also increasing. Water levels were above flood stage for 217 days in a 38-year period from 1880 to 1917 at St. Louis. That figure rose to 312 days for the 38 years between 1918 and 1955, and to 485 days for the 38 years between 1956 and 1993. Without the influence of the Missouri River, the change is even more significant. In Pool 24, the number of days above flood stage for the same three periods was 295, 470, and 1,166, respectively.

The annual flood is one of the most important factors that controls a river reach's annual productivity. Many river animals and plants are well adapted to floods and readily occupy and use flood zones to reproduce, feed, and grow. However, if flood waters rise or fall too rapidly, or the flood zone shifts too much from one year to the next, much of the ecological value associated with a flood is lost.

Criterion 4. The reach's capacity to function as part of a healthy basin.

From an ecological basin perspective, rivers provide several functions. They carry surface water and materials out of the basin and are therefore vital elements of continental water and nutrient cycles. Floodplains, when

connected to their river channels, provide opportunities for nutrients and organic material to be recycled and used to the greatest extent possible. Because of its position in the basin, the ecological state of a river is also dependent on the health of the basin itself.

Basin land cover and use control a variety of physical and biological conditions within the UMRS. They affect the distribution and rate of snow melt and rainwater runoff and therefore the delivery of materials (sediments, nutrients, and contaminants) to the floodplain river reaches. Before European colonization, the stream network delivered these materials to the rivers at rates to which river plant and animal populations were adapted. The materials originated in undisturbed sub-basins with riparian forests, prairies, and wetlands that stored water during wet periods and slowly released it during dry periods (Figure 2-6). High and low flows were additionally buffered by the storage capacities of the stream network.

Today, much of the UMRS basin landscape is dominated by agricultural practices, especially corn and soybean production (Figure 2-7). These landscapes typically release greater amounts of sediments, nutrients and contaminants, and concentrate flows in both space and time (DeMissie and Kahn, 1993, Hey and Philippi, 1995) because modern urban and rural drainage networks deliver runoff to the rivers more quickly, with greater velocity, and at higher stages than in the past (Belt, 1975; Bellrose *et al*., 1983; LTRMP data [see previous section]). Agricultural and urban land uses also generate a variety of contaminants not present in the past. Fertilizers and herbicides can be delivered in concentrated pulses if application occurs just before a heavy rainfall.

A unique, basin-scale feature of the UMRS, its interbasin connection with the Great Lakes through the Illinois Waterway, has exposed the stream network to exotic, and potential nuisance, species. Zebra mussels, the European Ruffe, and the Round Goby are recent examples.

Another unique basin-scale feature of the UMRS is the influence of the Missouri River on the Unimpounded Reach. Regulation of water levels in large impoundments of the Missouri River for flood control and recreation has altered the natural hydrograph downstream. The impoundments also trap sediments, and have been implicated in the reduction of coastal wetlands at the mouth of the Mississippi River.

The above observations indicate that the ecological health of the UMRS reaches has been constrained by declines in the more general health of their basins. Further, their ability to perform basin-level ecological functions, such as the floodplain processing of nutrients or the transport of sediment loads, has been also been altered.

Criterion 5. The degree to which the annual flood pulse "connects" the main channel to its floodplain.

Under natural conditions, spring high flows resulting from snow melt and rainfall within the UMRS basin would overflow UMRS channels and inundate low areas of the floodplain. From year to year, the size and duration of the inundated area, or flood zone, would vary depending on the magnitude and length of the flood.

A growing body of ecological information has recently indicated how important the extent and annual duration of the flood zone inundation is to river species and several important ecological processes. The successful spawning of many fish species and annual recruitment, nutrient recycling, and emergent plant growth and distribution are all intimately dependent on the timing, duration, and extent of the annual flood pulse.

The construction of navigation dams and levees and subsequent reductions in the size of the potential flood zones of the UMRS are among the most significant human-induced changes. Dams permanently flooded areas that previously drained and became exposed during a considerable portion of the annual discharge cycle, whereas levees have effectively eliminated a

large portion of the floodplain from high water inundation.

LTRMP spatial analyses in Pools 8 and 25 and the Unimpounded Reach of the UMR documented how these alterations have changed the extent of the flood zone. The areal extent of the flood zone, both as it is now and as it would be if the dams and levees were not present, was calculated for the 50-year average high and low flow for each of seven different locations. The areal extent of the flood zone in Pool 8 has decreased due to the impounding action of the dam, which keeps much of the pre-existing flood zone permanently inundated. In Pool 25, changes were attributable to the combined presence of levees and the navigation dam, with levees restricting high flows and the dam impounding low flows. The smaller flood zone in the Open River is attributable to the presence of levees that prevent flood water from reaching the floodplain.

Criterion 6. The ability of infrequent natural events (floods and droughts) to maintain ecological structure and processes within the reach.

Under natural conditions, floods that occurred every 100 to 500 years within the UMRS shaped the floodplain by re-routing channels through its bottomland forests and marshes and depositing sand and sediment on different land surfaces.

Long term overbank impacts associated with 100- to 500-year floods have been largely eliminated by development of the levee system. The most notable ecological effect of this change has been in the forest community, which is now less diverse both in terms of species and the age-structure of the trees that remain. Each of these variables is indicative of poor ecosystem health.

FINDINGS AND CONCLUSIONS

- Presented together in a river reach report card demonstration (Figure 2-9), the criteria discussed above indicate that ecological health of the three UMR reaches decreases from upstream to downstream. The Lower Illinois River is the least healthy reach within the UMRS.

- The abundance and distribution of plant and animal populations within the UMRS change from year to year in response to weather conditions and river flows. These changes are as difficult to predict as the weather patterns that control them.

- Hydrodynamic variability and consequent population responses are part of the natural dynamics of river ecosystems and are important to sustaining their long term diversity.

- Long term habitat changes, especially those that create permanent conditions that are beyond the suitability range of river species, are of great concern. It is now possible to forecast the direction and some of the likely future ecosystem conditions

associated with pool aging. However, it is not yet possible to predict the rate of change, or how soon a shift to a different, potentially less desirable, stable ecological state, as occurred on the Illinois River, might occur.

- The Upper Impounded Reach of the UMR is the relatively healthiest reach within the system. Habitats in this reach are degrading primarily because of long term changes in dynamic river physical processes associated with channel training and impoundment. Floodplain development has not been a major problem,[5] except where tributaries enter the floodplain.

- The Lower Impounded Reach of the UMR supports fewer backwaters and marsh habitats and their associated species. In this reach, suspended sediment loads increase, and therefore sedimentation problems are typically greater here. Floodplain development has isolated much of the floodplain. In combination with greater flood flows, this produces more rapid water level fluctuations that are atypical of large, floodplain rivers and less suitable for aquatic plants. The larger islands in this reach are commonly protected from bank erosion by rock revetment, and therefore are not as much of a concern from the perspective of reduced habitat diversity.

- Most of the floodplain in the Unimpounded Reach of the UMR is isolated from the river; water level fluctuations are extreme; and suspended sediment loads are high. The reach does support a range of river species, and its forests are demonstrating the ability to recover from the flood of 1993.

- The Lower Reach of the Illinois River remains ecologically unhealthy. In addition to sedimentation problems typical of the whole system, the plant and invertebrate communities of these reaches have not recovered from the disturbance event of the 1950s. Habitat rehabilitation within this reach will continue to be difficult, because it will likely need to address multiple limiting factors (sedimentation, altered water level regimes, contamination) at the same time.

[5] This is in part due to more than 200,000 acres of floodplain lands along the mainstem of the Upper Mississippi River having been acquired for the Corps of Engineers 9-Foot Channel Navigation Project and subsequently transferred to the USFWS for management as part of the national refuge system.

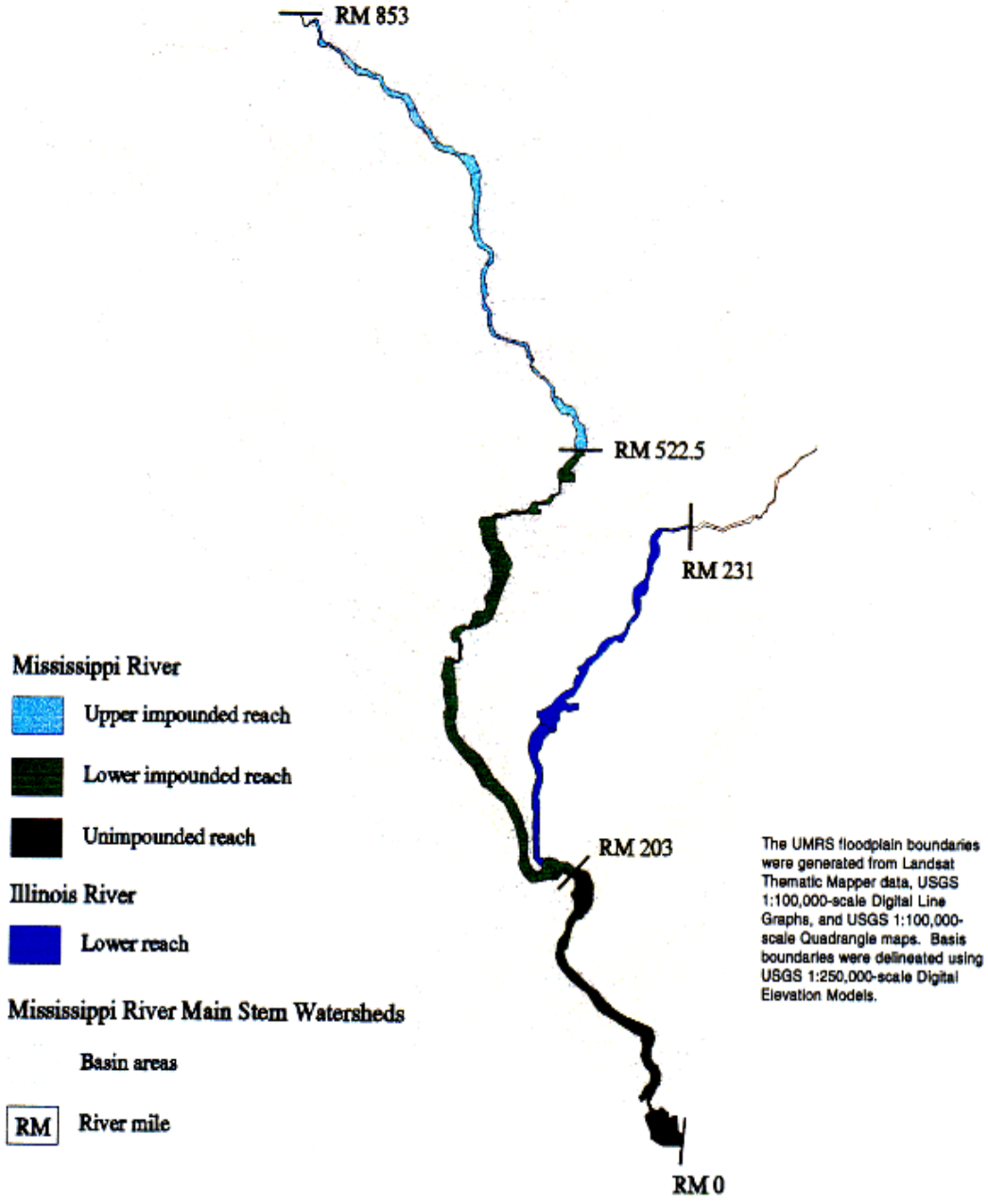


Figure 2-1. Four floodplain reaches of the Upper Mississippi River System.

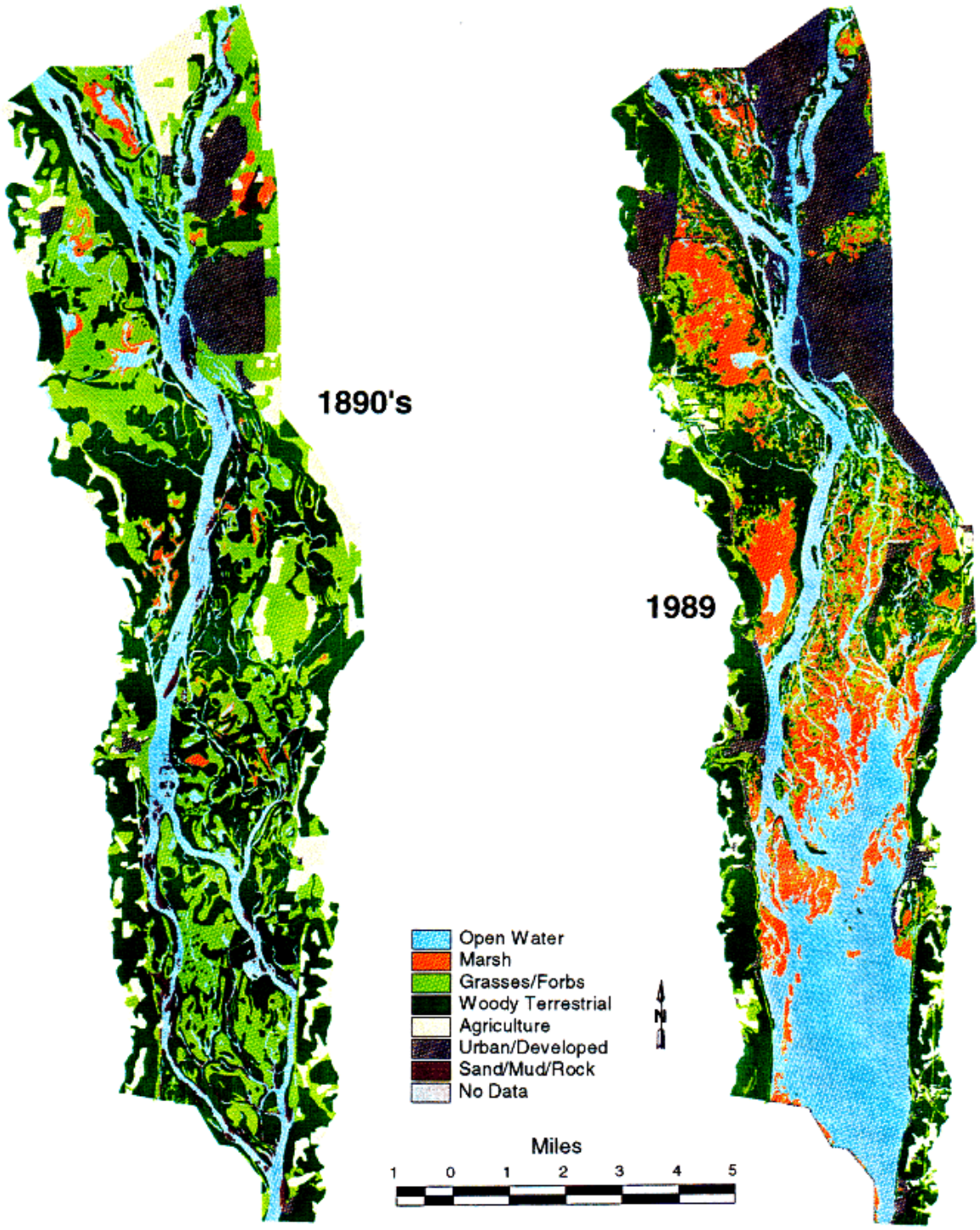


Figure 2-2. Land cover change in Navigation Pool 8, Upper Mississippi River, 1898-1989. Pool 8 is typical of other pools in the Upper Impounded Reach in terms of the degree to which impoundment increased the open water area above the dam. Source: Environmental Management Technical Center.

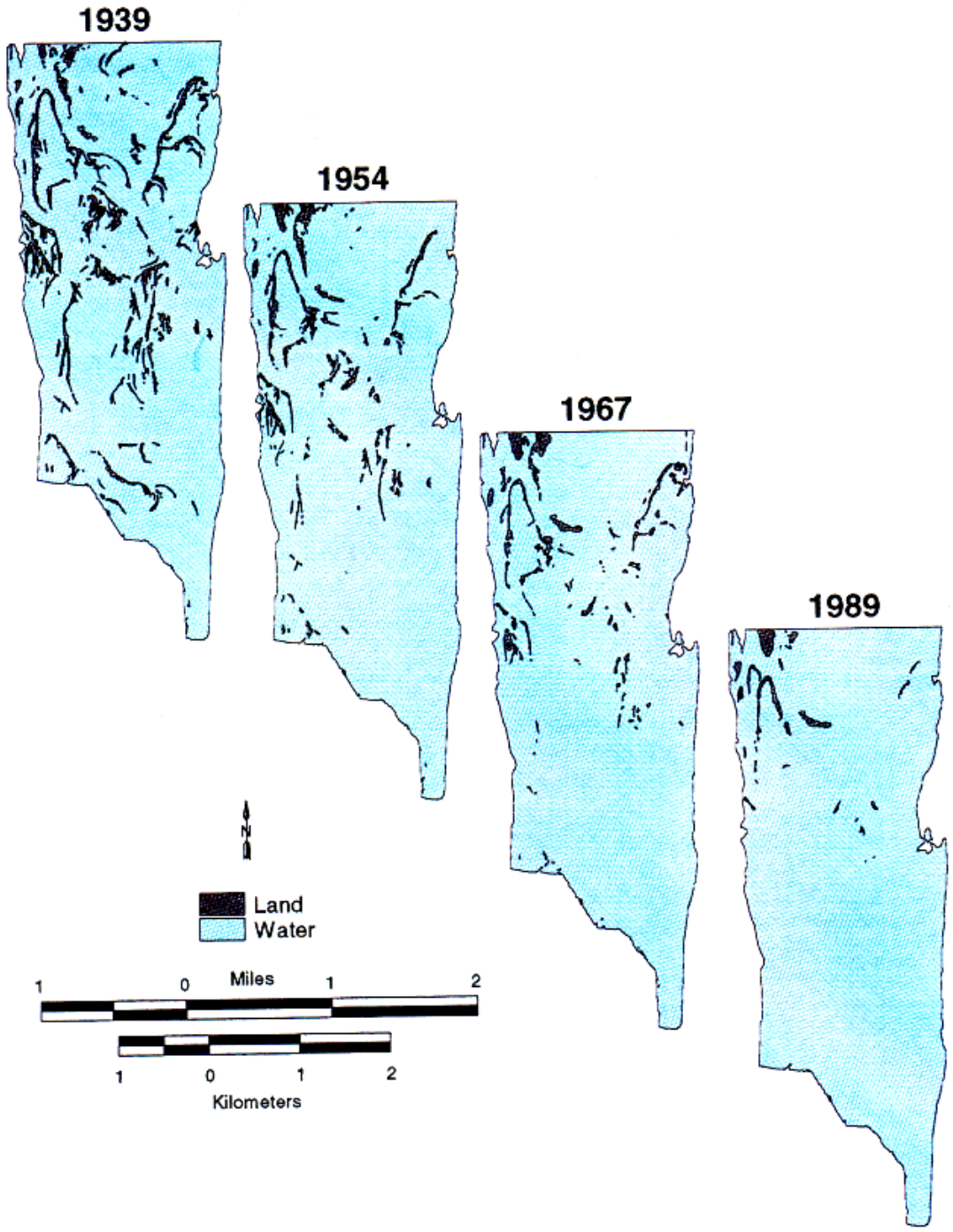


Figure 2-3. Island loss in Pool 8, Upper Impounded Reach, since impoundment. Source: Environmental Management Technical Center.

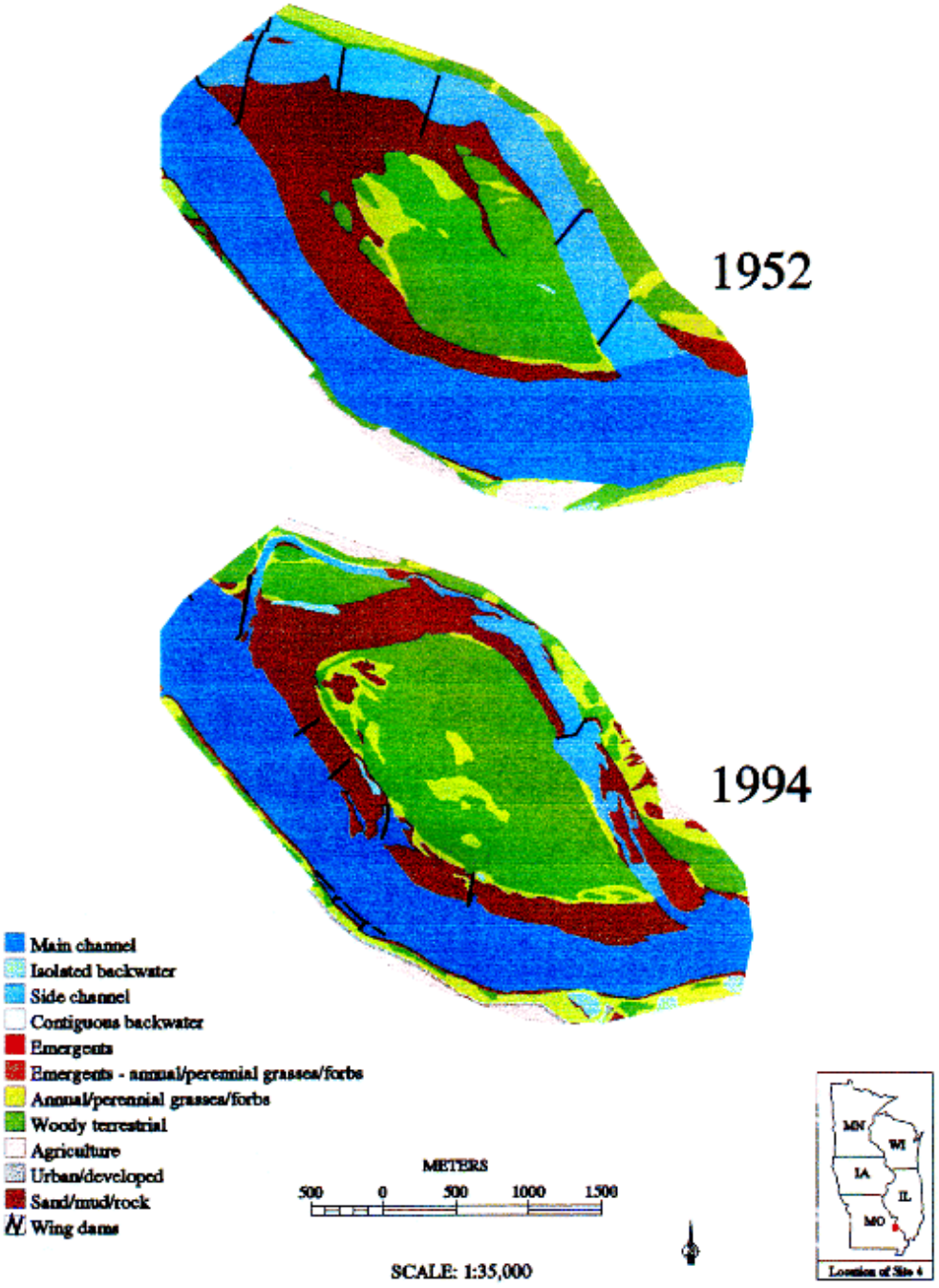


Figure 2-4. Physiographic changes near a side channel in the Unimpounded reach of the Upper Mississippi River, 1952-1994. The site typifies the loss of side channel aquatic habitat that has occurred at more than 20 such sites in this river reach. The changes resulted from the construction of closing dams to restrict river flows to the main navigation channel. Source: Environmental Management Technical Center.

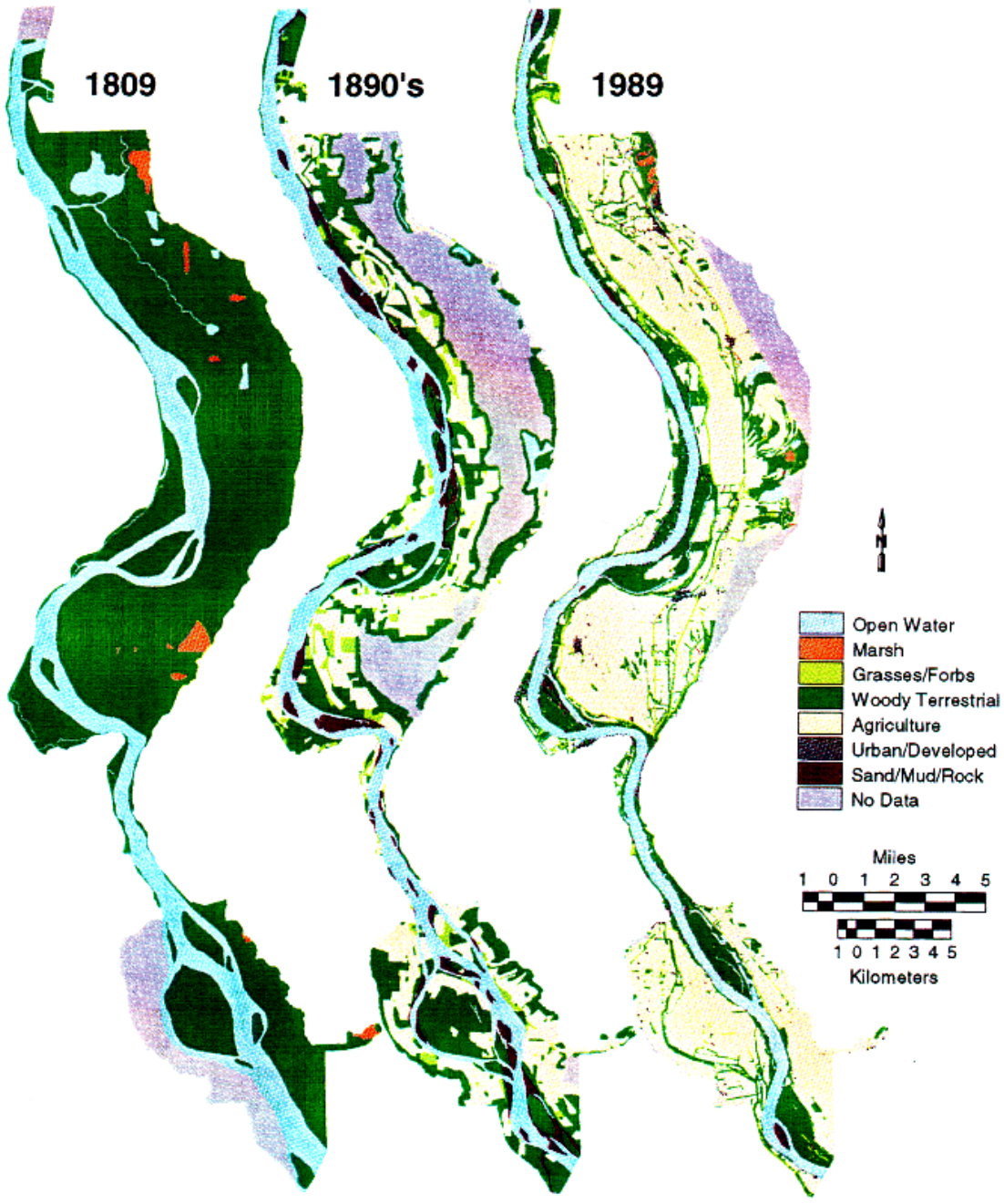


Figure 2-5. Long term land cover change in the Unimpounded Reach of the Upper Mississippi River, 1809-1989. Source: Environmental Management Technical Center.

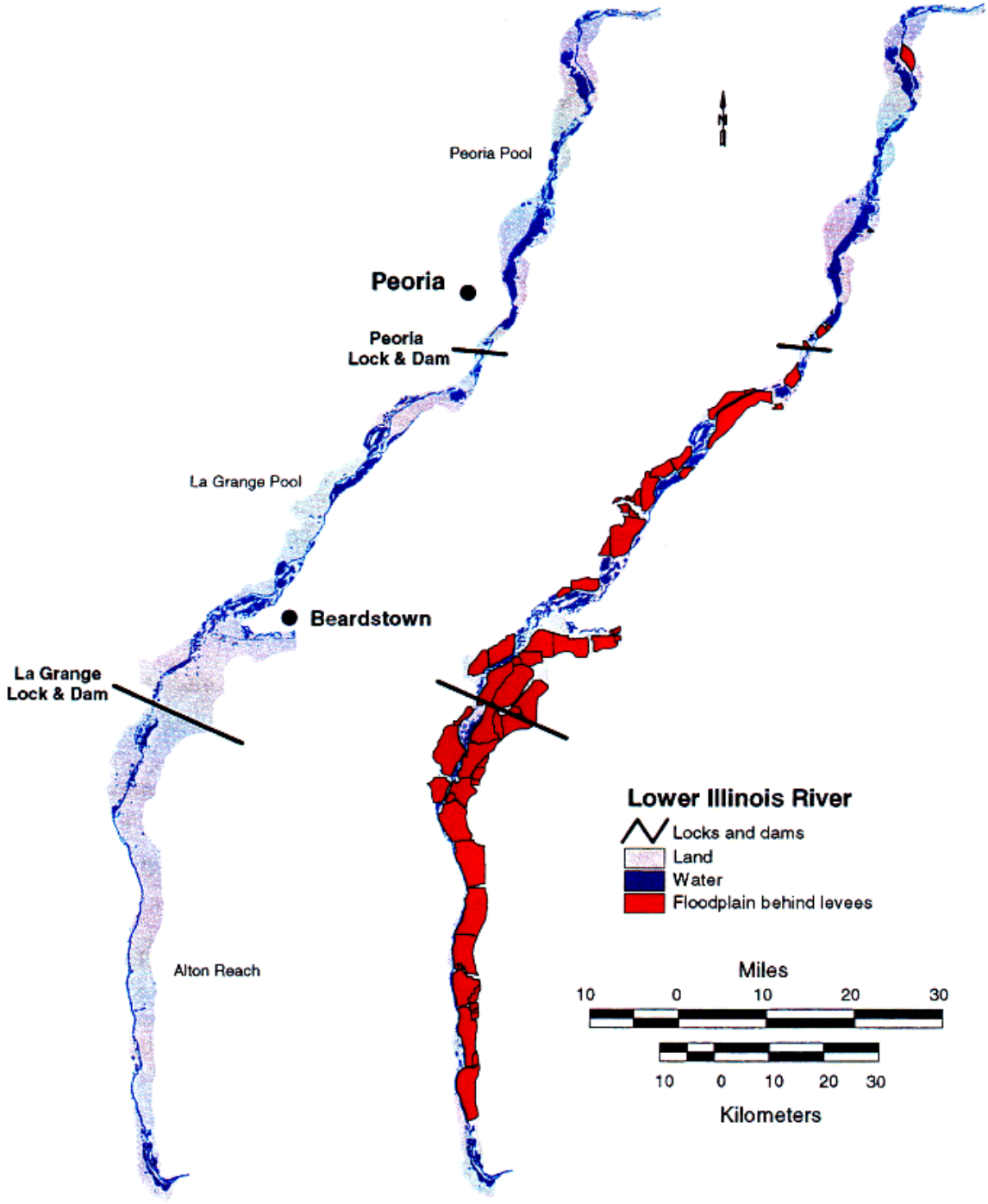


Figure 2-6. The Lower Reach of the Illinois River, showing the floodplain (left) and current agricultural levee districts. The levee information was produced by the Rock Island District, Corps of Engineers, for the Scientific Assessment and Strategy Team following the 1993 Midwest flood. Source: Environmental Management Technical Center.

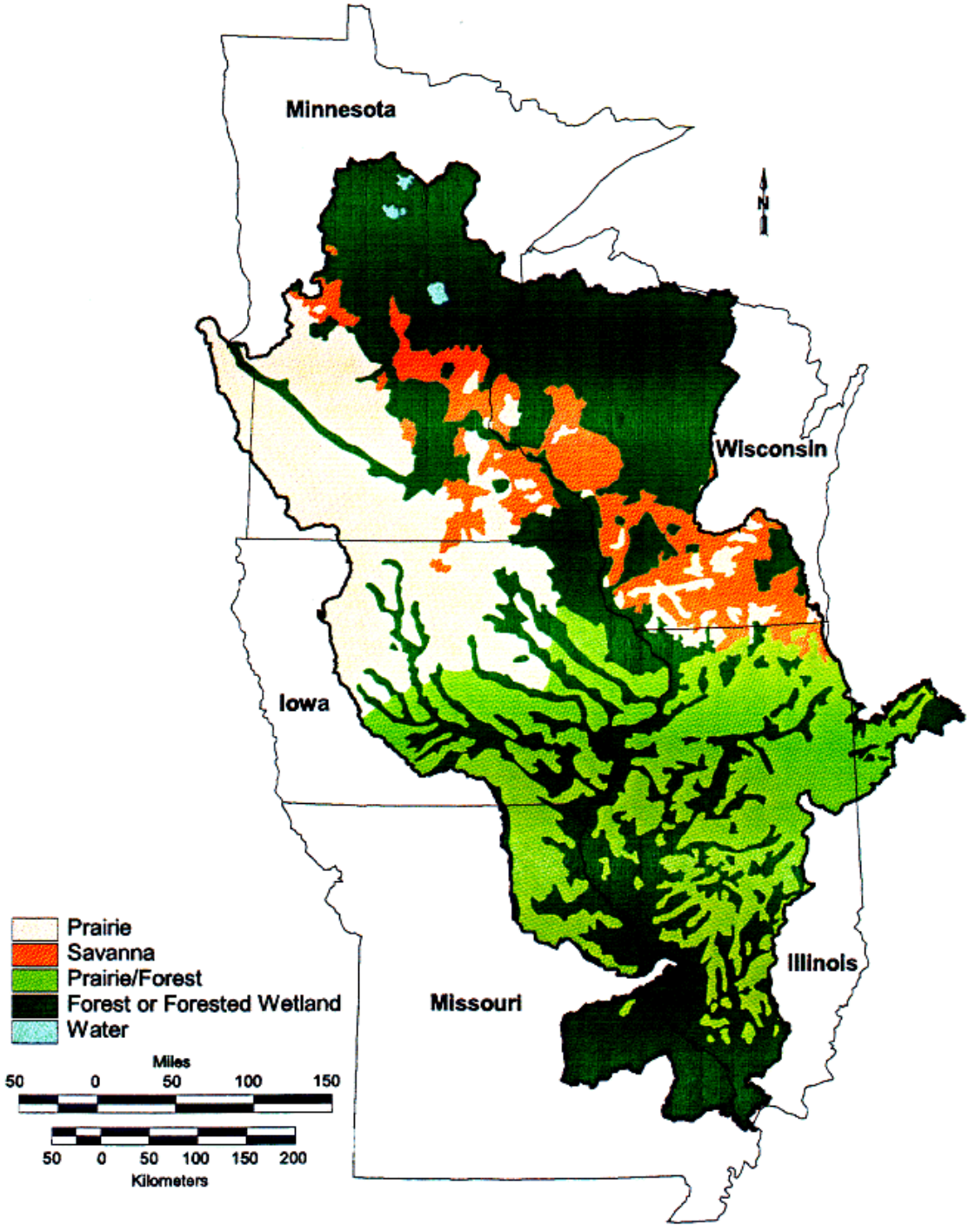


Figure 2-7. The potential natural vegetation of the Upper Mississippi River Basin (based on Kuchler (1964); source of map: Environmental Management Technical Center).

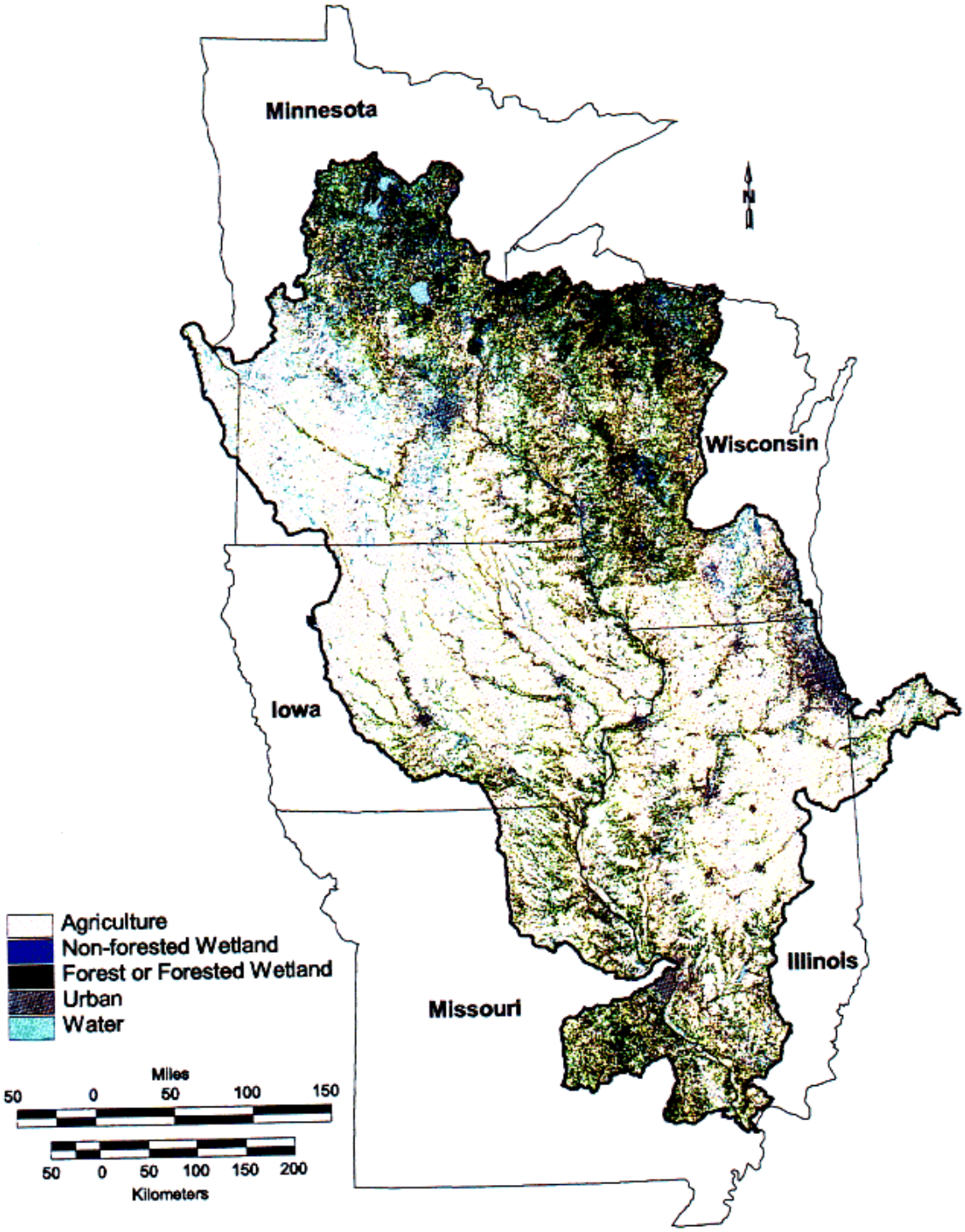


Figure 2-8. Current Land Cover and Land Use within the Upper Mississippi River Basin (based on USGS GIRAS data; source of map: Environmental Management Technical Center).

An Ecological Report Card for Four Floodplain Reaches of the Upper Mississippi River System.

Criteria for Evaluating Reach Ecosystem Health	Upper Mississippi River, Upper Impounded Reach (Pools 1-13): Rating	Explanation	Upper Mississippi River, Lower Impounded Reach (Pools 14-26): Rating	Explanation	Upper Mississippi River, Unimpounded Reach: Rating	Explanation	Illinois River, Lower Reach: Rating	Explanation
General Ecosystem Criteria								
1. Presence of habitats and viable native animal and plant populations that the reach, if undisturbed, would support	++	Although gradually declining in structural diversity, the wetlands created after impoundment still support viable river populations. Mussel diversity has declined. Zebra mussels are latest exotic to threaten native species.	++	Similar to Upper Impounded Reach, but greater encroachment of levees into floodplain. Forests are less diverse and have a simpler age structure. Zebra mussels are latest exotic to threaten native species.	+	Limited off channel habitats, and wide, rapid water level fluctuations. Zebra mussels are latest exotic to threaten native species.	+	Aquatic vegetation and native invertebrates still limited. Zebra mussels are latest exotic to threaten native species.
2. Ability to recover from disturbances	++	Invertebrates and aquatic vegetation recently have demonstrated continuing capacity to recover from floods, droughts and pollution.	+	Similar to Upper Impounded Reach, regeneration of willows and cottonwoods limited.	++	Similar to Upper Impounded Reach, willows and cottonwoods regenerating adequately.	-	Aquatic vegetation and invertebrate have not recovered after major declines in the 1950's.
3. Ability of ecosystem to sustain itself	+	Habitat quality and diversity continues to decline as pools fill and age. Some pools may be near a sediment transport equilibrium.	-	Similar to Upper Impounded Reach, suspended sediment loads and sedimentation rates are greater.	-	Suspended sediment loads are high. Increasing trend to greater flood peaks and longer flood durations.	-	Suspended sediment and nutrient loads are high. Point source pollution control in Upper Reach may gradually help cleanse this reach.
Floodplain River Criteria								
4. The reach's capacity to function as part of a healthy basin	++	Reach with least basin land cover change, but elevated suspended sediment and nutrient loads.	+	Major land cover changes, from forests and prairies to agriculture and urban, have altered the volume, rates, and kinds of materials carried by tributaries in this reach.	+	Major land cover changes, from forests and prairies to agriculture and urban, have altered the volume, rates, and kinds of materials carried by tributaries in this reach. Sediment and water discharge altered by large reservoirs on upper Missouri River.	-	Major land cover change in basins drained by tributaries in this reach. Elevated suspended sediment, and nutrient loads.
5. Annual channel/floodplain connectivity and exchange	++	Channel/floodplain connectivity enhanced by lack of levees.	+	Greater isolation of floodplain by levees.	-	Almost all of the floodplain is levied. Value of floodpulse lowered as a result of water level fluctuations that are too rapid.	-	Much of the floodplain is leveed. Long term filling of backwaters and sediment deposition in terrestrial habitats has reduced flood storage capacity of floodplain and increased flood peaks.
6. Ability of infrequent natural events to maintain ecosystem structure and processes	-	Channel-forming ability of infrequent floods almost eliminated by channel training structures and dams	-	Channel-forming ability of infrequent floods almost eliminated by channel training structures, dams, and levees.	-	Channel-forming ability of infrequent floods almost eliminated by channel training structures and levees.	-	Channel-forming ability of infrequen floods almost eliminated by channel training structures, dams, and levee

Legend:

- +++ No ecological constraints associated with this criterion exist.
- ++ Some ecological constraints exist.
- \+ Many constraints, or constraints with broad spatial coverage, exist.
- \- Constraints associated with this criterion currently are considered ecologically unhealthy.

Figure 2-9. An Ecological Report Card for Four Floodplain Reaches of the Upper Mississippi River System.

Long Term Resource Monitoring 3

The monitoring and computerized inventory and analysis elements of the EMP were born out of a critical need for the standardized collection, integration, analysis, and reporting of scientific information to UMRS resource managers and decision-makers. These two components have come to be jointly referred to as the Long Term Resource Monitoring Program (LTRMP).

LTRMP fish sampling on a backwater of the UMRS.

MISSION AND GOALS

The mission of the LTRMP, as outlined by legislation, the master plan, and program guidance documents, is to provide resource managers and decision-makers with information necessary to maintain the UMRS as a sustainable multiple-use large river ecosystem. The long-term goals of the LTRMP were established through extensive Federal and State agency participation. The goals include: (1) develop a better understanding of the ecology of the UMRS and its resource problems, (2) monitor resource change, (3) develop alternatives to better manage the UMRS, and (4) provide for the proper management of long term resource monitoring program information.

PROGRAM OVERVIEW

Need for the Program

The UMRS and its floodplain have been and continue to be highly affected by human actions, two of the most significant being: (1) the establishment and maintenance of a navigation channel traversing the entire 1,300-mile length of the UMRS and (2) levee construction resulting in a 48% reduction in the total amount of periodically inundated floodplain. In addition, natural processes, such as climate and sedimentation, interact with human activities to shape the river in a variety of both subtle and profound ways.

To understand how this dynamic system functions and to effectively manage it, system-wide monitoring, scientific research, and integrated information systems are needed.

Program Description

The LTRMP is funded through the Corps of Engineers as part of the EMP. The U.S. Geological Survey (USGS), in cooperation with the five Upper Mississippi River Basin states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), carries out the LTRMP. The Environmental Management Technical Center (EMTC) located in Onalaska, Wisconsin, is the USGS facility responsible for program management and administration.

Environmental Management Technical Center, Onalaska, Wisconsin.

Implementation of the LTRMP currently represents approximately 66% of the EMTC's total workload.

Six State operated field stations have been established along the river (Figure 3-1). Their primary responsibility is the standardized sampling/measuring of the following physical, chemical, and biological parameters: water quality, fish, macroinvertebrates, and vegetation in six river reaches.

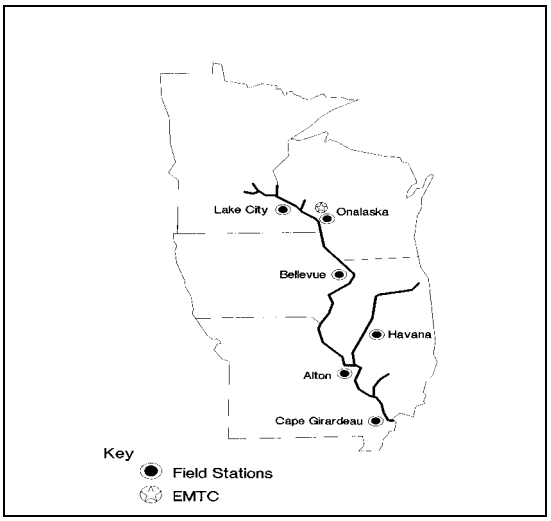


Figure 3-1. EMTC and field stations locations.

Procedure manuals for data collection have been developed to assure consistent, scientifically valid sampling. Standardized gear and sampling equipment have been acquired, and field station staff have been trained to use it. An extensive quality assurance/quality control program is in place.

Peer review is an integral part of the scientific method. At the EMTC, peer review is used routinely at several levels to ensure credible research, sound science, and useful products. This includes oversight by an international science review committee and regional expertise.

Ecological components being monitored by the LTRMP include:

- Water quality
- Water levels and discharges
- Vegetation
- Sedimentation
- Macroinvertebrates
- Fish
- Land cover and use

Natural resource and river management problems being investigated include:

- Navigation effects
- Sedimentation
- Water level regulation

The automated systems and data management practices of the EMTC provide for long term archiving of data and research results and direct access by resource managers, decision-makers, industry, and the public.

Implementation Status and Accomplishments

An Operating Plan, completed in 1988 and revised in 1993, forms the basis for Program implementation.

For management purposes, LTRMP activities have been combined and grouped under four Programmatic goals. The following paragraphs describe each goal, associated activities, and a sample of important findings and accomplishments.

Goal 1 - Develop a Better Understanding of the Ecology of the UMRS and its Resource Problems

Informed management requires an improved understanding of the ecosystem and its resource problems. The river basins of the UMRS are subject to many natural and human-induced disturbances. Navigation effects, sedimentation, and water level regulation have been identified by interagency committees as three major problem areas for the LTRMP to address.

Activities under this goal include research and analyses intended to increase our knowledge of how the floodplain river ecosystem of the UMRS operates and responds to natural events and human activities. This information is necessary for evaluating the ecological risks posed by different river uses and setting priorities for management actions. Information generated under this goal helps to identify the causal factors responsible for the system changes observed during monitoring.

One of the first steps toward implementing and refining LTRMP monitoring and research was the development of a conceptual model to describe the structure and function of the river at various scales. In a system as large and diverse as the Upper Mississippi River, physical and biological attributes of the system are affected by events at many scales. The scales recognized as important include: the basin, stream network, floodplain reach, navigation pool, and aquatic areas (backwaters, side channels, etc.). In addition to refining experimental design, the conceptual model helps prioritize effort and identify cause-and-effect mechanisms.

Concepts of ecosystem health have also been developed to characterize the UMRS. General and specific criteria are used to assess UMRS ecological factors such as: the presence of habitats necessary to support native plants and animals, the ability to recover from disturbance, and the ability to sustain itself as a viable ecosystem. The four floodplain reaches defined by the LTRMP display a wide range of health, but none meet all the criteria of a healthy, functional river floodplain ecosystem.

Commercial navigation and its adverse effects on ecological health were recognized as important research areas early in the development of the LTRMP. To elucidate the physical effects of navigation, the LTRMP funded studies of the hydrodynamic and sediment resuspension impacts of commercial and recreational boat traffic. The studies conducted by the Illinois State Water Survey aided in developing models to predict the physical impacts of commercial navigation. The data and models are currently being used by the Corps of Engineers in the Upper Mississippi River - Illinois Waterway System Navigation Feasibility Study.

Extreme hydrologic events (such as the 1988-89 drought and 1993 flood) provide unique opportunities to investigate ecological response to a natural disturbance. Taking advantage of the “natural experiments,” LTRMP researchers com-pleted investigations of plant response during the drought and following the return to more typical river conditions. Submersed plant die-offs in the upper reaches of the river were attributed to nutrient limitations and shading by algae. In southern reaches, submersed plants flourished in the atypically clear and stable waters. The flood of 1993 provided

opportunities that confirmed and quantified the beneficial impacts of a flood on the growth of some fish species and allowed the development of predictive models that estimate the flood-induced mortality for several tree species. Other flood studies investigated water quality, submersed aquatic plants, macro-invertebrates, fish communities, and reptiles and amphibians.

Goal 2: Monitor Resource Change

A primary effort of the LTRMP is to monitor and evaluate long term changes or trends in selected physical, chemical, and biological components of the UMRS.

The primary components are:

- Water quality
- Fish
- Vegetation
- Invertebrates

Additionally, selective monitoring of mussels, exotic species, sediment, and certain other system parameters has been pursued.

The LTRMP monitors UMRS invertebrate resources.

Activities under this goal are intended to create, in a standardized format, a record of how UMRS ecosystem components are changing over time. Consistent and reliable monitoring data are vital to management decisions related to ecosystem goals. Spatial analyses of the monitoring data will help to identify reach-specific habitat needs and develop strategies for habitat protection, restoration, and enhancement. Monitoring river animal and plant populations is helping managers determine which species are in need of specific management actions and document the success of ecosystem management efforts.

Aquatic vegetation is an important UMRS ecosystem component being monitored as part of the LTRMP.

- **Bathymetry.** Sediment and bathymetric surveys in backwaters provide data necessary to assess changes due to sedimentation and also to complete hydraulic models. Some highlights resulting from bathymetric surveys include the finding that sedimentation rates in impounded reaches may be slowing compared to rates experienced immediately after impound-ment, and documentation of the loss of bathymetric diversity due to island erosion and sedimentation. Bathymetric information is also used in hydraulic models that can estimate water levels, flow distribution in channels, and sediment movement. When incorporated into GIS coverages, these data are invaluable in describing ecological change to researchers, managers, and the public. In addition to routine backwater surveys in LTRMP study reaches, the LTRMP assisted with the collection and interpretation of bathymetric data collected at 1-mile intervals along the entire Upper Mississippi and Illinois Rivers. These data will be critical to systematically modeling site-specific commercial traffic impacts.

- **Sediment.** Sediment surveys are conducted to quantify sediment types in trend pools and relate them to other ecological factors. A rapid analysis tool, called a sediment penetrometer, was developed to increase the rate at which the data can be collected. Normal survey techniques required substantial laboratory analyses, but the new tool has been calibrated to conditions found on the UMRS and eliminates the need for most laboratory analyses. Additional sediment work includes compiling all the available sediment data on the Illinois River, monitoring of sediments entering from tributaries, and developing sediment budgets in several key pools.

- **Hydrology.** Hydrologic information (discharge and water levels) has been acquired for the entire period of record (some stations >100 years) for the entire river. Analyses of these data have been used to assess changes imposed by navigation dams and to evaluate dam operating procedures. Analyses that incorporate bathymetric GIS coverages and hydraulic models now provide the ability to forecast how different water level management strategies can affect river habitats. Such information is critical to assess the effectiveness of habitat restoration efforts, including island building, seed islands, and drawdowns. Another significant finding in the Open River Reach demonstrated that flood stage water levels have increased due to levee construction and low flow water levels have decreased due to downcutting in the main channel.

- **Water Quality.** Water quality monitoring has demonstrated that oxygen levels in the river are generally good, except during winter under ice in some backwaters and during summer in thermally stratified backwaters. Water clarity declines in the downstream direction as tributaries, especially in agricultural watersheds, deliver sediment eroded from the basin. The increasing turbidity downstream provides an explanation for the current distribution of submersed aquatic plants that were once more evenly distributed throughout the UMRS. Even in the Upper Impounded Reach where submersed aquatic plants are abundant, changes in ambient turbidity have been related to changes in the plant community. Analyses of chemical data collected by the LTRMP reveal a moderately nutrient enriched environment, although recent data suggest reductions in the nutrients entering the river. Increased tributary monitoring is addressing the systemic patterns of nutrient sources and sinks in an attempt to determine the UMRS contribution to nutrient loading in the Gulf of Mexico.

- **Submersed Aquatic Vegetation.** Submersed aquatic vegetation monitoring, aerial photograph interpretation, and GIS land cover-land use maps have been instrumental in creating a systemic GIS coverage of the UMRS. Annual submersed aquatic vegetation monitoring has revealed systemic patterns of aquatic plant distribution, finding the most species and the highest abundances in the Upper Impounded Reach and few or no aquatic plants in the other reaches. Annual surveys have also revealed the dynamic nature of submersed aquatic plants. Die-offs during the 1988-1989 drought have reversed and most plant beds have recovered.

- **Land Cover.** Interpretation of aerial photography has been instrumental in developing systemic land cover-land use maps. The systemic coverage based on 1989 aerial photographs will provide a baseline of aquatic and floodplain habitats that can be used for habitat rehabilitation and enhancement project planning, the U.S. Environmental Protection Agency's oil spill contingency planning, and the multi-agency Migratory Bird Strategy.

- **Macroinvertebrates.** Macroinvertebrate (mayflies and fingernail clams) monitoring has revealed important spatial distributions, both within study reaches and systemically throughout the UMRS. Generally, macroinvertebrates are more abundant in the Upper Impounded Reach than in any other. Within this reach, Pool 13 supports substantially more fingernail clams than do

Pools 4 or 8. Mayflies appear to be more evenly distributed than fingernail clams in this reach. Explanations of the distribution of fingernail clams have most often been related to municipal and industrial pollution from Minneapolis-St. Paul, Minnesota. Recent investigations also reveal within-pool patterns of macroinvertebrate distribution that are most likely related to nutrient (food) availability, flow, and substrate characteristics. Hydraulic modeling and fingernail clam sampling at the Lake Onalaska Islands HREP project is helping to elucidate the interrelations between several physical factors and macroinvertebrate distribution and abundance.

- **Fish.** Fish monitoring has documented the presence of 127 fish species in the six study reaches. There is no apparent decline in the number of species, although many species occur in lesser (blue suckers) or greater (bluegills) abundance than in the past. Changes in the abundance of some fish species have been linked to dam impacts. The blue sucker, for example, is a species adapted to swift flowing water in riverine rapids that were eliminated by the dams. Dams have also blocked migratory species such as the skipjack herring, the only known host of the ebony shell mussel whose abundance has declined dramatically in the upper pools. One of the most significant findings to date is differences in the relative abundance of backwater dependant species such as bluegill, largemouth bass, white crappie, and black crappie. Monitoring data reveal greater abundance of these species in river reaches that have high proportions of off-channel habitat. Such findings can help establish habitat goals for reaches that currently lack high abundance of these popular sport fish. Cooperative efforts between the LTRMP and the Upper Mississippi River - Illinois Waterway System Navigation Feasibility Study have provided an opportunity to sample main channel fishes that had historically been overlooked due to sampling difficulties. The results indicate that the main channel does indeed support viable fish communities, including many of the big river species suspected to be at risk from commercial navigation.

- **Birds.** Although a wildlife monitoring component was never developed for the LTRMP, land cover GIS coverages have been used to model likely bird species distributions based on habitat availability. As a cooperator in the multi-agency Upper Mississippi River Migratory Bird Plan, the LTRMP helped develop and maintains a GIS based ecological modeling tool that includes the habitat needs of almost 300 bird species.

- **Exotics.** Exotic species have been documented in submersed aquatic plant, fisheries, and macroinvertebrate sampling, as well as from aerial photograph interpretation. Eurasian milfoil is a submersed aquatic plant that has been widely dispersed by fishermen, and currently competes with native plants for space and nutrients. Terrestrial exotic plant species identified include the widely dispersed European reed canary grass that has been present for many years and recent introductions of purple loosestrife. Exotic plant pathogens, such as Dutch elm disease, have been implicated in changes to the terrestrial plant community. Exotic invertebrates include the Asian clam that has been present for many years and the zebra mussel that is a recent invader likely to negatively impact freshwater mussels. Exotic fishes detected include the highly abundant common carp and less abundant bighead carp and grass carp.

Goal 3: Develop Alternatives to Better Manage the Upper Mississippi River System

Goal 3 activities are conducted from an adaptive management approach designed to test hypotheses about the behavior of an ecosystem being changed by human use. An adaptive design permits learning from a policy action so that future decisions can proceed from a better knowledge base.

Understandings derived from monitoring (Goal II) and research (Goal I) are used to predict how the biological resources of interest will respond to alternative management actions. Learning takes place as a result of monitoring the effects of the management actions. Future actions can be adjusted in response to this new knowledge regarding ecosystem functioning.

The activities associated with this goal support and are integrated with specific U.S. Army Corps of Engineers navigation impact assessments, habitat rehabilitation and enhancement projects, and other Federal and State natural resource programs.

Development and implementation of resource management plans are the responsibility of State and Federal agencies along the UMRS. However, they increasingly are relying upon databases and information from the LTRMP. LTRMP staff coordinate with the UMR management community to cooperatively plan activities and share information.

LTRMP spatial databases have been made available to UMRS resource managers who use them to evaluate environmental conditions in their river reaches. They were used extensively by teams of managers and researchers developing ecosystem management strategies. Spatial data is continually expanded and will eventually cover all river reaches. These data will likely form the basis of the habitat needs assessment proposed for the future.

Recognizing that the LTRMP is a program based on partnerships, the LTRMP conducted an expectations survey of its partners to better address their needs and concerns. The partner expectations have provided the support for many LTRMP investigations that were designed to assist the formulation of management objectives and alternatives.

Habitat rehabilitation and enhancement monitoring has provided many applied research opportunities for the LTRMP. Cooperation among several agencies provided the information necessary to evaluate fish response to habitat improvements in the Finger Lakes and Brown's Lake HREPs. In the Finger Lakes, increased flow into isolated backwaters was shown to increase dissolved oxygen concentrations. Fish response to increased flow was investigated to determine optimum gate openings to improve conditions for fish without exposing them to stressful conditions. In Brown's Lake, LTRMP investigations helped determine the appropriate timing and duration of gate openings to improve fish habitat. Studies investigating environmental changes due to island construction have helped identify conditions favorable to fingernail clams and, consequently, to develop objectives and improve designs for future projects. The seed island concept is an innovative approach to habitat improvement that resulted from island project investigations.

With water level management for environmental benefits gaining increased attention throughout the UMRS, LTRMP hydrologic modeling and bathymetric GIS coverages have proven invaluable to managers. Hydraulic models have been used to assess the extent to which water level manipulations will affect whole pool reaches. The information is being used to modify dam operating rules in Pool 25 and also to estimate the effect of drawdowns in Pool 13. Results have indicated that for some alternatives involving dam regulation, ecological benefits could be gained without affecting commercial traffic.

Goal 4: Provide for the Proper Management of Long Term Resource Monitoring Program Information

The use of automation technology to support UMRS management decisions is a key element of the LTRMP. A high priority was placed on developing the current system to support management, distribution, analysis, and access to LTRMP data.

EMTC computer systems are used to archive and manage LTRMP data.

Activities under this goal focus on four objectives: (1) providing management and direction for automation activities; (2) providing LTRMP staff with the automation tools necessary to accomplish assigned work; (3) ensuring the management of collected data; and (4) providing resource managers, decision-makers, and the public access to LTRMP data.

Equipment maintenance is critical to providing resource management agencies and others with continuous access to LTRMP data and information.

- **Databases.** Information management and dissemination has been a high priority since the inception of the LTRMP. Standard operating procedures for data recording, entry, and verification have greatly increased the speed of data distribution, as well as the quality of the data. LTRMP data on water quality, fish, macroinvertebrates, vegetation, sedimentation, and water levels and discharge have been placed in a master database management system that is accessible by LTRMP partners and the general public through the Internet and other media. The LTRMP World Wide Web (WWW) site (http://www.emtc.er.usgs.gov), established in 1993, offers more than 8,200 files on fish, vegetation, macroinvertebrates, water quality, water levels, discharge, aerial photography, satellite imagery, scientific publications, and geographic information systems data. During 1996, the Web site was visited more than 535,000 times by individuals from all 50 states and over 70 foreign countries. In addition, the LTRMP has supported over 1,600 requests for automation services.

- **Geographic Information Systems.** The LTRMP Geographic Information System uses state-of-the-art technology and is recognized by experts for its leadership in collecting, organizing, and manipulating spatial data. Currently, the LTRMP supports data covering land cover/land use, soils, geology, transportation, hydrography, land ownership and other features. The land cover/land use information is a cooperative effort of the LTRMP remote sensing work group and the GIS work group. Thousands of aerial photographs have been reviewed by experts in photointerpretation and plant communities to produce a database that covers over 75% of the UMRS.

- **Publications.** Written reports are the standard means used to disseminate data, information, and research results to LTRMP partners. Through the years, LTRMP funds have fully or partially supported the production and distribution of more than 300 reports and related publications.

Informational pamphlets, newsletters, and project status reports have also proven to be effective mechanisms to reach the public and LTRMP partners.

LTRMP STRENGTHS AND WEAKNESSES

Background

The LTRMP has been a highly successful program primarily due to its focus on partner expectations and willingness to seek scientific and management reviews[1] of its performance. Invariably, reviews have been complementary of the efforts of the LTRMP and emphasize the rarity of such comprehensive programs among large river ecosystems, and even other ecosystem types. At the same time, each review has identified aspects of the LTRMP that should be revised, expanded, or initiated. In addition to periodic program reviews, LTRMP activities are directed by representatives of each partner agency through an advisory group known as the LTRMP Analysis Team (A-Team).

The first reviews were conducted in 1990, when the first scientific review panel of international experts and another panel of local resource managers were employed to evaluate LTRMP science and management, respectively. During 1992, the U.S. Army Corps of Engineers, North Central Division completed a review of the entire Environmental Management Program that included scientific and management evaluations of the LTRMP. The most recent reviews were completed in 1997, when the international science review committee was reconvened, another management review team was organized, and the new EMTC parent agency, the U.S. Geological Survey - Biological Resources Division, conducted scientific and administrative reviews (see Attachment 4).

[1] The specific recommendations stated in these reviews are provided as part of Attachment 4.

Program Strengths

The major strengths of the LTRMP are its partners throughout the UMRS devoted to understanding, protecting and restoring the river, the existence of six fully operational scientific field stations and the EMTC to conduct monitoring and research in several regions of the UMRS, and a long term commitment to collect and analyze information concerning UMRS natural resources. The partnership that planned and implemented the LTRMP has fostered a previously unknown level of cooperation among members of the river scientific and management community. It provides a forum for UMRS coordination, problem identification, and issue resolution. Over the last 10 years, LTRMP partners have equipped and staffed field stations; developed, implemented, and improved monitoring; refined data management; directed resources toward mutually beneficial research; and maintained support for the concept of long term data collection.

To ensure the utility of the monitoring data, the LTRMP has developed standardized methodology for data collection, processing, and distribution among the field stations and partners to assure comparability between geographic reaches of the UMRS. The development of base maps that define specific aquatic areas (habitat types) and the implementation of stratified random sampling, as recommended in previous scientific reviews, makes the data collected and conclusions that can be drawn from them quite robust. Since implementing the stratified random sampling design, monitoring results can be extrapolated to nearby unsampled sites without increasing sampling costs. The need for accurate and rapid data processing and accurate data management resulted in the development of an extensive QA/QC program and a world class data clearinghouse. LTRMP information has been accessed world-wide, but its most frequent users continue to be program partners who use the information in their day-to-day management of the river. Among the most frequent users of LTRMP information are planners developing Habitat

Rehabilitation and Enhancement Projects and conducting the Upper Mississippi River - Illinois Waterway System Navigation Feasibility Study.

The long term nature of the LTRMP is unique among large river systems and has been heralded as a model for other programs. The 15-year time frame was recognized as the minimum necessary to capture information on a dynamic system. To date, the LTRMP has collected data during the third worst drought and the biggest flood on record. Continued monitoring during "normal" conditions will help evaluate ecosystem responses to these and other extreme events. With the LTRMP infrastructure in place, the Program remains poised to capture other unique and unanticipated events.

Program Weaknesses

The LTRMP is challenged by the geographic magnitude of the UMRS that includes over 1,300 miles of navigable rivers that are influenced by a basin that covers nearly 190,000 square miles and includes over 30,000 miles of tributary streams. Monitoring such a vast system is a daunting task. Budget and legal restrictions have precluded important work at the basin scale. Additionally, the Upper Mississippi River Basin Commission initially envisioned a program that included monitoring of 22 river reaches, but current program funds support only six.

Some ecosystem components recognized as important during the initial planning stages of the LTRMP have not been incorporated into the LTRMP due to insufficient funding. Wildlife (i.e., mammals, birds, and reptiles and amphibians) and freshwater mussels are both ecologically and economically important, but LTRMP partners decided that the core resource components (water quality, fish, vegetation, and macroinvertebrates) should not be compromised to incorporate additional components. The LTRMP has instead tried to acquire additional resources to implement applied research and species-habitat modeling of a few key wildlife groups. The LTRMP infrastructure has also provided opportunities for other researchers to share equipment and expertise to implement studies of wildlife and mussels.

Costs of acquiring and analyzing spatial data have been greater than expected. The cost to develop land cover-land use maps of a typical navigation pool exceeds $60,000. Complete coverage of the UMRS would cost more than $2 million. While many partners anticipated complete annual coverages, prohibitive costs have resulted in multiple year coverages for only a few specific locations that have been identified as highly dynamic and/or important to resource management concerns. The LTRMP has been very successful, however, in acquiring outside funding to complete land cover-land use maps for almost all the impounded reaches, part of the Unimpounded Reach, and the Lower Illinois River (approximately 75% of the UMRS). In addition to land cover maps, many investigations increasingly rely on detailed bathymetric data, hydraulic models, and substrate type and distribution maps. These are expensive and currently only available for some LTRMP study reaches.

A final concern for the success of the LTRMP is that 15 years may not be long enough to distinguish trends associated with pool aging from short term cycles related to climate patterns or how stream flow variability affects physical driving forces and biological production and diversity. From an ecological perspective, "long term" for a large river system is measured in decades, not years. Hydrologic analyses, for example, reveal approximate 10-year cycles in stream flow that probably control patterns in plant and animal abundance and distribution. In an ecosystem that has evolved over thousands of years, a century may not be long enough to detect some river conditions (e.g., a 500-year flood). The LTRMP should be supported on a level that will allow it to monitor cyclical events many times to better predict ecological responses to both natural events and human activities.

PARTNERSHIP DEVELOPMENT

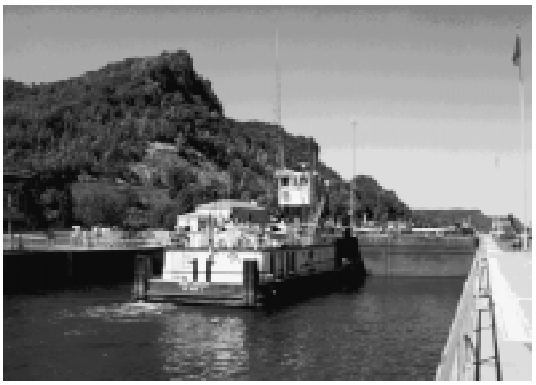
An essential role of the LTRMP is integrating and analyzing the data collected by its six field stations with data from other sources.

Partners identify and finance additional information necessary to accomplish their specific missions. In almost all cases, this additional information complements the original effort. Program partners recognize that they can combine some of their resources and data with LTRMP data and resources to create a relationship that benefits all. Following are several examples of such partnerships:

Navigation Studies

In the Corps of Engineers' 1992 Midterm Evaluation Report transmittal letter, BG Russell L. Fuhrman, at that time Commander of the former North Central Division, U.S. Army Corps of Engineers, stated:

> *The Long Term Resource Monitoring Program (LTRMP) will be a key influence in reconciliation of future conflicting interests by producing scientific, rational decisions. We have identified over $5 million in past and currently scheduled LTRMP products that are complementary to the Upper Mississippi River-Illinois Waterway Navigation Study. This research is applicable to the effects of the 2nd lock at Melvin Price Lock and Dam, as well as all future projects. We anticipate a multiplier effect from LTRMP products. The tremendous potential of the LTRMP is apparent for several Corps of Engineers missions, including operation and maintenance of navigation projects.*



Tow locking through Lock and Dam 7 at Dresbach, Minnesota.

EPA Inland Waterways Spill Response Mapping

The EMTC is funded by the Environmental Protection Agency (EPA) to manage the Midwest Inland Waterways Spill Response GIS Mapping project. This effort provides community planners, oil spill responders, and river managers with graphical and technical information on resources at risk during an inland waterway spill. Data are collected through partners such as the Upper Mississippi River Basin Association and the Great Lakes Commission. This project has provided the LTRMP with floodplain GIS data such as: sensitive areas for mammals, aquatic plants, invertebrates; water intake sites; and basin-wide transportation and hydrography data that would otherwise not be available.

Upper Midwest Gap Analysis Project (GAP)

GAP is a nationwide effort to create biological diversity and species richness spatial databases. GAP has coordinated the purchase of Landsat[2] scenes, which are being used to create land cover/land use databases for the Upper Midwest. These data, along with the habitat relationship databases and the public ownership databases that the GAP is creating, will assist the LTRMP in performing basin scale spatial analysis. This analysis is fundamental to determining

[2] Landsat is a satellite-based, passive remote sensing system that provides medium resolution land use/land cover information.

UMRS sedimentation and nutrient runoff rates. Knowledge of these rates is crucial to realizing long term ecological viability of the Upper Mississippi River. Also, these data are crucial to program partners, such as the Natural Resources Conservation Service and the EPA.

Canada geese benefit from UMRS resources.

Migratory Bird Strategy

The EMTC was funded by the U.S. Fish and Wildlife Service to provide GIS modeling support to initiate a multi-agency Migratory Bird Strategy for the Upper Mississippi River.

Conducting GIS training and collecting aerial photography of additional river reaches has been part of this effort. A prototype decision support system to help the USFWS more effectively manage refuge lands, including identification of habitat needs, is being pursued.

UMRS Vegetation Mapping

The U.S. Army Corps of Engineers has provided non-LTRMP funding to continue the high resolution 1989 land cover/use mapping project for the UMRS. This project has mapped over 50% of the UMRS from 1989 aerial photography. This project supports site-specific planning and management and systemic analysis.

MetaMaker Software

All Federal activities that create spatial databases must use the Federal Geographic Data Committee (FGDC) format when describing the content of their databases. This "metadata" (data about data) is then globally shared. The LTRMP, in cooperation with USGS Biological Resources Division staff, has developed an automated method to meet its metadata requirements. The USGS Biological Resources Division and other Federal agencies and non-governmental organizations are using this software tool.

Cooperative Education Opportunities

LTRMP staff have earned solid reputations for their expertise in the biological sciences, geography and cartography, report production, and computer technologies. Several high schools, colleges, and universities have developed close working relationships with the EMTC. These partnerships involve cooperative efforts where students gain experience in field data collection, spatial database development, technical report production, and computer technology while the LTRMP gains assistance in developing its products. As of December 1996, over 150 individuals have participated in this activity.

Biomonitoring of Environmental Status and Trends (BEST)

The EMTC is cooperating with the USGS BEST program in the Upper Mississippi basin and floodplain by collecting and automating data involving toxic threats to priority watersheds identified by the USFWS. The program will create digital spatial data and the interfaces necessary to serve them electronically. This project allows the EMTC to develop and gain access to databases that will assist in the integration and analysis of LTRMP data and be useful in long term studies of water quality on the Upper Mississippi River.

National Biological Information Infrastructure

The USGS Biological Resources Division has provided financial support for sharing LTRMP data through the National Biological Information Infrastructure (NBII). With the support of the Secretary of the Interior, the LTRMP expanded its WWW site. The Web site now offers more than 8,200 files on fish,

vegetation, macroinvertebrates, water quality, water levels, aerial photography, satellite imagery, scientific publications, and other GIS data. This effort directly supports the LTRMP requirement to ensure that data and information about the river system are readily accessible to resource managers and decision-makers.

Through the NBII, the Biological Resources Division also funded the EMTC to place automated aerial photographs of the UMRS on its web page. The EMTC scanned over 2,000 aerial photos taken in 1994 covering the entire 1,300-mile UMRS, created index maps, and placed the data on the EMTC's WWW server. These photographs can be electronically accessed and downloaded by Program staff, partners agencies, industry, and the public.

The NBII is supporting the development of a metadata clearinghouse for biological information. This clearinghouse will be used to share a wide variety of information, including metadata on LTRMP data sets.

FINDINGS AND CONCLUSIONS

Implementation of the LTRMP has provided Upper Mississippi River System scientists and natural resource managers with one of the most comprehensive large river monitoring programs in the world. The LTRMP has collected unbiased information necessary to comprehend and assess ecological conditions in four distinct river reaches. LTRMP monitoring and research findings have proven invaluable to river managers who must provide high quality recreational opportunities and ecological services to their constituents.

The LTRMP has also provided a long-needed data management system to compile, organize, and distribute information to the many interested parties on the Upper Mississippi River System. The nonadvocacy science program has fostered communication, increased the level of cooperation, and helped define expectations for the future of the river. Continuation of the LTRMP is vital to future multi-interest management of the Upper Mississippi River System.

Habitat Rehabilitation and Enhancement Projects

4

INTRODUCTION

Wood duck taking flight.

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

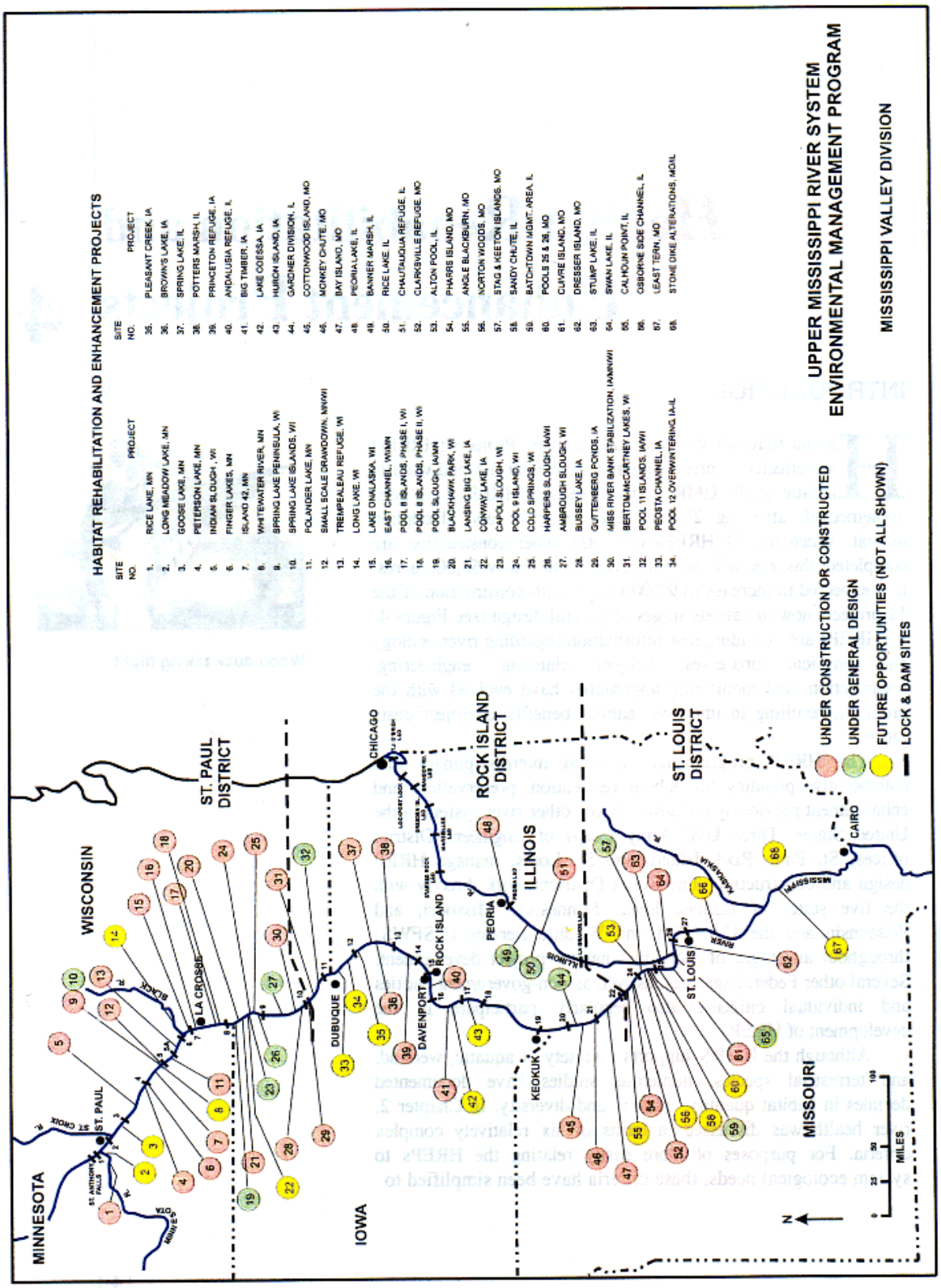


Figure 4-1. UMRS-EMP Habitat Rehabilitation and Enhancement Projects.

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.

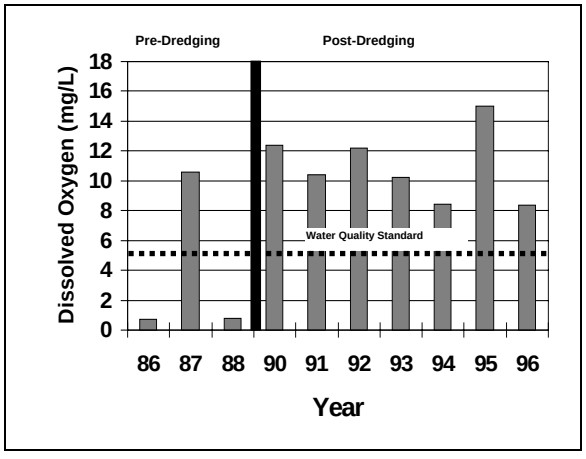


Figure 4-2. Lake Onalaska Islands, Wisconsin HREP. Average surface dissolved oxygen for sites 4 and 5 combined, during late January and February. (Source: Wisconsin Department of Natural Resources)

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.

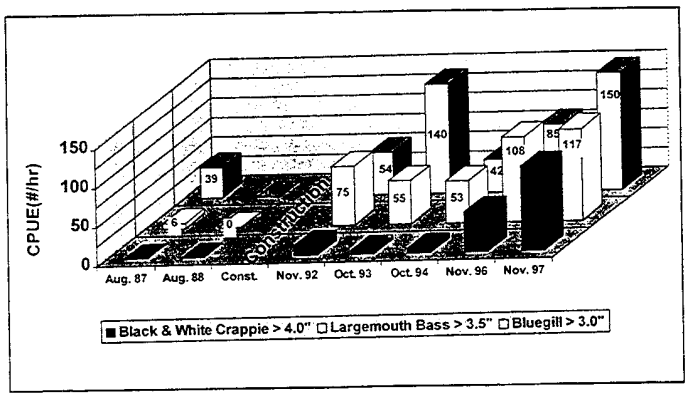


Figure 4-3. Bertom and McCartney, Wisconsin HREP. Electro-fishing Catch-Per-Unit Effort (CPUE) of target species of fish ≥ 1+ years of age in dredged pockets reference stations. (Source: Wisconsin Department of Natural Resources)

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).

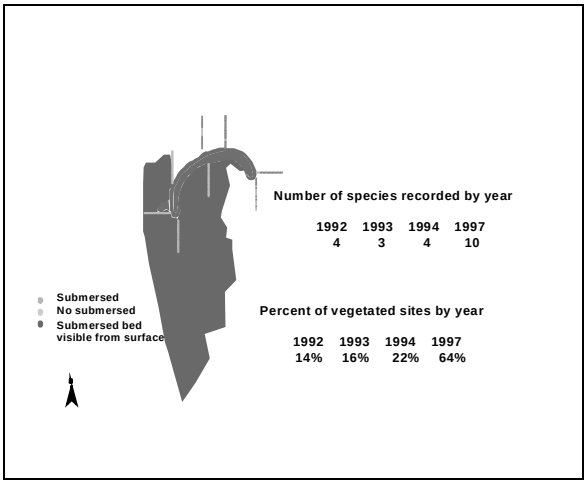


Figure 4-4. Occurrence of submersed vegetation around Arrowhead Island, 1997, Pool 7, UMRS. (Source: Wisconsin Department of Natural Resources)

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%.

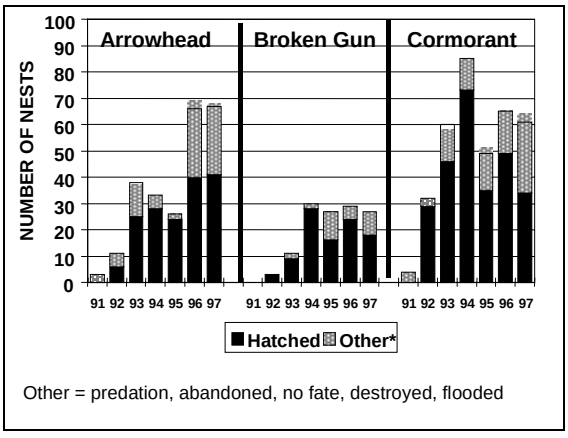


Figure 4-5. Lake Onalaska Islands, Wisconsin HREP. Waterfowl nesting success on the Onalaska HREP islands, 1991-1997. [Note: Broken Gun Island experiences significantly more human disturbance than the other islands. (Source: Wisconsin Department of Natural Resources)]

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.

Public Perspectives 5

This chapter is intended to communicate the general public's perspectives and perceptions of the UMRS and the EMP. Included in this chapter are a summary of the public's participation in the EMP to date and the results of a recent major public survey on river-related issues and management options.

Coordination with the public through the first 10 years of this program has been accomplished primarily via public meetings for HREPs, distribution of project planning and implementation documents, and presentations on the program made at various forums. More public outreach will be necessary in the future as efforts to refine and quantify long-term ecological goals and objectives are undertaken.

PUBLIC INVOLVEMENT

General

The working partnership that has formed in conjunction with the implementation of the EMP includes various government agencies, non-governmental interest groups, and members of the general public. This partnership has been crucial to successful interagency coordination. Public outreach has occurred through multiple mechanisms, including public meetings (both project-specific and more general) and presentations. Fact sheets, program updates, web sites, and videos have been developed and disseminated by the Corps of Engineers, the USGS, and other EMP partners.

Corps District Efforts

For each HREP, the responsible Corps of Engineers District prepared a Definite Project Report (DPR), which includes an Environmental Assessment, requiring public review. The DPR distribution list includes Congressional representatives; Federal,

State, and local agencies; special interest groups; organizations; various media outlets; local post offices; local libraries; and individual citizens. HREP public meetings are often included at various project development stages and during the DPR review period. The typical format at the meetings is a summary and update of the EMP and a discussion of the specific features of the proposed HREP. The public provides input concerning the problems in the area, potential solutions, and the proposed project. In the St. Paul District, more than 40 public meetings have been held in conjunction with HREPs since the EMP began. The participating natural resource agencies (USFWS and State DNRs) are actively involved in the meetings. Attendance at the meetings is normally less than 50 people, but this number has been exceeded occasionally when significant issues exist. The typical public response is support for the proposed project and the general desire to see habitat improvements accomplished at a faster rate. A frequent statement heard is "let's do more of this." Since the meetings focus on specific HREPs, changes in HREP implementation can result from the meetings.

There have been several instances where suggestions from the public have prompted project modifications that better address the habitat improvement objectives, as explained in Chapter 4.

Public meeting for Pool 8 Islands, Phase II Habitat Project.

District staff members also speak to organizations, local clubs, public officials at all levels, conferences, and other special interest groups. These presentations can include EMP displays, fact sheets, and status sheets, and frequently result in newspaper, television and/or radio coverage. An informational meeting held in Lansing, Iowa, in 1993, provided a general update of the EMP and was well received. The public response to learning about EMP has been favorable. Information about the EMP and HREPs is also provided via the District Internet-accessible web sites.

EMTC Efforts

More than 250 scientific and technical reports, program summaries, newsletters, and Project Status Reports have been produced since the EMP began. These publications are sent to program partners, decision-makers, and other interested parties to keep them informed about EMTC activities. The River Almanac, an information-sharing bulletin published periodically by the EMTC, provides program information to approximately 2,000 subscribers. The EMTC maintains a web site where LTRMP material can be accessed. The site is visited an average of 80,000 times per month, and more than 10,000 files are available for downloading.

A 17-minute video depicting LTRMP and HREP activities was produced in 1992, with almost 200 copies now distributed. The video has been shown more than 2,500 times to EMP partners, school groups, civic organizations, and the general public. The EMTC and the LTRMP field stations provide fact sheets and EMP brochures to visitors, tour groups, and other individuals who want information about the LTRMP.

To help explain program activities and findings, LTRMP staff give more than 50 papers and poster presentations a year and average 150 other outreach activities a year, such as professional conferences, demonstrations to students, media interviews, and responses to requests for data and publications. A large display is used at conferences, fairs, open houses, and public meetings to provide an overview of the LTRMP. Every year, the staff also conducts four week-long training sessions on Geographic Information Systems and up to 40

informal seminars on computer and information technology.

Other EMP Partner Efforts

The USFWS has been extremely active in promoting HREP activities and disseminating information to the public. Refuge personnel meet with local groups and individuals on a regular basis to give project and program updates, answer questions, and provide educational experiences. USFWS personnel are active participants at public meetings for HREPs, give tours of the projects to local interests, conduct media days, and serve as a local contact for public inquiries on a daily basis. The USFWS has found significant public interest in EMP activities.

Group being briefed about habitat project in the field.

The State natural resource agencies actively participate in the development of HREPs and the associated public coordination efforts. Some states have gone beyond these efforts. For example, the State of Wisconsin has developed brochures and displays and made numerous presentations to local groups. All of the states have worked with their Congressional delegations to promote and support the EMP.

Other organizations, such as the Minnesota-Wisconsin Boundary Area Commission and American Rivers, have printed articles about the EMP in periodical publications. These organizations have mailing lists that reach thousands of private citizens.

RIVER RESOURCE VALUES AND EXPECTATIONS

The human dimension is an important, yet often overlooked, aspect of river ecosystem planning and analysis. However, one of the important missions of the LTRMP is to provide decision-makers with information to maintain the UMRS as a viable large-river ecosystem, given its multiple-use character. Within the context of this mission, a survey of the general public was conducted to assay river resource values and expectations. The survey supplements information gathered through the public involvement process by covering a broader range of river issues and by capturing viewpoints representative of the full public, rather than only those who participate more actively in the EMP.

The survey was developed by the EMTC and accomplished as part of the LTRMP.[1] The survey consisted of interviews with 2,500 randomly selected individuals residing in Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The interviews were conducted by telephone between September 7 and October 24, 1996, by Survey Center Marketing Research of Chicago under government contract. The survey sample of 2,500 was divided to include 500 interviews per state; it was further divided to distinguish between interviews held with residents of counties bordering the navigable portions of the river system (300 per state) and with residents of each state's remaining counties (200 per state). The survey response rate was 60% and the results are considered accurate to +/-2%.

Results (for all respondents combined) showed that citizens value and appreciate the river system in complex ways, and have diverse opinions about how the river system should be managed in the future. Water quality and pollution were overwhelmingly the biggest concerns held by citizens. Potential management actions related to these

[1] The State of Missouri provided $5,000 in direct support of this project. The St. Paul District of the U.S. Army Corps of Engineers administered the contract.

issues received the strongest support. Efforts to improve and increase habitat and the aesthetic quality of the river ranked next highest, followed by flood protection measures.

Tow and backwaters of Pool 10.

People Value the River

Respondents value the river system for a wide variety of reasons. There was virtually unanimous agreement (99%) that it is important to take care of the river system so that we can pass it along to future generations for their enjoyment. There also was a high level of agreement (over 80% for most indicators) that the river is important for environmental, commercial and economic, recreational, historical, and aesthetic reasons. Only 28% of the respondents stated that the river has no particular importance to them personally (see Figure 5-1).

Environmental Considerations Are People's Biggest Concerns

Water quality and pollution are overwhelmingly the biggest concerns of citizens. When asked to identify the most important problem on the stretch of the river with which they were most familiar, three-quarters of respondents who had an opinion mentioned a water quality issue. Flooding issues were the only other category to be mentioned by more than 10% of the respondents with an opinion.

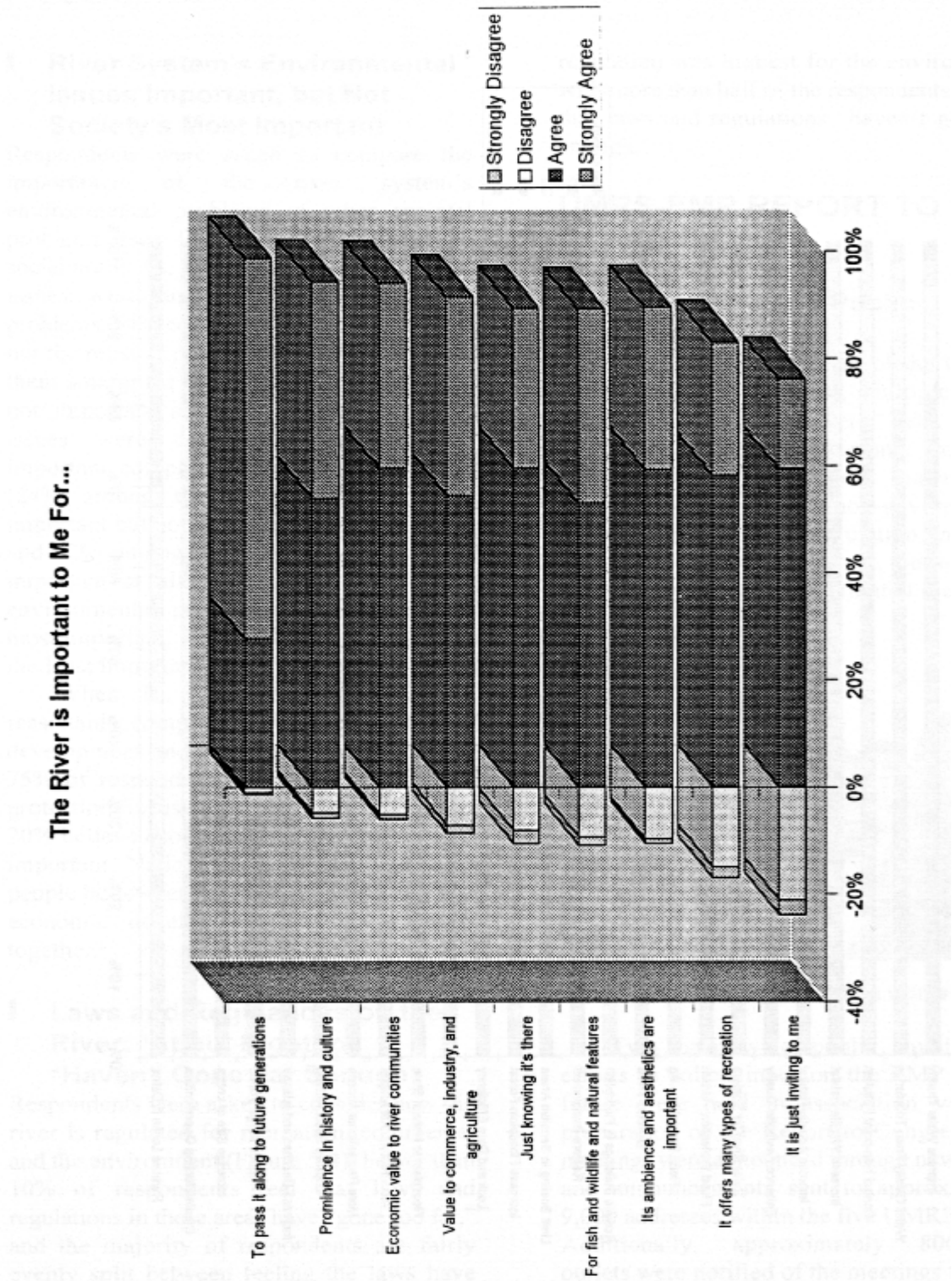
Environmental Management Actions Most Strongly Supported

Respondents were asked to identify their level of support for various river management actions using a five-point scale ranging from 1=no support through 5=strong support (see Figure 5-2).

Efforts to improve water quality and reduce pollution received the strongest support, with more than half of all respondents indicating strong support, and less than 5%indicating no support. Efforts to improve and increase habitat and the aesthetic quality of the river system ranked next highest, and so on.

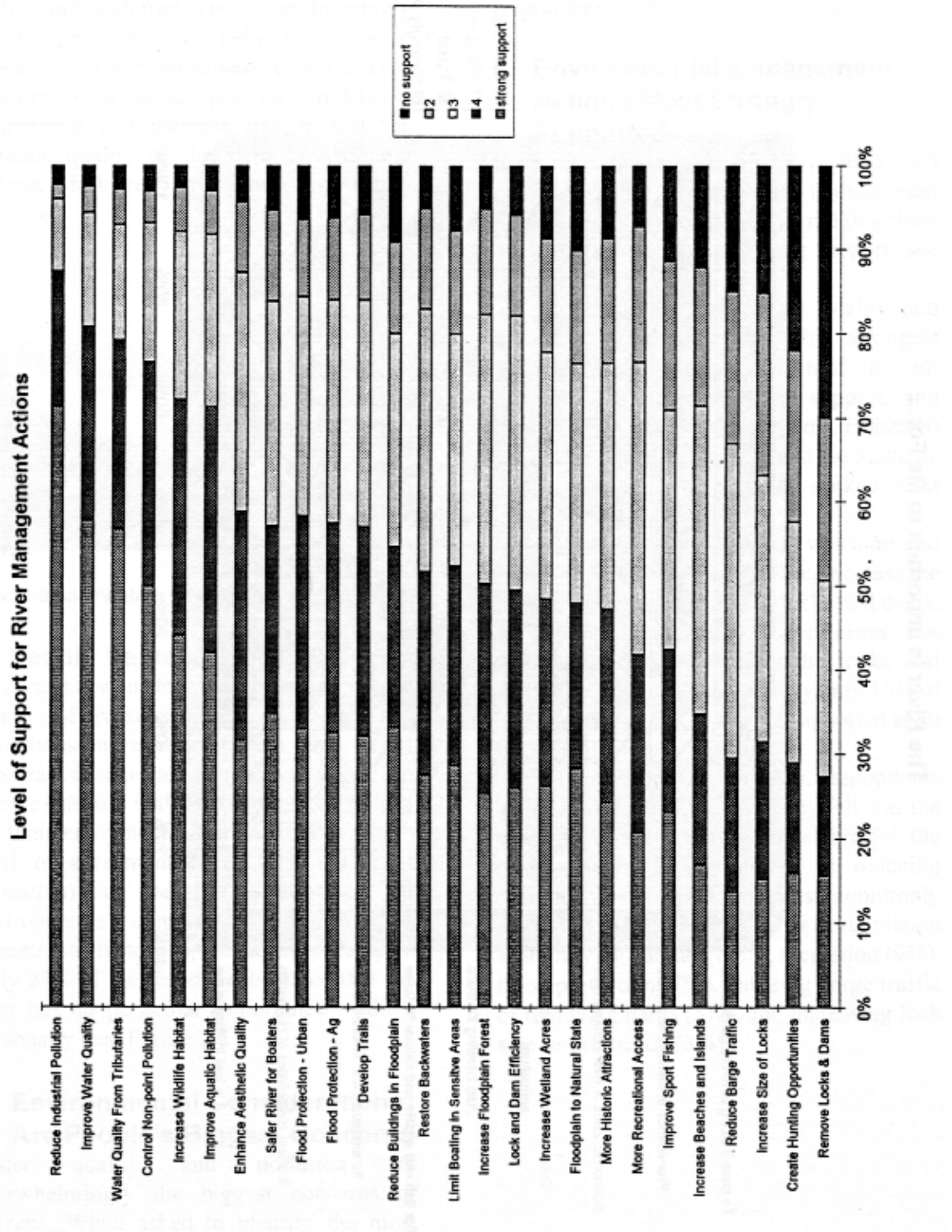
The lowest overall support was indicated for efforts to reduce barge traffic, increase the size of the locks, remove the locks and dams, and create more hunting opportunities. For example, efforts to remove the locks and dams were strongly supported by only 15% of the respondents, and were not supported at all by 30% of the respondents.

As an additional indicator, respondents were asked to identify what they felt was the most important management effort for the river system. Efforts aimed at reducing pollution were again the most commonly identified (62%), followed by efforts related to improving habitat (15%), recreation (9%), flood protection (7%), reducing barge traffic or removing dams (5%), and increasing lock size or efficiency (3%).



The reasons are listed in order of highest mean score, from top to bottom, on the figure.

Figure 5-1. Survey Results on why the river is important.



Efforts are listed in order of strongest to weakest support (based on mean score),starting from the top of the figure.

Figure 5.2. Survey results on level of support for river management actions.

River System's Environmental Issues Important, but Not Society's Most Important

Respondents were asked to compare the importance of the river system's environmental problems to other societal problems (see Figure 5-3). Compared to social problems, 19% felt river environmental issues were among the most important problems, 54% considered them important but not the most important, and 27% considered them among the least important problems or not important at all. River environmental issues were considered slightly more important compared to economic problems (24% among the most important, 54% important but not among the most important, and 22% among the least important or not important at all), and compared to other environmental problems (31% among the most important, 52% important, 17% among the least important or not important at all).

When it is impossible to find a reasonable compromise between economic development and environmental protection, 75% of respondents believe environmental protection is usually more important, and 20% believe economic development is more important. National data suggest that most people believe environmental protection and economic development can be achieved together.[2]

Laws and Regulations on the River: "About Right" or "Haven't Gone Far Enough"

Respondents were asked to consider how the river is regulated for recreation, commerce, and the environment (Figure 5-4). Fewer than 10% of respondents feel that laws and regulations in these areas have "gone too far," and the majority of respondents are fairly evenly split between feeling the laws have "struck about the right balance" or "haven't gone far enough." Support for stronger regulation was highest for the environment, with more than half of the respondents feeling that laws and regulations "haven't gone far enough."

UMRS-EMP REPORT TO CONGRESS

Formulation and Public Outreach

Early on in the development of the UMRS-EMP Report to Congress, multiple report formulation meetings were held. These meetings included participants from the Federal and State resource management agencies and several non-governmental organizations. These formulation meetings established the report format, outline, and content expectations and initiated the public involvement process.

Report to Congress formulation workshop.

Two basin-wide public involvement efforts to solicit input on the EMP and its future were held in association with the preparation of the Report to Congress. The meetings were announced through newsletters and announcements sent to approximately 9,000 addresses within the five UMRS States. Additionally, approximately 800 media outlets were notified of the meetings through press releases. The media coverage of the meetings reached thousands of members of the public.

[2] "From Anxiety Toward Action: A Status Report on Conservation in 1994." The Times Mirror Magazine's National Environmental Forum Survey, June 1994.

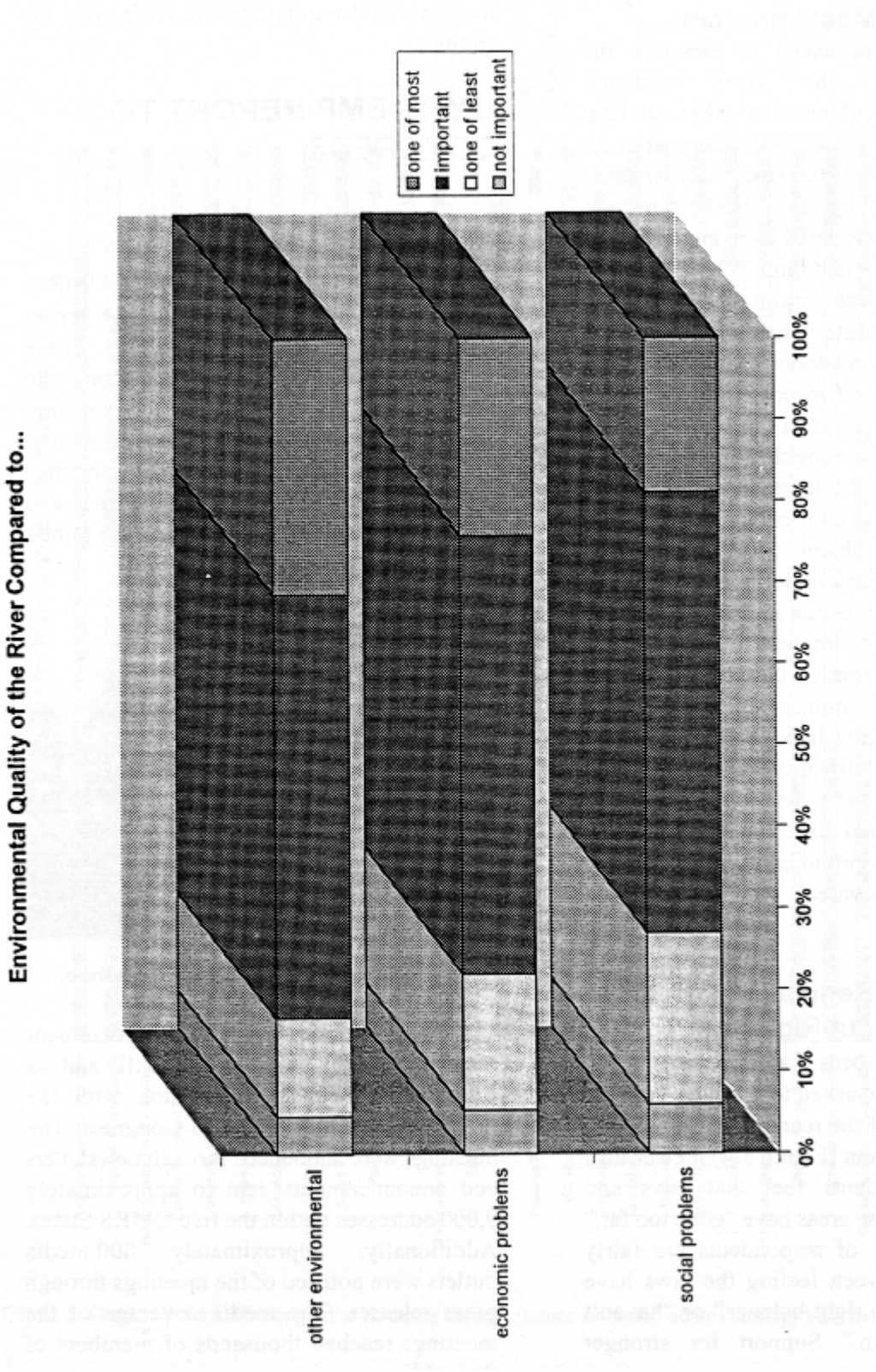


Figure 5-3. Survey results comparing environmental quality of the river to other societal problems.

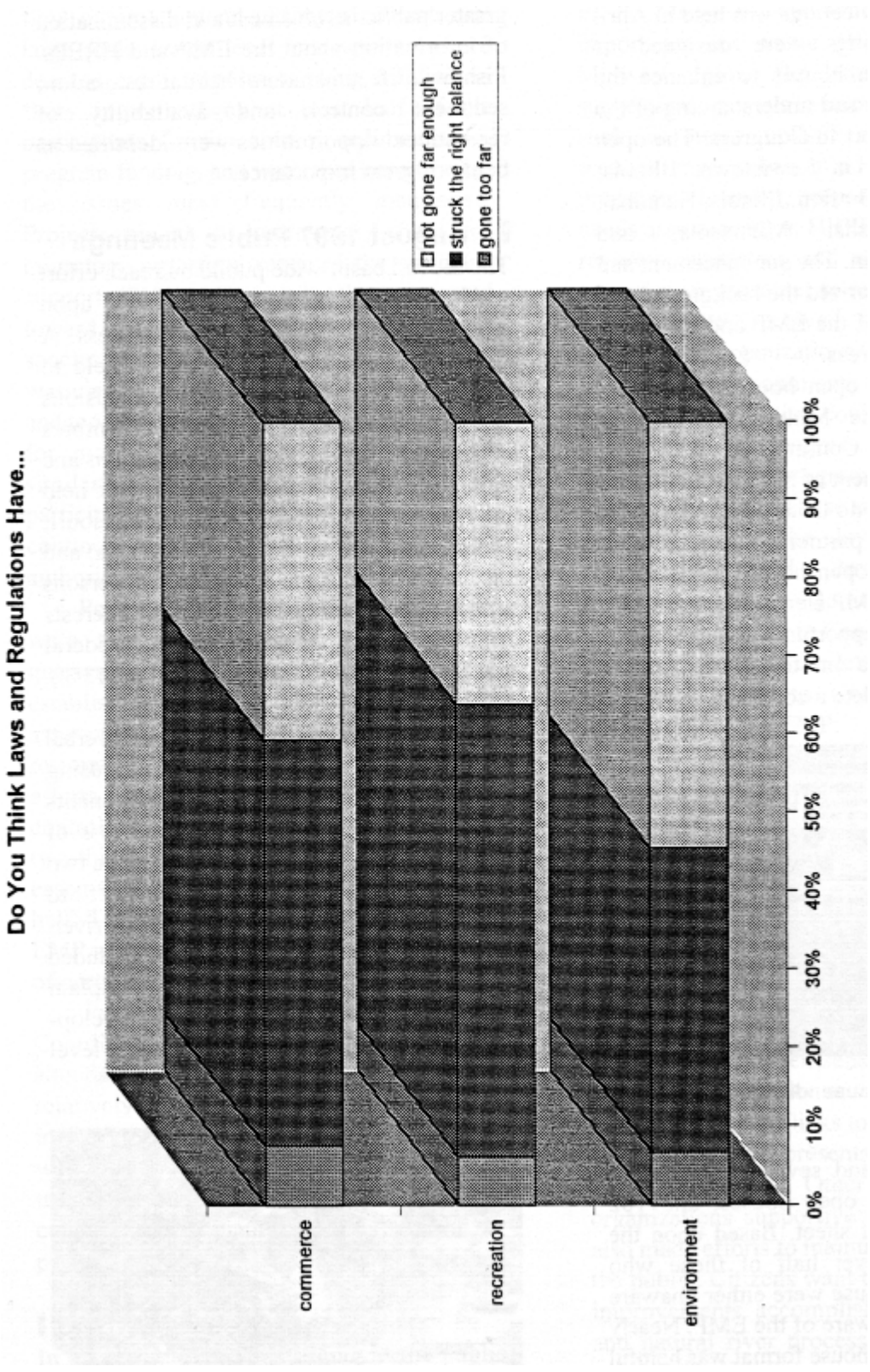


Figure 5-4. Survey results concerning laws and regulations on the river.

Spring 1997 Open Houses

The first series of meetings was held in April 1997. The meetings were designed as informational open houses to enhance the public's awareness and understanding of the EMP and the Report to Congress. The open houses were held in Lewistown, Illinois; Bettendorf, Iowa; Grafton, Illinois; Hannibal, Missouri; Wabasha, Minnesota; and Onalaska, Wisconsin. The announcement and news release summarized the background and accomplishments of the EMP and discussed the Report to Congress.

An additional open house, hosted and coordinated by the Minnesota-Wisconsin Boundary Area Commission and the Wisconsin Department of Natural Resources, was held in Prairie du Chien, Wisconsin, on May 1, 1997. The partnering agencies also were present. The open houses emphasized the HREP and LTRMP elements of the EMP. The public had the opportunity to talk to EMP team members on a one-to-one basis, view displays, and complete a comment sheet.

UMRS-EMP open house display and public outreach efforts.

One hundred and seventy-five people attended the seven open houses, and 102 returned a comment sheet. Based upon the comment sheets, over half of those who attended an open house were either unaware or only somewhat aware of the EMP. Nearly all felt that the open house format was helpful to them in learning about the program, and that they had a better understanding of the EMP after attending an open house. A common theme among the written responses at the open houses was a strong desire for greater public involvement and dissemination of information about the EMP and HREPs. Fish, wildlife, and natural habitat restoration; sediment control; and availability of recreational opportunities were identified as being of great importance.

August 1997 Public Meetings

The second basin-wide public outreach effort was undertaken during August 1997, upon release of the draft Report to Congress. A series of five public meetings was held to present the report's preliminary conclusions and recommendations to interested members of the public, and to solicit their reactions and opinions on these issues. Meetings were held in Peoria, Illinois; St. Louis, Missouri; Davenport, Iowa; Red Wing, Minnesota; and La Crosse, Wisconsin. A total of 182 persons attended the meetings, representing interests from environmental groups (26%), Federal and State agencies (20%), agriculture (13%), and recreation (10%).

Public input was gathered through verbal comments and written worksheets, focusing on both the HREP and LTRMP components of the EMP. Participants identified loss of habitat diversity and water quality as the two highest priority issues with respect to improving the "ecological health" of the river. Other high priority issues identified included loss of floodplain wetlands; floodplain confinement, encroachment, and development; sediment delivery; water level fluctuation; and shoreline erosion.

Public meeting participants completing worksheets.

Projects featuring bank stabilization,

flow control, upland sediment control, and large-scale water level management were deemed most important, being viewed as "very important" by at least half of the participants. Erosion control, sedimentation, program funding, and watershed control were the issues most frequently mentioned. Projects aimed at improving habitat for migratory waterfowl received the strongest support (71%), along with those targeted toward game fish (54%), and endangered species (40%). Funding for habitat projects was viewed as too low by half of participants, and too high by 1 out of 10. The funding level for monitoring and research was judged similarly. More than three-quarters of participants felt the EMP should be a continual program, instead of having a fixed authorization period.

Potential future actions for the EMP were also considered. More than three-quarters of participants were in favor of establishing a systemic habitat needs assessment to help guide future habitat restoration, protection, and enhancement efforts. Including small upland sediment control projects in the EMP was favored by two-thirds of participants, and including land easements or acquisitions was favored by half. The level of public involvement in the EMP was judged to be too low by two-thirds of participants, and about right by the rest.

Participants at the September 1997 EMP Coordinating Committee meeting felt that attendance at the public meetings was relatively low, but noted that it was probably indicative of the public=s general satisfaction with the EMP (high turnouts have traditionally occurred when people were concerned or unhappy with a program or project).

Written Responses

In addition to the verbal input at the public meetings, 33 letters were received from individuals and non-governmental organizations in response to the distribution of the draft Report to Congress. About 90% of the letters specifically mentioned support of the EMP. Many of the letters stressed the importance and value of the river to the Midwest region. The letters also included suggestions on ways to improve the program, such as more upland sediment control features; more urban area HREPs; increased public involvement; preparation of a habitat needs assessment; an HREP-specific science review committee; and additional use of natural river processes to rehabilitate habitat. All 14 letters received from government agencies and organizations were supportive of the EMP. Their comments focused primarily on improvements that could be made to the draft Report to Congress. The letters also suggested various program modifications to improve the EMP. These suggestions played a major role in the development of the "Conclusions and Proposed Program Implementation Modifications" and "Recommendations to Congress" chapters of this report. None of the letters in response to the draft Report to Congress advocated termination of the EMP.

FINDINGS AND CONCLUSIONS

Each Corps of Engineers District has included public involvement as part of its normal planning process for HREPs and has made special efforts to solicit public input and provide information when appropriate. The EMTC has also been sensitive to the public desire for information and has structured the LTRMP to provide links to the public through publications, staff presentations, and Internet communications. Other agencies and organizations supportive of the EMP have also made efforts to maintain a dialogue with the public. Citizens want to see more habitat improvements accomplished using HREPs and natural river processes. Most feel that existing funding levels are too low for habitat projects, monitoring, and research.

The results from a survey of the public values and expectations related to the UMRS show that citizens value and appreciate the river system and support its preservation for the enjoyment of future generations. They realize the importance of the river for multiple

uses, but are especially concerned about its environmental health and recognize the need for environmental laws and regulations to properly manage the river system.

People who attended the public meetings for the Report to Congress feel that a habitat needs assessment is needed to adequately manage the resources of the river system. The public feels an "ownership" of the UMRS and is concerned about actions taken and how they affect the health and well-being of the system. They also feel it is important to keep the public involved by expanding the level of public involvement activities in the EMP.

Program Alternatives 6

INTRODUCTION

The preceding chapters provided a detailed look at *how* the current EMP is being implemented and *what* that implementation is achieving. They have also provided insight and understanding as to *why* a dedicated program such as the EMP was and will continue to be necessary for the UMRS.

In this chapter, three alternatives specifically identified in the program's authorizing legislation[1] (i.e., terminate, continue, or continue and modify the EMP) are defined and considered. Options (e.g., program priorities, funding levels, time frames) for *what* the EMP should be in the future and *how* it should be accomplished to best meet partner and public expectations are presented and evaluated relative to the fundamental goal "to ensure the coordinated development and enhancement of the UMRS" of WRDA '86. The preferred alternative is then identified and described.

In assessing the merits of the options and alternatives considered, the EMP partners took into account additional factors including: contribution to program goals and objectives, value of maintaining interagency partnerships, sensitivity to fiscal realities, need for accountability, practicality of implementation, policy issues and constraints, and appropriate roles of Federal and State government.

> ***…the Secretary [of the Army], in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall conduct an evaluation of [(A) a program for the planning, construction, evaluation of measures for fish and wildlife habitat rehabilitation and enhancement; (B) implementation of a long-term resource monitoring program; and (C) implementation of a computerized inventory and analysis system] and submit a report on the results of such evaluation to Congress. Such evaluation shall determine each such program's effectiveness, strengths, and weaknesses and contain recommendations for the modification and continuance or termination of such program."***
>
> **—Water Resources Development Act of 1986, Section 1103(e)(2), as amended**

[1] Section 1103, WRDA '86. See text box above and report Attachment 1.

Program Options

▪ **Agency Roles.** The Corps of Engineers has served as lead agency for the EMP since its authorization. Yet, other options, including transferring authority for all or parts of the program to other agencies, do exist.

Maintaining implementation responsibility for habitat projects with the Corps is appropriate. The Corps has the necessary planning, engineering, and contracting expertise. In addition, habitat project work frequently requires close coordination with other river system functions, including navigation, flood control, recreation, and resource management, for which the Corps has significant responsibilities.

As the leading Federal agency for natural resources science, the USGS is well positioned to implement the LTRMP. However, maintaining authority for LTRMP with the HREPs helps to ensure that the important linkages between science and restoration protection, and enhancement work are maintained. It also preserves the less tangible but important aspects of interagency partnership.

Mechanisms for enhancing the interagency partnership that has been fundamental to the success of the EMP include expanding linkages among programs of different agencies and establishing charters for current coordination committees to provide clarification and accountability of all agencies' roles.

▪ **Program Duration.** The EMP was originally authorized for 10 years, with an additional 5 years added in 1990. Options for a new authorization include another finite period or continuing authorization. A continuing authority would ameliorate problems associated with scheduling and funding a number of individual projects, each of which has a different construction period. It also would help sustain a monitoring and analysis program which is recognized as a long term, ongoing need. However, a continuing authority does not explicitly accommodate the potential need for changes in the program over time. Thus, a combined approach could be employed, whereby a continuing authority is coupled with a requirement, similar to the existing authority, that periodic reports to Congress be made.

Funding Options

▪ **Funding Framework.** Options for EMP funding authorization include the existing approach, whereby annual fixed amounts are specified; a total program amount for the life of the authorization period; or a non-specified amount. Fixed annual authorizations can be problematic if not adjusted for inflation. A total program amount for the life of authorization would provide the greatest flexibility to respond to variable annual needs. However, such an approach is not compatible with a continuing program authorization. An unspecified authorization amount provides no Congressional indication of the appropriate level of investment and no benchmarks for program partners to use in budgeting decisions.

▪ **Funding Amount.** Since 1991, the EMP has been authorized at $19.455 million annually. The EMP is a program composed of multiple activities and projects designed in response to changing environmental needs over time. This is in contrast to a single project for which a definitive cost estimate can be made. Thus, the level of investment is driven by efforts to balance national priorities within established budgetary constraints. In determining whether an appropriate future EMP authorization should be more, less, or the same as past investments, it should be recognized that the annual amounts reflected in the existing authorization were developed in 1981. In the past 16 years, inflation alone would increase those costs by a total of 75%.

▪ **Funding Source.** If the Corps is to continue to serve as the lead agency for a future EMP, three budget categories are available: General Investigations (GI), Construction General (CG), and Operation

and Maintenance (O&M). None of the Corps' budget categories is ideally suited to the nature of the activities undertaken in the EMP. The LTRMP carries out monitoring and data analysis, while the habitat program is primarily a construction activity. Within the HREP program, some projects resemble operation and maintenance activities (e.g., water level management). In balance, the construction budget is most appropriate given that the EMP is clearly not a study (suggesting GI authority), nor is it conducting O&M in the traditional sense. Also, habitat restoration, protection, and enhancement, all of which are essentially construction activities, do and likely will continue to represent the largest percentage of total program funding.

Cost Sharing Options

Cost-sharing options range from 100% Federal to 100% non-Federal. Other relevant options include 25% or 35% non-Federal, both of which have precedents in other Corps authorities[2] established to carry out for environmental protection, restoration, and enhancement work.

For the LTRMP, 100% Federal funding, as the current EMP authorization provides, recognizes that monitoring, data analysis, and applied research associated with a "nationally significant" ecosystem that spans multiple-state jurisdictions is most appropriately funded by the Federal government. That funding base may be leveraged by utilizing and incorporating data sets and information generated and funded by others, such as State and local governmental agencies, non-governmental organizations, and universities.

Restoration, protection, and enhancement of fish and wildlife habitats typically produces benefits beyond the local or even State level and therefore should be looked upon as a shared responsibility. Cost-sharing enhances joint decision-making.

One cost-sharing formula for habitat projects would be 25% non-Federal, paralleling the formula currently used for Section 1135 projects. Similar to Section 1135 projects, which are associated with existing Corps projects, habitat projects are principally undertaken on a river system that is managed by the Corps as a Federal navigation project.

Those projects undertaken on lands managed as a national wildlife refuge are appropriately funded at 100% Federal cost. Current law prescribes such an approach in recognition of the on-going Federal responsibility for such land, as well as limitations which states have in investing in Federal lands.

The potential exists for enhanced recognition of non-Federal contributions in the form of in-kind services and increased responsibility for design and construction by the non-Federal sponsor. Precedent exists in the Water Resources Development Act of 1996 amendments to the Section 1135 program for crediting in-kind services and provisions for executing reimbursable work (Section 211). Credit for in-kind services has the potential benefit of leveraging Federal dollars.

Program Components

As currently structured, the EMP includes five components for which specific funding levels are authorized: habitat projects, long term resource monitoring, computerized inventory and analysis, recreation projects, and the economic impacts of recreation study. While options for a future EMP could include various combinations of these five components, in reality, habitat projects and the LTRMP are the heart of the EMP. Maintaining them as individual components of a single authorized program would ensure that the critical linkages between them are preserved.

The long term resource monitoring and computerized inventory and analysis components have become virtually indistinguishable and in fact are inextricably related. For this reason, they have come to be jointly referred to as the Long Term Resource Monitoring Program (LTRMP).

Other current program components need not continue in the future because they are either completed (study of economic impacts

[2] See report Attachment 5.

of recreation) or because other authorities are available (recreation projects.)

Recreation projects have not been pursued under the EMP. While recreation is an important use of the UMR, recent Administrations have deemed such projects a non-Federal responsibility.

HABITAT RESTORATION, PROTECTION, AND ENHANCEMENT OPTIONS

Other Authorities

There is a variety of other authorities that could be used to undertake some of the activities now accomplished under the EMP. For example, the Corps has various environmental authorities[3] including Section 1135, Section 204, and Section 206. Similarly, the USFWS has responsibility for such programs as Partners for Wildlife, the Small Wetland Acquisition Program, and refuge management. However, none of these alone, or in combination, could fully replace the EMP. They were designed, in many instances, for different purposes. Many of them are targeted to smaller scale resource issues than those generally encountered on the Upper Mississippi River System. More importantly, the combination of discrete projects undertaken through a variety of different authorities does not constitute a comprehensive approach for maintaining and improving an entire ecosystem. Nor do they offer the extensive partnership benefits of the EMP. These are the unique values and potentials of the EMP.

[3] See report Attachment 5 for more details.

Upland Sediment Control

Erosion in upland areas has a significant effect on 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. While not expressly precluded under the EMP authorization, Corps policy has regarded such features as beyond its purview and as the responsibility of other agencies.

Nevertheless, two EMP projects 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.

There are various options for enhancing the EMP's capacity to address upland sediment: amend the EMP authority to expressly allow upland sediment control features; pursue such approaches under the existing EMP authorization by changing Corps policy; or utilize existing authorities of other agencies.

Land and Easement Acquisition

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 reflecting the current Administration's position and policies as developed for other Corps programs.

Initial policy stated "The use of privately-owned lands (or other lands that do not fit into the categories [of lands managed as a National refuge, Corps project lands, or state-owned lands managed by a state for fish and wildlife purposes]) for fish and wildlife enhancement projects should not be pursued." The consequence of this policy was twofold. First, the policy of "no acquisition" focused habitat projects in areas

where there were existing Federal and State land holdings. This severely hampered accomplishment of EMP goals in certain reaches/pools of the Upper Mississippi River Basin—i.e., areas where wildlife habitat lands in Federal and State ownership were few. In particular, the Open River reach below St. Louis is largely leveed, with the floodplain in private ownership. Opportunities for habitat enhancement and restoration are thus limited. To date, no HREPs have been undertaken on this lower river reach.

Second, the policy also excluded land or easement acquisition from willing sellers as a measure available for evaluation and implementation within the EMP. Applying resources to preserve existing habitats that are essentially healthy or to enhance marginal habitats that are not currently within the State and National Wildlife Refuge system could be a more economically efficient means to achieve environmental restoration, protection, and enhancement.

In October 1994, the USACE modified the policy on land acquisition to its current status. This modification resulted in inclusion of land acquisition as an additional technique for habitat enhancement and restoration within the following parameters:

a) The acquisition is primarily for fish and wildlife preservation, enhancement or restoration purposes;

b) It is cost efficient compared to other techniques;

c) The land acquisition component has a non-Federal sponsor to acquire the land, fulfill the construction cost sharing requirements, and assume full responsibility for all project operation and maintenance activities for fish and wildlife on such land;

d) The project or any portion thereof for which lands are to be acquired is cost shared 75% Federal and 25% non-Federal;

e) Similar to the Section 1135 program, cost sharing for proposed habitat projects that include components of both land acquisition and construction would consist of a lands, easements, rights-of-way, relocation and dredged material disposal area credit applied to the non-Federal sponsor's portion of the 25% cost share requirement. (If the value of the LERRD contribution exceeds 25% of the total project cost, the Federal Government would reimburse the difference to the non-Federal sponsor.)

f) Lands purchased for inclusion in a national wildlife refuge would be acquired under the existing programs and authorities of the USFWS.

g) No greater than 10% of the total allowable program funds for habitat projects of the UMRS-EMP would be used for land acquisition through the 1994 through 2002 period.

h) Any land acquired must include active construction and/or operation and management measures to improve the value of the fish and wildlife habitat over its value in its current condition.

To date, the impacts of the 1994 change in policy have been minor. Because substantial lead time typically is required for land or easement acquisition and most HREPs were initiated prior to the policy change, there have been few opportunities to pursue projects under the new policy. However, the Rice Lake HREP (Illinois River, La Grange Pool) is evaluating land acquisition alternatives made possible by this policy change.

Options for establishing land and easement acquisition from willing sellers as a viable habitat restoration tool include amending the EMP legislation to expressly authorize it or revising administrative policies that currently constrain it.

Innovative Projects

The EMP has taught us that some of the standard approaches to environmental restoration, protection, and enhancement may not be the most effective and that some of the traditional planning and construction guidelines stifle innovation. The original concept of the EMP included traditional, innovative, and experimental; small and large scale; and structural and nonstructural projects. The types of projects that will most effectively meet system goals and objectives will change over time as we gain experience, develop new technologies, and recognize river system dynamics.

There is a variety of policy options available for enhancing the EMP's ability to adapt to changing needs and pursue promising new avenues. One option is to reconsider the traditional design of a 50-year project life, which also requires a 50-year O&M commitment from the USFWS or non-Federal sponsor. However, the pursuit of innovative projects and the spatial distribution of projects may be limited in the future by the practical effect of cost sharing requirements which can preclude projects on Federal lands unless they meet the requirements of Section 906(e) of the 1986 Water Resources Development Act.

LONG TERM RESOURCE MONITORING OPTIONS

Program Focus

A variety of options exists for changing the focus of the monitoring and research program established under the EMP. The options identified as being of greatest interest to river management agencies are: modify monitoring design; increase emphasis on research activities of direct relevance to management actions; expand the number of components monitored (e.g., wildlife, mussels, and additional water quality parameters); and expand support of navigation project O&M research requirements including forecasting of future river conditions. These changes do not require legislative action.

The focus of the LTRMP was never intended to be technology development, even though a computer inventory and analysis (CIA) element was authorized separately. An information management system is an integral part of the program and not an end in itself. Eliminating the distinction between the CIA and LTRM would recognize this relationship.

- **Spatial Scale.** The LTRMP's primary monitoring activities currently are limited to five pools and a selected reach of the open river. Options include monitoring additional pools and open river reaches and expanded monitoring of floodplains, tributaries, and the UMR basin.

PLANNING OPTIONS

No quantitative, systemic plan exists for UMRS habitat restoration, protection, and enhancement, or, more broadly, for integrating the multiple uses, development, and management of the river. Options identified to meet this need include a system-wide habitat needs assessment, a broader ecosystem management plan, or an integrated basin-wide management plan. It is recognized that there is a need for a greater level of comprehensive planning and integrated management of environmental and economic activities and programs on the river. However, such an effort was deemed beyond the scope of what the EMP alone was designed to achieve.

ALTERNATIVES CONSIDERED

After considering a variety of options for changing specific aspects of the current EMP, a range of basic alternatives was formulated that combines those options into programmatic "packages" for evaluation (see Table 6-1). Each alternative offers a different strategic approach to meeting the ecological needs of the UMRS.

TABLE 6-1: Summary and Comparison of EMP Alternatives by Features			
Features	**End EMP**	**Continue (at 1986 levels)**	**Continue and Modify**
Time Frame	Not applicable	15-year fixed duration re-authorization (2003-2018)	Continuing authority with requirement for a Report to Congress every 6 years
Total Federal Funding (excluding periodic planning costs)	0	$19.455 million/year [1/]	$33.17 million/year [2/]
Federal Funding Source(s)	Not applicable	Corps of Engineers [3/]	Corps of Engineers [3/]
Habitat Protection, Restoration and Enhancement			
• Funding (Federal)	0	$13.0 million/year	$22.75 million/year [2/]
• Cost Sharing	Not applicable	-25% non-Federal on non-refuge lands -100% Federal on refuges	-25% non-Federal on non-refuge lands -100% Federal on refuges
• Geographic Scale	Not applicable	Main channel and floodplains of navigable system	Main channel, floodplains, and immediately adjacent upland areas of navigable system
• Features	Not applicable	Habitat projects, including hydraulic exchange, water level management, backwater dredging, island construction, and other traditional and innovative habitat rehabilitation, protection, and enhancement measures	HREPs undertaken in context of system-wide habitat needs assessment; habitat projects, including hydraulic exchange, water level management, backwater dredging, island construction, and other traditional and innovative habitat rehabilitation, protection, and enhancement measures; upland sediment control; land/easement acquisition from willing seller(s)
• Lead Agency	Not applicable	Corps of Engineers	Corps of Engineers
Monitoring, Data Analysis, and Applied Research			
• Funding	0	$5.955 million/year	$10.42 million/year [2/]
• Cost-Sharing	Not applicable	100% Federal	100% Federal
• Geographic Scale	Not applicable	Monitoring of select pools	Monitoring at widely distributed channel and floodplain locations. Emphasis on acquiring and analyzing data at multiple scales.
• Lead Agency	Not applicable	USGS, with funds provided through Corps of Engineers	USGS, with funds provided through Corps of Engineers
Habitat Needs Assessment			
• Funding	0	0	Up to $1 million (initial cost). Approximately $250,000 (in 1997 dollars every 6th year thereafter)
• Activity	Not applicable	None	Comprehensive Habitat Needs Assessment
• Lead Agency	Not applicable	Not applicable	Corps of Engineers

[1/] Includes $500,000/year authorized for recreation projects.

[2/] Current EMP authorized appropriation for the HREP and LTRMP program elements updated for inflation. (1981 appropriation level X 1.75)

[3/] It is proposed that program funding continue to be provided through the Corps' Construction General (CG) budget.

End EMP (No Action Alternative)

- **Description.** EMP authorization would expire at the end of fiscal year 2002. No UMRS-specific program authority would replace it.

- **Features.** After 2002, UMRS habitat restoration, protection, or enhancement would be accomplished under other existing authorities. Monitoring, data analysis, and research would be limited to those sites and parameters of greatest interest to individual State or Federal agencies.

- **Implementation.** No action, other than annual appropriations through FY 2002, would be required of Congress. HREP planning and design work would be discontinued unless project construction could be completed prior to 2002 or implementation could be funded under another authority, such as Section 1135. Projects currently under construction would be accelerated, if necessary, to realize completion by fiscal year 2002. The Environmental Management Technical Center's LTRMP responsibilities would be dismantled with data and equipment transferred to the Corps of Engineers or other appropriate agencies.

Continue EMP

- **Description.** The budget and structure of the current EMP would continue unchanged after FY 2002.

- **Features.** The process for identification and selection of HREPs would remain essentially unchanged. The types of projects undertaken would conform to existing Corps policy. The pace of project implementation would decrease as the effects of inflation over time reduce actual purchasing power. LTRMP monitoring design would need to be regularly revised and data analysis and research efforts reprioritized to meet funding limitations.

- **Implementation.** Congressional action would be required to extend authorization beyond FY 2002. Partner agencies would help restructure and downscale the habitat program and LTRMP due to the effects of inflation.

Continue and Modify EMP

- **Description.** A continuing authority and increased funding level would be provided to continue and enhance two program components: HREPs and LTRMP. A habitat needs assessment would be conducted to help guide the selection and design of HREPs and provide a basis for project performance measurement.

- **Features.** HREP measures would be expanded to include a wider variety of restoration, protection, and enhancement techniques, including upland sediment control of local watersheds directly affecting riverine habitat; land and easement acquisition from willing sellers; and more innovative measures.

  The LTRMP would continue with an emphasis on: a) improving monitoring design; b) applied research to provide information needed for river management; c) an expanded array of components monitored, including wildlife, mussels, and enhanced water quality parameters; and d) expansion of spatial scale to include more widely distributed sampling locations within the floodplain and analysis at multiple scales. In addition, LTRMP responsibilities would be expanded to include broader responsibilities for HREP monitoring and support for the habitat needs assessment (HNA).

An HNA would be conducted[4] at the outset of the newly authorized program to identify objectives and opportunities for habitat protection, restoration, and enhancement. In general, the assessment would include a description of historical and existing habitat conditions, as well as an identification of objectives for future habitat conditions. Such an assessment would help guide the selection and design of HREPs by defining habitat needs at system-wide, river reach, and pool scales. It would address a variety of habitat requirements, including physical, chemical, and biological parameters. Six-year updates would provide a basis for recommending future changes to Corps policies and to the EMP authorizing legislation, including funding.

Every six years, a Report to Congress would be provided. Given that the EMP would be authorized as a continuing program, it is recognized that periodic adjustments may be needed. The Report to Congress would describe program accomplishments, including progress toward meeting the needs identified in the HNA, and recommend program modifications, if necessary, to achieve habitat restoration and protection objectives.

- **Implementation.** Congressional action would be required to: amend Section 1103 to provide continuing authority, increase the authorized funding level, and institutionalize further reporting to Congress on a 6-year schedule. Corps of Engineers policies including those related to land acquisition, upland sediment control, 50-year project life, and demonstration projects would be clarified or revised.

[4] Efforts to develop an HNA for the UMRS are under way. The funding requirements identified in this report would support the expedited development of an HNA at higher resolution. This product will allow both the HREP and LTRM elements of the EMP to be better, more efficiently, and effectively implemented. The HNA also is expected to provide an important component of any future comprehensive planning and management efforts for the UMRS.

ALTERNATIVES EVALUATION

Criteria

In weighing alternatives for a future EMP, the following criteria were considered:

- **Completeness.** For a future EMP, completeness would mean all necessary investments and future actions needed to realize full implementation of a range of ecosystem restoration, protection, and enhancement measures and monitoring and research requirements are met. Monitoring and research provide the essential information necessary to validate how actual conditions approach established ecosystem goals.

- **Effectiveness.** For a future EMP, effectiveness would mean that implementation of the alternative represents progress towards a shared UMR ecosystem vision. This clearly assumes that ecosystem goals and objectives exist and a means to measure the results of implementing the alternative is available.

- **Efficiency.** For a future EMP, efficiency would mean that restoration alternatives are incrementally analyzed and the most cost-effective means of producing the target outputs is selected.

- **Acceptability.** For a future EMP, acceptability would mean the alternative is broadly recognized as an appropriate means for realizing systemic ecological goals. It is widely supported by governmental agencies, non-governmental organizations, and the general public, and the alternative accommodates multiple participant involvement in its accomplishment.

RESULTS

The End EMP alternative (or no action alternative) would result in enhancement of some 35,000 acres of riverine and riparian habitat over the life of the program.[5] LTRMP data would contribute to future river studies. Habitat project and monitoring and research proponents would in the future have to look to other Federal or State authorities to accomplish habitat rehabilitation and enhancement and data collection and analysis.

The alternative of a "cross-cut budget" approach, under which EMP activities would in the future be carried out under other existing programs of the Corps and other Federal agencies, has been explored and rejected because of its potential to fragment the effort. Fundamental to this issue is that Congress enacted Section 1103, the Upper Mississippi River management Act of 1986, "to ensure the coordinated development and enhancement" of the UMRS.

The Continue EMP alternative at 1986 funding levels would result in rehabilitation and enhancement of some 3,000 acres of habitat on an average annual basis through FY 2002. The level of LTRMP data collection and applied research activities would decline as real costs increase over time.

The Continue and Modify EMP alternative would increase the efficiency and effectiveness of EMP habitat enhancement and rehabilitation projects, and expand the usefulness of LTRMP data collection and research. This alternative ranks the highest according to the four screening criteria of completeness, effectiveness, efficiency, and acceptability. An average of 5,000 acres of riverine and floodplain habitat would be rehabilitated and enhanced annually during the first six-year cycle of the modified EMP.

[5] Total number of acres would be dependent upon actual program funds made available through FY 2002.

Conclusions and Proposed Program Implementation Modifications[1]

7

Since European settlement, the Upper Mississippi and Illinois Rivers and their watersheds have been greatly altered by human activity. One of the most significant alterations of the rivers has been the construction of a system of locks, dams, and channel training structures to improve their navigability. River impoundment for navigation purposes initially increased the extent of wetland and aquatic habitat in the river floodplains. However, the continuing delivery of sediment from the system's watershed in combination with the decreased sediment storage and transport capabilities of the regulated (pooled) river system has led to an overall decline in habitat quantity and quality.

Many other human activities and their effects (e.g., changes in basin land cover/land use, implementation of urban flood control projects, continuing point and non-point pollution, and the introduction of non-native species) present additional challenges to the integrity of the river ecosystem.

Human demands on the natural resources of the UMRS are likely to increase over the foreseeable future. Meanwhile, the public will continue to expect the system's environmental qualities to be maintained for their benefit and that of future generations. This is the fundamental reason why the EMP was first authorized in 1986 and why it needs to be continued.

Five overarching conclusions, based on the results of this review of the EMP's outputs, strengths, and weaknesses and future recognized needs of the UMRS, have been drawn:

[1] All recommendations requiring legislative action by the Congress of the United States are presented in Chapter 8 of this report. Institution of the program implementation modifications proposed in this chapter is within the existing purview of the U.S. Army Corps of Engineers.

The UMRS-EMP currently is the single most important and successful program authorized by the Federal government for the purposes of understanding the ecology of the UMRS and sustaining its significant fish and wildlife resources.

Although the National Wildlife Refuge System, NRCS conservation programs, and other government efforts to protect and improve natural resources all have and continue to play very substantial roles in assuring the current health and future sustainability of the UMR ecosystem, they do not individually or collectively provide the balanced combination of monitoring, research, and habitat rehabilitation, protection and enhancement that is unique to the EMP. This is also true of the Corps of Engineers' other environmental restoration authorities. Those authorities provide important site-specific restoration opportunities but lack the systemic perspective that guides and drives the implementation of programs such as the EMP. In addition, these other authorities are not yet of the magnitude necessary to meet the monitoring and research and habitat restoration, protection, and enhancement needs of the UMRS.

The degradation and loss of UMRS aquatic, wetland, and floodplain habitat can be substantially offset by the application of habitat restoration, protection, and enhancement measures. Such measures must be based upon quantitative and qualitative goals that are compatible with the multiple purpose use of this national resource.

The HREP element of the EMP is demonstrating that fish and wildlife habitats can be successfully restored and improved. Traditional, innovative, and experimental construction and resource management approaches have been employed to slow, and perhaps reverse, downward trends in UMRS habitat quality and quantity without constraining other uses of the river system.

A habitat needs assessment (HNA) should be completed to establish a technically sound, consensus-based management framework or "blue print" for the restoration, protection, and enhancement of the UMR ecosystem. This assessment would begin to identify, at the system, pool, and reach levels, the long term habitat requirements and serve to refine the focus of future system monitoring and research activities.

In evaluating the current program and identifying options and alternatives for the future, the Corps of Engineers and the EMP partners recognized that current ecological goals and objectives for the UMRS and quantification and evaluation metrics for the EMP need to be further refined. This refinement process is fundamental to maintaining program focus and realizing maximum program outputs over time.

During the past decade, implementation of the EMP has provided the additional experience, knowledge, and tools necessary to more explicitly state UMR ecosystem goals and objectives. Our understanding of the ecology of regulated rivers has grown, availability of spatial data about the UMRS has increased, and analytical technologies have evolved. These changes allow development of a more comprehensive "blueprint" for future habitat conditions on the UMRS. The accomplishment of a habitat needs assessment, recommended as part of the preferred alternative for the future of the EMP, would increase the resolution of long term, system, reach, and pool-level, environmental goals and objectives. It will also provide additional measures for evaluating the results and tracking the progress of future UMRS habitat restoration, protection, and enhancement efforts and monitoring and research activities.

Increasingly effective management of regulated river systems, such as the UMRS, is dependent upon long term monitoring to detect system changes and applied research to understand system dynamics and relationships.

The LTRM and CIA elements of the EMP are meeting many important UMRS data and information needs and bringing about an expanded understanding of system dynamics, trends, and dependencies. An expanded LTRMP, which incorporates the CIA, is necessary to realize the original monitoring and research expectations of the 1986 WRDA; to support future UMRS comprehensive planning and management initiatives; and to allow full implementation of the suite of recommendations included in recent program science and management reviews. With an increasingly complex array of demands being placed upon the UMRS, an extensive applied monitoring and research program will continue be necessary to balance the system's many uses.

Implementing the EMP has resulted in an unprecedented level of communication and cooperation among the Federal and State partner agencies responsible for UMRS management. However, greater public involvement, outreach, and education also are needed.

One of the greatest and yet most difficult to quantify outputs of the UMRS-EMP has been the increased interaction between UMR resource management agencies and the general public. A heightened understanding of the roles, responsibilities, capabilities and limitations of the many agencies involved with program coordination and management has been acquired, resulting in a better understanding of and appreciation for the many different resource management perspectives that exist. Collectively, these coordination and communication outputs add up to improved working relationships; effective partnerships; and, ultimately, more balanced resource management.

Although participation in the EMP by non-governmental organizations and members of the general public has been expanded, additional coordination and outreach should be pursued to assure that all river constituencies are fully involved in all aspects of program implementation.

LTRMP AND HREP CONCLUSIONS AND PROPOSED PROGRAM IMPLEMENTATION MODIFICATIONS[2]

The following conclusions and proposed program implementation modifications present the accomplishments and weaknesses of the LTRMP and HREP elements of the EMP and communicate suggestions for changes in the Corps of Engineers' policy, guidance, or program implementation procedures. These proposals were identified during the report formulation and public review process.

The Long Term Resource Monitoring Program (LTRMP)[3]

- **The LTRMP is making significant contributions to our understanding of the ecology of the UMRS. Resource managers and decision-makers are increasingly using LTRMP biological, physical, chemical, and land use/cover data to accomplish better river system planning and to make more informed river system management decisions.**
- **LTRMP data and analyses are providing meaningful characterization of system conditions and identification of long term trends. This enables better prediction of the impacts of human and natural actions and allows**

[2] Conclusions and proposed program implementation modifications specific to the Traffic Monitoring, Economic Impacts of Recreation, and Recreation Projects elements of the EMP are presented in Attachment 3.

[3] LTRMP has come to refer to both the LTRM and CIA program elements identified in the EMP's authorizing legislation.

the Corps and others to design, construct, operate, and maintain their UMRS projects in a more environmentally sustainable fashion.

- **The LTRMP has established the institutional framework (e.g., sampling protocols, centralized database) and infrastructure (e.g., field stations, equipment) necessary for conducting systemic monitoring and applied research at a level that was previously not possible.**
- **The LTRMP is increasing the accessibility of UMRS data and information to resource managers and the public.**
- **The LTRMP must continue to adapt to evolving management data and information needs and advancements in ecological science and technology. This adaptation will require infra-structure modifications, monitoring program changes, and reprioritization of research efforts.**
- **The LTRMP plays an important role in the planning and implementation of HREP projects. An expanded LTRMP would allow for a much greater level of involvement by the program's science staff in the identification, formulation, monitoring, and assessment of HREPs.**
- **The LTRMP's acquisition of additional key spatial data coverages (e.g., water depths and velocities, habitat types and distributions, substrate qualities, land ownership) is essential to its ability to support successful river resource planning and management.**

The Habitat Rehabilitation and Enhancement Projects (HREPs)

- **HREPs constructed to date have directly restored, protected, or enhanced over 28,000 acres of critical UMRS fish and wildlife habitat.**
- **Important system-level ecological benefits are known to accrue from the site-specific improvements (e.g., spawning habitat, food resources, nesting opportunities, shelter, etc.) provided by individual HREPs.**
- **The HREPs have made significant contributions to the science of habitat and ecosystem restoration by developing new and increasingly effective planning tools, engineering designs, and evaluation methods.**
- **The challenge for the future is to better couple HREP evaluation data, LTRMP systemic data, and decision support tools now available with the experience gained in the design and implementation of HREPs over the past 10 years to shape system-wide habitat restoration, protection, and enhancement strategies.**

Proposed Program Implementation Modification
The Corps of Engineers, Mississippi Valley Division should assure that an HNA for the UMRS is completed. The HNA would include quantitative objectives for habitat conditions throughout the UMRS, providing an improved framework for habitat project selection, design, and evaluation.

- **Most habitat project implementation costs have declined as a result of evolving HREP planning, design, and construction approaches.**
- **Corps of Engineers Districts now have over 10 years of experience in the planning, design, implementation, and evaluation of HREPs. Further**

delegation[4] of project approval authority would streamline project implementation and thereby reduce program costs.

Proposed Program Implementation Modification
To reduce habitat project review and approval time and therefore implementation costs, the U.S. Army Corps of Engineers, Mississippi Valley Division should delegate approval authority for those projects with an estimated construction cost of $1 million or less to the District level.

Proposed Program Implementation Modification
To gain additional project implementation efficiencies, the U.S. Army Corps of Engineers, Headquarters should delegate approval authority for those projects with an estimated construction cost of $5 million or less to the Division level.

- **HREPs implemented to date have been essentially confined to lands already under public ownership. On the lower two-thirds of the UMRS, limited public land ownership has restricted options for restoring, protecting, and enhancing habitat.**

Proposed Program Implementation Modification
The Corps of Engineers, Headquarters should review and, if necessary, modify current policies and guidance to ensure that HREPs can include obtaining real estate interests from willing sellers when and where such actions are determined to be consistent with and supportive of program goals and objectives. *Any new or revised policy and guidance should include a provision for the government to reimburse the local sponsor for all lands, easements, rights-of-way, relocations, and disposal sites (LERRDs) cost in excess of 25% of the total project cost.*

- **Sediment delivery from uplands immediately adjacent to HREP project sites needs to be simultaneously addressed to maximize project life and outputs.**

Proposed Program Implementation Modification
The Corps of Engineers, Headquarters should modify EMP policies and guidance to allow the inclusion of upland sediment controls as part of HREPs in cases where sediment from the local watershed is directly affecting the project area and upland sediment control is a cost-effective measure for achieving project objectives.

- **Most HREPs have met, and in many cases exceeded, their physical and chemical design objectives. Quantitative verification of biological outputs is more difficult to accomplish. Performance (physical, chemical, and biological) monitoring of habitat projects, although costly, is expanding our understanding of habitat requirements of UMRS species. EMP partners have used these performance monitoring results to design more cost-effective projects as the program has evolved.**

Proposed Program Implementation Modification
The U.S. Army Corps of Engineers, St. Paul, Rock Island, and St. Louis Districts should continue the physical, chemical, and biological monitoring of pre- and post-project conditions. Integration of project-specific monitoring with the systemic monitoring activities of the LTRMP should be enhanced. Biological response monitoring of selected habitat restoration, protection, and enhancement measures is essential to evaluating the ecological and cost effectiveness of the HREP program element and should continue to be supported.

[4] Approval authority for projects with an estimated total construction cost of $2 million or less was delegated to the Division level in December of 1993.

- **Collaborative planning and design of HREPs has identified a number of experimental and innovative project opportunities such as seed islands, small scale drawdowns, wing dam notching, and pool-level management.**

Proposed Program Implementation Modification
Future EMP efforts to restore, protect, and enhance UMRS habitat should continue to include an appropriate mix of large-scale actions, which are compatible with other river system purposes, such as pool-scale water level management modifications, and smaller projects affecting limited areas. The U.S. Army Corps of Engineers, St. Paul, Rock Island, and St. Paul Districts should continue to place increasing emphasis on using natural river processes and innovative measures in the design and construction of habitat projects.

Proposed Program Implementation Modification
A concerted effort by the U.S. Army Corps of Engineers, Mississippi Valley Division and Headquarters should be undertaken to identify factors (e.g., project life design requirements, definitions of project failure, and experimental design) that may currently be limiting program innovation. Subsequently, any potentially constraining policies and guidance should be reviewed and, if necessary, modified.

ADDITIONAL GENERAL CONCLUSIONS AND PROPOSED PROGRAM IMPLEMENTATION MODIFICATIONS

- **Charters for the EMP-CC and LTRMP A-Team reflecting greater involvement and stronger empowerment of the EMP partner agencies need to be established. These charters would further clarify roles, responsibilities, and expectations of program partners; assure clear lines of communications; and strengthen partnership linkages.**

Proposed Program Implementation Modification
The Corps of Engineers, Mississippi Valley Division should facilitate development of charters, within the constraints imposed by Federal law, for the EMP-CC and LTRMP Analysis Team.

- **The EMP would benefit from greater participation by all river constituencies.**

Proposed Program Implementation Modification
The Corps of Engineers, St. Paul, Rock Island, and St. Louis Districts should increase the level of public involvement in the planning and implementation of the UMRS-EMP. Efforts should be taken to inform the public about habitat project purposes (resource management goals and objectives), expected outputs, and actual performance. In addition, opportunities to support public education that increases general understanding of the UMR ecosystem and management challenges should be pursued.

Recommendations to the United States Congress

8

The EMP is providing important outputs:

- **Restoration, protection and enhancement of aquatic and wetland and floodplain habitat throughout the UMRS.**
- **Monitoring, data analysis, and applied research resulting in an increased understanding of both the regulated and open reaches of the UMRS.**
- **Improved and extended partnership among the many UMRS management agencies, interest groups, and the general public.**
- **A model program applicable to other river systems and water resources**.

This report both qualitatively and quantitatively concludes that an expanded, more robust EMP for the UMRS is needed. The UMRS-EMP must be of the magnitude, standing, and duration necessary to: meet the long term data and information needs of river managers and users; offset the continuing loss of UMRS aquatic, wetland, and floodplain habitats; support future efforts to more comprehensively manage the UMRS and its basin; and, ultimately, fulfill public expectations of a healthy, sustainable UMR ecosystem that can simultaneously accommodate equally important recreational and economic uses.

The following recommendations to Congress[1] for future program duration, funding level, reporting requirements, and cost-sharing were developed in consultation with the program partners (i.e., the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, and the U.S. Department of the Interior), other Federal agencies, and various non-governmental interest groups.[2]

- **That Congress further amend Section 1103 of the Water Resources Development Act (WRDA) of 1986, as previously amended, to provide for the continuing authorization of a program for the implementation and evaluation of measures for fish and wildlife habitat restoration, protection, enhancement, and for resource monitoring and research.**

- **That the annual amount authorized to be appropriated for the program for the implementation and evaluation of Habitat Rehabilitation and Enhancement Projects (HREPs) be increased to $22,750,000.**[3]

- **That current program authorization language specifying separate LTRM and CIA program elements be rewritten to identify a single long term resource monitoring, data analysis, and applied research element, herein referred to as the LTRMP.**

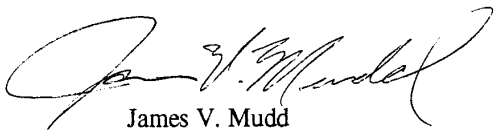
- **That the annual amount authorized to be appropriated for the LTRMP, which is 100% federally funded, be increased to $10,420,000.**[3]

- **That the Secretary of the Army, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, be required to submit a report to Congress every 6 years describing the accomplishments of the programs; providing updates of a systemic habitat needs assessment; and identifying any needed adjustments (e.g., funding level, program scope, etc.) in the authorization. Submittal of this report is to be timed so as to allow consideration as part of a comprehensive Water Resources Development Act.**

- **That cost sharing for EMP HREPs be continued as prescribed by Section 906(e) of the WRDA of 1986, under which implementation costs of projects "on lands managed as national wildlife refuge" are 100% Federal, and implementation costs of all other projects are shared 75% Federal/25% non-Federal, providing:**

  (a) That up to 80% of the 25% non-Federal cost share of an HREP may be in the form of in-kind services, including a facility, supply, or service or lands (LERRDs credits) that is necessary to carry out the project. This would be similar to other habitat restoration programs such as Section 1135 of the WRDA of 1986, Project Modifications for the Improvement of the Environment, as amended by Section 204(d) of the WRDA of 1996.

  (b) That, subject to the availability of funds, non-Federal interests may be reimbursed for the Federal share, without interest, of studies, design documents, and implementation costs of approved HREPs.



James V. Mudd
Colonel, U.S. Army
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Rock Island District

[1] These recommendations will be subject to further review and possible revision by the U.S. Army Corps of Engineers prior to submittal of this report to the U.S. Congress.

[2] A multi-participant Issues Resolution Conference (IRC) was convened April 24-25, 1997.

[3] Proposed funding authorization level is equal to that identified in the 1981 UMRS Master Plan Report indexed for inflation.

Attachment 1

EMP Legislation

WATER RESOURCES DEVELOPMENT ACT OF 1986
P.L. 99-662

SEC. 1103. UPPER MISSISSIPPI RIVER PLAN.

(a)(1) This section may be cited as the "Upper Mississippi River Management Act of 1986".

(2) To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system. Congress further recognizes that the system provides a diversity of opportunities and experiences. The system shall be administered and regulated in recognition of its several purposes.

(b) For purposes of this section—

(1) the terms "Upper Mississippi River system" and "system" mean those river reaches having commercial navigation channels on the Mississippi River main stem north of Cairo, Illinois; the Minnesota River, Minnesota; Black River, Wisconsin; Saint Croix River, Minnesota and Wisconsin; Illinois River and Waterway, Illinois; and Kaskaskia River, Illinois;

(2) the term "Master Plan" means the comprehensive master plan for the management of the Upper Mississippi River system, dated January 1, 1982, prepared by the Upper Mississippi River Basin Commission and submitted to Congress pursuant to Public Law 95-502;

(3) the term "GREAT I, GREAT II, and GRRM studies" means the studies entitled "GREAT Environmental Action Team—GREAT I—A Study of the Upper Mississippi River", dated September 1980, "GREAT River Environmental Action Team—GREAT II—A Study of the Upper Mississippi River" dated December 1980, and "GREAT River Resource Management Study", dated September 1982; and

(4) the term "Upper Mississippi River Basin Association" means an association of the State of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, formed for the purpose of cooperative effort and united assistance in the comprehensive planning for the use, protection, growth, and development of the Upper Mississippi River System.

(c)(1) Congress hereby approves the Master Plan as a guide for future water policy on the Upper Mississippi River system. Such approval shall not constitute authorization of any recommendation contained in the Master Plan.

(2) Section 101 of Public Law 95-502 is amended by striking out the last two sentences of subjection (b), striking out subsection (i), striking out the final sentence of subsection (j), and redesignating subsection "(j)" as subsection "(i)".

(d)(1) The consent of the Congress is hereby given to the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, or any two or more of such States, to enter into negotiations for agreements, not in conflict with any law of the United States, for cooperative effort and mutual assistance in the comprehensive

planning for the use, protection, growth, and development of the Upper Mississippi River system, and to establish such agencies, joint or otherwise, or designate an existing multi-State entity, as they may deem desirable for making effective such agreements. To the extent required by Article I, section 10 of the Constitution, such agreements shall become final only after ratification by an Act of Congress.

(2) The Secretary is authorized to enter into cooperative agreements with the Upper Mississippi River Basin Association or any other agency established under paragraph (1) of this subjection to promote and facilitate active State government participation in the river system management, development, and protection.

(3) For the purpose of ensuring the coordinated planning and implementation of programs authorized in subsections (e) and (h)(2) of this section, the Secretary shall enter into an interagency agreement with the Secretary of the Interior to provide for the direct participation of, and transfer of funds to, the Fish and Wildlife Service and any other agency or bureau of the Department of the Interior for the planning, design, implementation, and evaluation of such programs.

(4) The Upper Mississippi River Basin Association or any other agency established under paragraph (1) of this subsection is hereby designated by Congress as the caretaker of the master plan. Any changes to the master plan recommended by the Secretary shall be submitted to such association or agency for review. Such association or agency may make such comments with respect to such recommendations and offer other recommended changes to the master plan as such association or agency deems appropriate and shall transmit such comments and other recommended changes to the Secretary. The Secretary shall transmit such recommendations along with the comments and other recommended changes of such association or agency to the Congress for approval within 90 days of the receipt of such comments or recommended changes.

(e)(1) The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, is authorized to undertake, as identified in the master plan—

(A) a program for the planning, construction, evaluation of measures for fish and wildlife habitat rehabilitation and enhancement;

(B) implementation of a long-term resource monitoring program; and

(C) implementation of a computerized inventory and analysis system.

(2) Each program referred to in paragraph (1) shall be carried out for ten years. Before the last day of such ten-year period, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall conduct an evaluation of such programs and submit a report on the results of such evaluation to Congress. Such evaluation shall determine each such program's effectiveness, strengths, and weaknesses and contain recommendations for the modification and continuance or termination of such program.

(3) For purposes of carrying out paragraph (1)(A) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $8,200,000 for the first fiscal year beginning after the date of enactment of this Act, not to exceed $12,400,000 for the second fiscal year beginning after the date of enactment of this Act, and not to exceed $13,000,000 per fiscal year for each of the succeeding eight fiscal years.

(4) For purposes of carrying out paragraph (1)(B) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $7,680,000 for the first fiscal year beginning after the date of enactment of this Act and not to exceed $5,080,000 per fiscal year for each of the succeeding nine fiscal years.

(5) For purposes of carrying out paragraph (1)(C) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $40,000 for the first

fiscal year beginning after the date of enactment of this Act, not to exceed $280,000 for the second fiscal year beginning after the date of enactment of this Act, not to exceed $1,220,000 for the third fiscal year beginning after the date of enactment of this Act, and not to exceed $875,000 per fiscal year for each of the succeeding seven fiscal years.

(6)(A) Notwithstanding the provisions of subsection (a)(2) of this section, the costs of each project carried out pursuant to paragraph (1)(A) of this subsection shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with the provisions of section 906 of this Act.

(B) Notwithstanding the provisions of subsection (a)(2) of this section, the cost of implementing the activities authorized by paragraphs (1)(B) and (1)(C) of this subsection shall be allocated in accordance with the provisions of section 906 of this Act, as if such activity was required to mitigate losses to fish and wildlife.

(7) None of the funds appropriated pursuant to any authorization contained in this subsection shall be considered to be chargeable to navigation.

(f)(1) The Secretary, in consultation with any agency established under subsection (d)(1) of this section, is authorized to implement a program of recreational projects for the system substantially in accordance with the recommendations of the GREAT I, GREAT II, and GRRM studies and the master plan reports. In addition, the Secretary, in consultation with any such agency, shall, at Federal expense, conduct an assessment of the economic benefits generated by recreational activities in the system. The cost of each such project shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with title I of this Act.

(2)(A) for purposes of carrying out the program of recreational projects authorized in paragraph (1) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $500,000 per fiscal year for each of the first ten fiscal years beginning after the effective date of this section.

(B) For purposes of carrying out the assessment of the economic benefits of recreational activities as authorized in paragraph (1) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $300,000 per fiscal year for the first and second fiscal years beginning after the computerized inventory and analysis system implemented pursuant to subsection (e)(1)(C) of this section is fully functional and $150,000 for the third such fiscal year.

(g) The Secretary shall, in his budget request, identify those measures developed by the Secretary, in consultation with the Secretary of Transportation and any agency established under subsection (d)(1) of this section, to be undertaken to increase the capacity of specific locks throughout the system by employing nonstructural measures and making minor structural improvements.

(h)(1) The Secretary, in consultation with any agency established under subsection (d)(1) of this section, shall monitor traffic movements on the system for the purpose of verifying lock capacity, updating traffic projections, and refining the economic evaluation so as to verify the need for future capacity expansion of the system.

(2) The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall determine the need for river rehabilitation and environmental enhancement and protection based on the condition of the environment, project developments, and projected environmental impacts from implementing any proposals resulting from recommendations made under subsection (g) and paragraph (1) of this subsection.

(3) There is authorized to be appropriated to the Secretary such sums as may be necessary to carry out this subsection.

(i)(1) The Secretary shall, as he determines feasible, dispose of dredged material from the system pursuant to the recommendations of the GREAT I, GREAT II, and GRRM studies.

(2) The Secretary shall establish and request appropriate Federal funding for a program to facilitate productive uses of dredged material. The Secretary shall work with the States which have, within their boundaries, any part of the system to identify potential users of dredged material.

(j) The Secretary is authorized to provide for the engineering, design, and construction of a second lock at Locks and Dam 26, Mississippi River, Alton, Illinois and Missouri, at a total cost of $220,000,000, with a first Federal cost of $220,000,000. Such second lock shall be one hundred and ten feet by six hundred feet and shall be constructed at or in the vicinity of the location of the replacement lock authorized by section 102 of Public Law 95-502. Section 102 of this Act shall apply to the project authorized by this subsection.

SEC. 906. FISH AND WILDLIFE MITIGATION.

(a)(1) In the case of any water resources project which is authorized to be constructed by the Secretary before, on, or after the date of enactment of this Act, construction of which has not commenced as of the date of enactment of this Act, and which necessitates the mitigation of fish and wildlife losses, including the acquisition of lands or interests in lands to mitigate losses to fish and wildlife, as a result of such project, such mitigation, including acquisition of the lands or interests—

(A) shall be undertaken or acquired before any construction of the project (other than such acquisition) commences, or

(B) shall be undertaken or acquired concurrently with lands and interests in lands for project purposes (other than mitigation of fish and wildlife losses),

whichever the Secretary determines is appropriate, except that any physical construction required for the purposes of mitigation may be undertaken concurrently with the physical construction of such project.

(2) For the purposes of this subsection, any project authorized before the date of enactment of this Act on which more than 50 percent of the land needed for the project, exclusive of mitigation lands, has been acquired shall be deemed to have commenced construction under this subsection.

(b)(1) After consultation with appropriate Federal and non-Federal agencies, the Secretary is authorized to mitigate damages to fish and wildlife resulting from any water resources project under this jurisdiction, whether completed, under construction, or to be constructed. Such mitigation may include the acquisition of lands, or interests therein, except that—

(A) acquisition under this paragraph shall not be by condemnation in the case of projects completed as of the date of enactment of this Act or on which at least 10 percent of the physical construction on the project has been completed as of the date of enactment of this Act; and

(B) acquisition of water, or interests therein, under this paragraph, shall not be by condemnation.

The Secretary, shall, under the terms of this paragraph, obligate no more than $30,000,000 in any fiscal year. With respect to any water resources project, the authority under this subsection shall not apply to measures that cost more than $7,500,000 or 10 percent of the cost of the project, whichever is greater.

(2) Whenever, after his review, the Secretary determines that such mitigation features under this subsection are likely to require condemnation under subparagraph (a) or (B) of paragraph (1) of this subsection, the Secretary shall transmit to Congress a report on such proposed modification, together with his recommendations.

(c) Costs incurred after the date of enactment of this Act for implementation and operation, maintenance, and rehabilitation to mitigate damages to fish and wildlife shall be allocated among authorized project purposes in accordance with applicable cost allocation procedures, and shall be subject to cost sharing or reimbursement to the same extent as such other project costs are shared or reimbursed, except that when such costs are covered by contracts entered into prior to the date of enactment of this Act, such costs shall not be recovered without the consent of the non-Federal interests or until such contracts are complied with or renegotiated.

(d) After the date of enactment of this Act, the Secretary shall not submit any proposal for the authorization of any water resources project to the Congress unless such report contains (1) a recommendation with a specific plan to mitigate fish and wildlife losses created by such project, or (2) a determination by the Secretary that such project will have negligible adverse impact on fish and wildlife. Specific mitigation plans shall ensure that impacts to bottomland hardwood forests are mitigated in-kind, to the extent possible. In carrying out this subsection, the Secretary shall consult with appropriate Federal and non-Federal agencies.

(e) In those cases when the Secretary, as part of any report to Congress, recommends activities to enhance fish and wildlife resources, the first costs of such enhancement shall be a Federal cost when—

(1) such enhancement provides benefits that are determined to be national, including benefits to species that are identified by the National Marine Fisheries Service as of national economic importance, species that are subject to treaties or international convention to which the United States is a party, and anadromous fish;

(2) such enhancement is designed to benefit species that have been listed as threatened or endangered by the Secretary of the Interior under the terms of the Endangered Species Act, as amended (16 U.S.C. 1531, et seq.), or

(3) such activities are located on lands managed as a national wildlife refuge.

When the benefits of enhancement do not qualify under the preceding sentence, 25 percent of such first costs of enhancement shall be provided by non-Federal interests under a schedule of reimbursement determined by the Secretary. The non-Federal share of operation, maintenance, and rehabilitation of activities to enhance fish and wildlife resources shall be 25 percent.

(f) Fish and wildlife enhancement measures carried out as part of the project for Atchafalaya Floodway System, Louisiana, authorized by Public Law 99-88, and the project for Mississippi Delta Region, Louisiana, authorized by the Flood Control Act of 1965, shall be considered to provide benefits that are national for purposes of this section.

(g) The provisions of subsections (a), (b), and (d) shall be deemed to supplement the responsibility and authority of the Secretary pursuant to the Fish and Wildlife Coordination Act, and nothing in this section is intended to affect that Act.

WATER RESOURCES DEVELOPMENT ACT OF 1990

SEC. 405. UPPER MISSISSIPPI RIVER PLAN.

Section 1103 of the Water Resources Development Act of 1986 (33 U.S.C. 652) is amended—

(1) in paragraph (e)(2) by striking “ten” and inserting “15”;

(2) in paragraph (e)(3) by striking “eight” and inserting “13”;

(3) in paragraph (e)(4) by striking “nine” and inserting “14”;

(4) in paragraph (e)(5) by striking “seven” and inserting “12”; and

(5) in paragraph (f)(2)(A) by striking “ten” and inserting “15”.

WATER RESOURCES DEVELOPMENT ACT OF 1992

SEC. 107. UPPER MISSISSIPPI RIVER PLAN.

(a) EXTENSION OF AUTHORIZATION. —Section 1103(e) of the Water Resources Development Act of 1986 (33 U.S.C. 652(e)) is amended—

(1) in paragraph (2) by striking “ten” each place it appears and inserting “15”;

(2) by redesignating paragraphs (6) and (7) as paragraphs (7) and (8), respectively; and

(3) by inserting after paragraph (5) the following new paragraph:

“(6) TRANSFER OF AMOUNTS.—

“(A) GENERAL RULE.—Subject to subparagraph (B), for each fiscal year beginning after September 30, 1992, the Secretary, in consultation with the Secretary of the Interior, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may transfer not to exceed 20 percent of the amount appropriate to carry out each of subparagraphs (A), (B), and (C) of paragraph (1) to carry out any other of such subparagraphs.

“(B) LIMITATION.—The aggregate amounts obligated in fiscal years 1988 through 2002—

“(i) to carry out paragraph (1)(A) may not exceed $189,600,000;

“(ii) to carry out paragraph (1)(B) may not exceed $78,800,000; and

“(iii) to carry out paragraph (1)(C) may not exceed $12,040,000.”.

(b) FISH AND WILDLIFE HABITAT REHABILITATION AND ENHANCEMENT PROJECTS. —Section 1103(e) of such Act is amended by striking paragraph (7)(A), as redesignated by subsection (a)(2), and inserting the following new paragraph:

“(7)(A) Notwithstanding the provisions of subsection (a)(2) of this section, the costs of each project carried out pursuant to paragraph (1)(A) of this subsection shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with the provisions of section 906(e) of this Act; except that the costs of operation and maintenance of projects located on Federal lands or lands owned or operated by a State or local government shall be borne by the Federal; State, or local agency that is responsible for management activities for fish and wildlife on such lands.”.

Environmental Management Program Financial Data

Attachment

2

UMRS-EMP EXPENDITURES AND PROPOSED FUNDING
($000)

11/20/97

	NON-FED EST COST	TOTAL EXPENDED THRU 97	FY 98 CARRY IN	FY 98 ALLOCA.	FY 98 TOTAL SCHED EXP.	FY 98 TOTAL SCHED OBLIG.	FY 98 ADDIT. CAPA.	OUT-YEARS PROPOSED FUNDING IF FULLY FUNDED FY99	FY 00	FY01	FY02	TOTAL
PROGRAM ELEMENTS												
HABITAT PROJECTS	4,557	79,017	441	6,795	9,238	9,028	6,299	12,235	12,230	12,230	12,222	137,172
HABITAT EVAL/MONITORING		3,959	136	447	583	457	0	565	565	560	563	6,795
		0										0
PROGRAM COOR.		8,058	7	647	654	648	0	700	705	710	715	11,542
REPORT TO CONGRESS		645	27	100	127	100	0	0	0	0	0	772
LTRM *4		51,669	643	5,038	5,681	5,038	917	5,955	5,955	5,955	5,955	81,170
RECREATION PROJECTS		9					*5					9
ECON. IMPACTS OF REC.	COMPLETE	768										768
TRAFFIC MONITORING	COMPLETE	206										206
TOTALS	4,557	144,331	1,254	15,027	16,283	15,271	7,216	19,455	19,455	19,455	19,455	238,434
TOTALS BY ORGANIZATION												
MVR	3,440	38,648	267	4,011	4,278	4,077	5,222	5,356	5,356	5,356	5,356	67,790
MVP	397	31,236	127	3,423	3,552	3,484	500	4,687	4,687	4,687	4,687	53,933
MVS	720	22,626	217	2,445	2,662	2,562	577	3,347	3,347	3,347	3,347	39,396
*4 (LTRM/UMRBA)		51,699	643	5,148	5,791	5,148	917	6,065	6,065	6,065	6,065	81,750
MVD		122	0	0	0	0	0	0	0	0	0	122
TOTAL	4,557	144,331	1,254	15,027	16,283	15,271	7,216	19,455	19,455	19,455	19,455	247,419 *2

NOTES:

*1 $16,000,000 minus Savings and Slippage of $973,000, taken only out of the three Districts

*2 Includes $4,426,000 unprogrammed additional capability in FY 98 if program were to be fully funded thru FY 02.

*3 Additional Capability shown does not reflect available funds at this time.

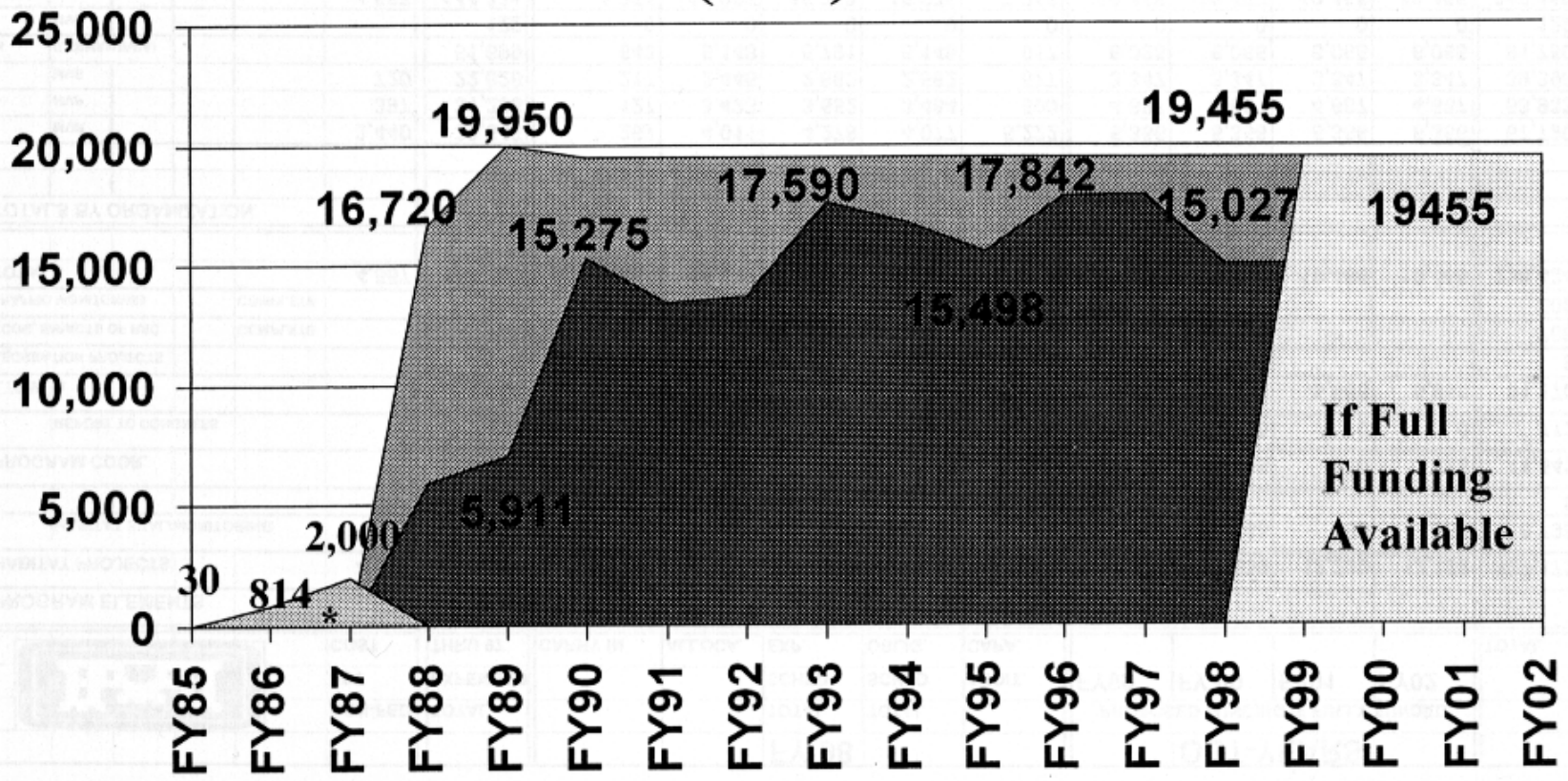
*4 LTRM allocation for FY 98 calculated as $5,265,000 minus 31% of $700,000 (cut from $19,700,000) with no S&S taken out.

*5 EMTC showing an additional capability of $917,000 in FY 98.

Total Federal Estimate 242,862 *2

FUNDING

(000)



*Supplemental Appropriations to Project occurred before Project Authorization

Summary of Other Program Elements

Attachment 3

Three additional program elements were authorized in the 1986 Environmental Management Program (EMP) enabling legislation—recreation projects, economic impacts of recreation study, and navigation traffic monitoring. While more limited in scope and funding than the Habitat Rehabilitation and Enhancement Project (HREP) and Long Term Resource Monitoring Program (LTRMP) elements, they were reflective of the diversity of uses and issues on the river system.

Recreation Projects

- ***Background.*** The authority to construct recreation projects was included as part of the EMP in recognition of the growing demand for river-based recreation.

- ***Accomplishments.*** Although planning was initiated for four projects in the first year of the program, in accordance with Administration policy and directives of the Headquarters of the U.S. Army Corps of Engineers, no recreation projects have been implemented as part of the EMP.

- ***Funding.*** The authorized funding level for EMP recreation projects was $500,000 per year. Prior to application of Administration policy guidance precluding recreation projects, $9,000 was expended in the first year of the program on recreation project planning.

Economic Impacts of Recreation Study

- ***Background.*** While recreation has long been recognized as an important use of the Upper Mississippi River, its economic value has not been fully understood. Thus, the purpose of the Economic Impacts of Recreation Study was to measure the economic importance of recreation expenditure to communities along the Upper Mississippi River. More specifically, the study produced estimates of the total number of recreation visitors, the activities they engage in, the amount of money they spend on recreation, and the patterns evident in their spending.

- ***Accomplishments.*** The study focused on use of recreational areas that are most closely associated with management issues on the Upper Mississippi River System (UMRS). These included over 600 developed recreation areas and sightseeing overlooks, 18,000 marina slips, and 2,800 permitted boat docks.

During the study year, more than 2.3 million recreational party trips to developed areas of the UMRS were made. These trips equated to over 12 million daily visits by recreationists. Approximately 75% of these visits were made by residents of counties that border the UMRS, with boating, fishing, and sightseeing constituting the most popular activities.

Regional economic modeling indicates that recreational activity on the UMRS supported $1.2 billion in total expenditures and 18,500 jobs nationwide in 1990. For the 76 counties in the study area, recreational activity supported $400 million in expenditures and 7,200 jobs. One-third of all spending in the 76 corridor counties was made by non-residents, representing "new dollars" to the region.

Results of the Economic Impacts of Recreation Study have been used to: compare economic development and alternative management options; evaluate facilities such as marinas and boat ramps; assess new programs and cost-sharing approaches; and, as part of the Upper Mississippi River System Navigation Study, estimate the environmental effects of recreational craft. In addition, the Waterways Experiment Station continues to use the data in advancing the methodology for assessing the economic impacts of the Corps' nationwide recreation program.

- ***Funding.*** Funding for the study was specified in the authorizing legislation in the amount of $750,000. That full amount was allocated and expended between FY 1986 and FY 1993.

Navigation Traffic Monitoring

- ***Background.*** Section 1103(h)(1) of the 1986 Water Resources Development Act directed the Corps of Engineers to "monitor traffic improvements on the system for the purpose of verifying lock capacity, updating traffic projections, and refining the economic evaluation so as to verify the need for future capacity expansion of the system."

When the Upper Mississippi River and Illinois Waterway navigation reconnaissance studies were initiated in FY 1989 and 1990, respectively, all traffic monitoring activities being carried out under the auspices of the EMP were discontinued and pursued instead in the context of those studies and the current UMR-IWW System Navigation Feasibility Study.

- ***Accomplishments.*** During the period of time that traffic monitoring activities were supported under the EMP funding authorization (FY 1986 - FY 1989), the following data collection and analysis efforts were undertaken:

- Navigation data for the Upper Mississippi and Illinois Rivers were consolidated into a regional database.

- Monthly and annual data collection was initiated on system traffic patterns, traffic delays, and barge rates.

- Historical data on commodities and tonnages for all Illinois River locks were placed in an electronic database.

- The General Equilibrium Model (GEM) was acquired to enable economic analysis on a system scale.

- The Waterway Economic Efficiency Model (WEEM) was acquired to evaluate small-scale waterway efficiency measures.

- 1987 traffic data by commodity were collected and analyzed.

- Timing studies were completed for Locks 14 and 22 and Peoria Lock.

- During 1988 and 1989, a *Traffic Monitoring Newsletter* was published quarterly.

These traffic monitoring and analysis activities validated the need and initiated much of the data collection necessary for the subsequent navigation studies. The consolidated regional database that was established has proved to be useful in providing data to industry and State and Federal agencies.

- ***Funding.*** The EMP authorizing legislation did not specify funding levels for traffic monitoring, but rather authorized "such sums as may be necessary." Between FY 1986 and FY 1990, $206,000 of EMP funds was made available for the traffic monitoring component. Thereafter, all traffic monitoring activities were made part of the on-going navigation studies.

CONCLUSIONS AND PROGRAM IMPLEMENTATION ENHANCEMENT PROPOSALS

Navigation Traffic Monitoring

- **Navigation traffic monitoring undertaken as part of the EMP in its initial years provided a valuable transition between the work initiated as part of the Master Plan and later efforts undertaken as part of the Upper Mississippi River/Illinois River Navigation Study.**

Program Implementation Enhancement Proposals
Any future UMRS navigation traffic monitoring should be accomplished as part of the Corps of Engineer's navigation-specific authorities and mission responsibilities.

Economic Impacts of Recreation

- **The Economic Impacts of Recreation Study provided useful information about recreational expenditures on the UMRS.**

Program Implementation Enhancement Proposals
Any future studies of the economic impacts of recreation on the UMRS should be accomplished under other authorities.

Recreation Projects

- **Cost-shared recreational projects originally authorized as part of the EMP have not been implemented to date due to Federal budgetary constraints in the early years of the EMP. However, ample general authority outside of WRDA '86 currently exists for the Corps to participate in development of such projects provided a local cost-sharing partner is available. Moreover, Section 208 of WRDA '96 directed that the "Secretary shall provide increased emphasis on, and opportunities for recreation at, water resource projects operated, maintained, or constructed by the Corps of Engineers." Given the above-described facts, a separate UMRS authorization need not be included as a part of a future EMP since Corps policy now affords recreational projects increased emphasis when they are cost shared and constructed as an integral part of an existing Corps project.**

Program Implementation Enhancement Proposals
Recreation features that provide public access or interpretive facilities such as boat ramps, piers/boardwalks, etc. can be cost-effectively incorporated into the construction of HREPs. Corps of Engineers policy and guidance should be reviewed and, if necessary, modified to readily allow the incorporation of such features into HREPs where a need has been determined and the project sponsor(s) support their inclusion.

Summaries of Key Related Reports

Attachment 4

1. Recommendations of the 1990 Science Review Committee.

A Scientific Review Committee visited EMTC in June 1990 when the Long Term Resource Monitoring Program for the Upper Mississippi River Basin was still being shaped. That Committee made nine recommendations designed to ensure that the program would generate front rank science as well as remaining firmly focused on its mandated objectives.

1. A general conceptual model of the FJMRB is essential to serve as a basis for project planning, problem identification, hypothesis formulation, resource allocation, and scientific synthesis at all pertinent spatial and temporal scales.

2. The LTRMP research group must recognize the importance of examining and linking different spatial and temporal scales in project design, data analysis and information synthesis. A spatio-temporal perspective that recognizes the existence of multiple scales is critical to understand and manage the riverine-floodplain system.

3. More emphasis must be placed by the project leader on achieving a holistic understanding of the UMRB by assuring that the translation of project results proceeds in a timely fashion from primary data to topical summary findings to whole project syntheses.

4. The LTRMP must place a high priority on integrating its personnel and its finding with the broader scientific community, including: 1) structuring research in the context of extant scientific literature, 2) publishing the findings in peer reviewed literature, 3) participating in national meetings of scientific societies, and 4) developing a modest program of competitive extramural support for collaborative research.

5. LTRMP leadership must develop a logical and objective rationale for prioritization of project resource allocation among competing subprojects. This rationale must be derived from the general conceptual model that guides the entire project.

6. There is a need for a coherent long-range information management plan to guide the CRIC [= CIA] program.

7. The great importance of retrospective data must be recognized, and procedures developed for systematic review in order to incorporate relevant data into the information phase of the project.

8. Staff size and expenses must be expanded to address additional research needs implied by the general conceptual model and to exploit more adequately the relevant bodies of techniques and methodologies.

9. Contingency plans must include provision for scientific study of short-term and extreme events in order to increase scientific understanding of the river system.

2. *Upper Mississippi River System Environmental Management Program Midterm Evaluation Report.*

The Executive Summary of the U.S. Army Corps of Engineers, North Central Division's August 1992 report is provided below:

The purpose of this report is to evaluate the performance of the Upper Mississippi River System Environmental Management Program (UMRS-EMP) from authorization in August 1985 through Fiscal Year 1991. The purpose of the UMRS-EMP is to ensure the coordinated development and enhancement of the Upper Mississippi River System. The program includes habitat rehabilitation and enhancement projects designed to counteract the effects of backwater and side channel sedimentation. Long Term Resource Monitoring will provide for more informed resource management and support the environmentally sustainable development of the UMRS.

The report concludes:

- ***Habitat projects are highly successful in alleviating sedimentation in the specific project areas.*** *Over 14,000 acres of the Upper Mississippi River System have directly benefited or will benefit from the completion of nine projects, ongoing construction at six other sites, and pending contract awards or construction approval at thirteen additional sites. Biological monitoring and visual observations have indicated that increases in fish and waterfowl species diversity and abundance are occurring at the completed projects.*

- ***The habitat project planning teams in the Districts have made great strides in refining and applying habitat models of representative target species to the formulation of projects.*** *By comparing habitat gains with costs, an incremental analysis for each proposed project identifies the most cost-effective plan. There is little specific guidance for the incremental analysis of habitat projects, and the EMP is advancing the state of the art/science. The HQUSACE staff has recognized the limitations of incremental analysis methods and is working with us to evolve more meaningful techniques and formats.*

- ***Administrative procedures do not allow for quick responses to habitat problems.*** *The time from project planning initiation to construction initiation has been three to five years. Administrative requirements have skewed the program in favor of large projects. Delegation of authority for small-scale habitat projects would enable relatively quick implementation of a number of potential projects that have not been formally proposed because of their smaller scale.*

- ***The Long Term Resource Monitoring Program (LTRMP) element of the EMP has become fully operational.*** *Six state-operated field stations and an Environmental Management Technical Center have been established. The large front-end investment costs have been completed.*

- ***NCD has concluded that LTRMP trend analysis data collection and research are proceeding on a scientifically sound basis.*** *During the first few years of the LTRMP, Trend Analysis monitoring proceeded without well-defined hypotheses to be tested. Subsequently, the LTRMP established a Scientific Review Committee and Technical Review Panel that has provided the basis for subsequent and ongoing program modifications. With NCD concurrence, future program reviews by the USFWS will focus on refinements to the current direction rather than making basic changes to the scientific basis of the program.*

- ***LTRMP management recognizes the need to continuously review trend analysis activities to support Corps of Engineers missions and the missions of our partner agencies.*** *The application of LTRMP products and the utilization of the EMTC resources for missions outside of the LTRMP hold great promise for the future. Examples include site selection for disposal of dredged material, natural resource management, and regulatory functions. The LTRMP water quality monitoring data and spatial data management capabilities can support Corps of Engineers missions. Recognizing the tremendous capabilities of the EMTC to provide future cost savings to other programs, efforts are underway to identify and implement specific linkages between the LTRMP and Corps missions.*

- ***The Corps of Engineers and the USFWS are in agreement that the LTRMP has a mandate to not only monitor and evaluate trends in the condition of UMRS resources, but also to conduct research to support environmentally sustainable development on the UMRS.*** *The infrastructure already exists to provide navigation study support in the form of data management, impact assessment research, and system-wide spatial information. The NCD's goal will be to leverage navigation study funds against the EMP investments already made, as well as those in the future. Over $5 million has been or is scheduled to be expended for products complementing the Upper Mississippi River-Illinois Waterway Navigation Study.*

- ***Traffic monitoring activities provided useful information for the Upper Mississippi River - Illinois Waterway Navigation study.***

- ***The Economic Impacts of Recreation Study will provide conclusive information about expenditures for recreation in the UMRS. Report to be completed by the end of 1992.***

- ***Recreation projects have not been implemented due to the low Federal priority on recreation.***

- ***Additional merits of the EMP include: (1) achievement of an effective and lasting partnership with the states of the UMRS, Region 3 of the USFWS, and others, (2) increased understanding and support of environmentally sustainable development and (3) enhanced knowledge and public appreciation of the missions of the Corps of Engineers.***

- ***The Project Management system is being implemented to ensure timely completion of habitat projects within budget.***

The following recommendations are made:

- ***That continued funding be provided to the EMP at the authorized level for the additional 5 years (beyond FY 1997) authorized by Section 1103 of WRDA 1986 and amended by Section 405 of WRDA 1990.***

- ***That the HQUSACE work with the NCD to develop appropriate frames of reference for the incremental analyses of habitat projects.***

- ***That ASA (CW) approve the delegation of authority for small-scale habitat projects.***

3. Proceedings of the Workshop for Engineering and Design of Environmental Management Program Projects, October 29-30, 1996.

The Executive Summary of that document is provided below:

> *The Rock Island District sponsored a Workshop for Engineering and Design of Environmental Management Program (EMP) Habitat Rehabilitation and Enhancement Projects (HREP) on October 29 and 30, 1996. Engineers, Planners, and Construction Representatives from St. Paul, Rock Island, and St. Louis Districts and North Central Division were in attendance. The Workshop included tours of the Spring Lake and Potters Marsh EMP projects on October 29, and presentations and facilitated group discussions on technical design features and overall management and contract administration on October 30. The primary focus of the Workshop was the exchange of ideas, techniques, and strategies to gain greater efficiency in executing the EMP program.*
>
> *Project successes were discussed, such as St. Paul District's experience with island construction and Rock Island and St. Louis Districts' successes with displacement method embankment techniques, along with "less than successes," such as the flood damage to the radial gate at the Rock Island District's Lake Chautauqua project. One of the greatest challenges in project construction is site conditions, as projects are often located in remote areas of the floodplain. Suggestions for improvement in this area were to award contracts with shorter construction seasons to reduce the risk of flooding, incorporating materials such as sheet pile to cut dewatering costs, and staging construction to facilitate access to the site. Technical exchange among all three districts focused on structural details such as pump types and stoplog materials, as well as more global issues of efficiently meeting sponsor needs.*
>
> *Lessons learned included the need for sound engineering investigations during design, particularly geotechnical, hydraulic, and survey data to avoid project modifications and quantity overruns. Other lessons learned included sedimentation rates greater than design estimates for dredged channels and adapting projects after construction to incorporate sponsor-requested operational changes.*
>
> *These projects are new and have more risk than traditional on-the-ground construction. This does not preclude the need for sound engineering judgment. Greater efficiency can be realized by involving engineers early in the project formulation process so as to better understand the site manager's project goals. As experience is gained through design, project operation, and performance evaluation, more innovative project features can be explored while implementing lessons learned and continuing dialogue exchange between the districts and other EMP players.*

4. *Second Science Review Committee Report on the Long Term Resource Monitoring Program - Environmental Management Technical Center.*

The Executive Summary from the December 31, 1996, report is as follows:

> *This is the report of the Science Review Committee (SRC) which visited the Environmental Technical Management Center (EMTC) on November 18-20, 1996. The Committee's*

charge is to review the scientific activities of the Long Term Resource Monitoring Program (LTRMP) in the Upper Mississippi River Basin (UMRB). This is an appropriate time for the review because the first 5-year trend analyses have just been completed. The committee found that the nine recommendations of the 1990 SRC have been conscientiously implemented with a high level of success. Noteworthy achievements that support the scientific activity include the development of the Computerized Information and Analysis system (CIA), external communications, and the level of cooperative activity that has been established. Continuing attention is needed to the advice of the 1990 Committee to analyze the UMRB system over a range of space and time scales, and to thoroughly examine historical data resources.

The present SRC has reviewed the legislative mandate and the social context of the LTRMP and concludes that the primary focus must be placed on the detection of trends in the entire UMRB system. Knowledge of these trends is needed to properly inform the policy debate and management of the system. Measurements need to be made of the fluxes of water, sediments and contaminants through the entire river system in order to understand more local ecosystem processes. The current monitoring effort is focused on local physicochemical and ecological sampling within certain pools. These local observations are important for understanding the structure and function of riverine ecosystems and to establish the magnitude and pattern of local variability.

Some changes are needed in the monitoring framework in order to expand from understanding the local level to understanding the entire system. System-wide trends will be measured over periods of a decade or more. Consideration should be given to selecting new sites for study so that eventually most or all pools and reaches in the system are observed. A rotation of intensive study sites can be set up so that pools and reaches are studied intensively for 3 to 5 years, then effort is transferred to other areas. After the lapse of a decade or more, the intensive effort returns to the original study sites to determine whether or not conditions have changed. Long term trends can also be studied by comparing current observations with historical data sets. Valuable efforts are being made within the CIA program to recover information on historical land use and river configuration. Similar efforts need to be made using historical information on water quantity, quality, and aquatic ecology.

Sampling protocols and methods for the pool studies are well established. The laboratory procedures for data quality assurance, quality control and information control are particularly effective. The staff is well aware that trend analysis of the current field data will permit optimization of further sampling effort. The SRC recommends that the EMTC senior staff place a high priority on analytical activities. The SRC remains concerned that much of the field sampling appears to be focused on obtaining only a few closely related measures at any one time. For example, limnological measurements and biotic sampling appear not to be simultaneous. Strong diurnal and synoptic variability may substantially interfere with analyses made from non-coincident data. Statistical methods also deserve close scrutiny. There appears to be a deliberate effort to organize observations to meet the requirements of advanced parametric methods with stringent control requirements. However, many environmental data cannot meet parametric completeness or distribution assumptions. Historical data almost certainly will not meet such assumptions. The SRC recommends that attention be paid to non-parametric methods within the context of a "clinical" approach to sampling and analysis.

Communications are a key aspect of any mandated program. The external technical communications of the LTRMP group appear to be at a high level, but there appear to be needs for increased internal communications to optimize scientific efforts. The role of cooperating scientists from partner agencies and from regional colleges and universities is a particular strength of this program. These people expand the number of active scientists well beyond the number of the core staff, and provide important sources of background information and communication routes to the larger public. The provision of data resources from the Center via the Internet is a pioneering achievement. The SRC reminds the Center that traditional written communications remain important for the general public and for many resource managers. The SRC is concerned that the data records of the program continue to be published on paper because rapid technological change can make electronic storage media obsolete over periods of decades.

The Committee was invited to consider the prospects for continued monitoring of the UMRB beyond the current legislative mandate. The SRC recommends that the program be continued, and that any reauthorization take into account what has been learned already. In particular, processes and activities throughout the basin influence the riverine system, and the program should be authorized to study these influences. The UMRB is a large and nationally significant system that continues to change over long periods of time. Public policy decisions about the system will be shaped both within and outside traditional agencies. The EMTC staff has established an excellent information base for current and future decision making. The LTRMP provides information on physical and ecological processes at the landscape scales and, over time, will be able to provide information for regional land management. These capabilities have been achieved by effective cooperation among several federal agencies and five state partners, so that problems which span several political and administrative units may be tackled efficiently.

Following are the 16 recommendations of the current SRC. These are repeated at the end of the report with a small number of additional contextual remarks.

Strategic recommendations: the structure of the program

1. There must be increased emphasis on studies at the systemic scale and on the upstream-downstream connections that make the river system what it is. As the first step, a box-cascade model of the river system should be articulated within the guiding conceptual model and used as the basis for implementing this approach to the system.

2. A detailed quantification of inputs to the river system must be conducted to reveal the basin and watershed influence on the river, and help to identify basin problems that need to be addressed to help to maintain and improve river conditions. An increased emphasis should be placed on viewing the UMR system as a single, integrated system, which means devoting more attention to the reach, river and basin scales. This is essential and is not inconsistent with the clear intent of the legislation, even though the legislation directs primary attention to the river itself.

3. Increased emphasis must be placed on lengthening the time horizon of observations, particularly by seeking and using historical records. This is the only way in which long-term trends will be discerned in less than one or two more decades, and we doubt that either the Congress or the public will be willing to wait so long for a first assessment of changes in the UMRB.

4. To further ensure that the research conducted at EMTC will meet the mandate of the UMRB program, adapt the conceptual model to explicitly show that the impacts of management changes in the system will be evaluated in terms of multiple sets of societal goals and values, and that the scientific information necessary to achieve these evaluations will be secured. In short, incorporate social context into the conceptual model.

Operational recommendations: data collection and analysis

5. Increased attention to hydrographic, morphometric and sedimentation data is necessary to understand the river system. These characteristics drive the system yet they are receiving comparatively little attention. Model approaches can be helpful but even they are limited to available data. The association of a geomorphologist and/or sedimentation specialist with the program may be helpful in this regard.

6. There is no distinction between monitoring and data analysis; they must both be conducted to answer questions. Hence, the analysis of data should be stressed, along with the collection of data. Within the LTRMP, there should be increased and continuous analysis of data collected and comparisons with historical conditions to guide and prioritize future sampling.

The "why" of each data collection effort must be obvious, so there needs to be a strong linkage between collections and analysis. Justifying or modifying further data collection effort in light of the results of analysis is also an opportunity to effect economies in the program.

7. It is necessary to use survey sampling and clinical statistical methods to better analyze the sampling efforts on both the spatial and temporal scales. This will help validate the approach, and help to prioritize sampling collection efforts based on input to analysis

procedures. To facilitate this work, it would be desirable to associate with the program a statistician who is very familiar with clinical and survey sampling approaches using nonparametric and multivariate methods.

8. Place increased emphasis on simultaneous collection of limnological data with fish and vegetation sampling in order to facilitate analyses that will answer critical questions. Limnological sampling should include additional cations and anions, and sediment sampling.

9. Consideration should be given to a NAWQA-type approach to long-term monitoring that will sample pools intensively for 3-5 years each on a rotational basis, with an ultimate focus on systemic conditions.

A temporally staged pattern of sampling, such as this, may be the only practical way to obtain sufficient data to distinguish system-wide and local long-term trends in the face of significant, short-term variability and the large geographical area.

10. The CIA/GIS/photointerpretation and remote sensing efforts appear excellent and should be continued, with additional attention to recovery of data of historical conditions. Other research can be facilitated by making additional use of the data resources provided by this program. This area of emphasis may require additional laboratory space in the Center.

Recommendations about communications

11. It is desirable to foster further in-house cooperation and sharing of resources and results. This will be essential to achieve the central goal of analyzing the status and trends of the river system in a holistic way.

12. It is desirable to further cooperative efforts with local, state and federal agencies. This is to share resources, to facilitate communication and to foster image. Include explicit consideration of what interest groups can best articulate the various goals that may be used to guide the Center's activities. Explicitly incorporate contacts with these groups into the science advisory process.

13. Volunteers may be appropriate for certain data collection activities and would be an effective way of involving the wider public directly in the program.

14. A book series of data reports (as USGS Open-File Reports or similar series) should be inaugurated, describing methods and error analyses as well as listing all the monitoring data, to provide assurance of continued accessibility of the data long after the program has ended. Consider the same approach to publishing research analyses.

Recommendations about the future

15. The Science Review Committee should meet in the next eighteen months to further evaluate the scientific efforts. This review should be held during the growing season to facilitate a limited amount of field evaluation of data collections and sites.

16. In re-authorizing this Program, Congress should consider expanding the scope of the effort to include scientific modeling of the relationships between human and natural activities in the entire UMR drainage basin as they affect the ecological status of the designated river reaches. Conditions in the river cannot be separated from conditions in the drainage basin that sustains it.

5. *Program Review of the Environmental Management Technical Center, U.S. Geological Survey—Biological Resources Division, February 1997.*

Recommendations

Science and Research

- The mission of the Center should appropriately extend beyond those activities required by the Act. EMTC should strive to become a more broadly based science program, building on the focus and expertise that have emerged from the capacities built through LTRMP and CIA activities. The Center should explicitly define its expanded mission. It might well focus on large river basins, especially in the mid-continent. This mission should explicitly recognize the importance of landscape, ecosystem, and watershed scale approaches that incorporate both riverine and surrounding upland habitats.

  The Center's LTRMP base should be expanded to address other science issues of importance to the Department of Interior (DOI) and other federal and state agencies. The explicit adoption of responsibility to serve DOI agencies is considered to be essential.

- Initiatives by the Center to expand its science activities using project funds from sources other than the Environmental Management Program are supported. Such projects and the resources they produce have been and should continue to be used to maintain and enhance facilities and capabilities, expand the expertise and experience of the staff, and balance erosion of buying power of the EMP base. Such projects tend to support LTRMP objectives and provide information and understanding that would not otherwise be obtained.

- There is (and should be) no distinction between monitoring and data analysis. A program such as LTRMP must involve not only scientifically sound collection of monitoring data but also research activities which include: design of monitoring systems, analysis of trends and correlations, focused research and synthesis. The Center's conducting of both monitoring and research activities, within and outside of the LTRMP context, is supported.

- In order to fulfill its research and monitoring missions, the Center Management should undertake a deliberate, proactive program to foster a more encompassing research climate at the Center.

- The planning and consultation process in use at the Center, however inclusive and useful, has become a burden that exceeds its value in producing good science of value to its partners. The BRD Science Implementation Plan provides a suitable substitute for this process. The Center should revise its procedures according to the BRD Implementation Plan.

- The next stage of monitoring should attempt to incorporate higher scale basin level questions. One important consideration is the ecological irrelevance of the definition of the Mississippi River Basin given by the Mississippi River Management Plan (limited to the navigable river channel and excluding most tributaries). While the Center must follow these limitations on LTRMP, it should

expand its scope to basin-wide considerations when the science question merits. In fact, the Center should take the initiative to become the data and science integration center for entire Upper Mississippi as envisioned in the Scientific Assessment Strategy Team (SAST) recommendations.

- The Center is especially encouraged to conduct focused studies such as those represented in the HREP program. These studies address specific hypotheses associated with management needs. Focused hypothesis testing studies should become an increasing portion of the Center's scientific activities. The current emphasis on trend analysis should continue. The Center is also urged to turn its resources to correlation and modeling studies seeking relationships among variables.

- It is essential that the Center connect more strongly with research scientist in other agencies and at Universities to participate in the data analysis. Hypotheses that are generated from these analyses should be followed by extramurally funded studies.

- The Center is urged to become more intimately connected with broader scientific enterprises. The Center will never in itself be able to hire the cadre of scientists of different disciplines and interests needed to do the evaluation of existing data sets that they deserve and to pursue all the interesting and useful research questions that emerge. The Center needs to be a part of a larger community of active scientists and managers and that it should be more engaged in an active and ongoing dialogue with a broader range of scientists, and potential partners, cooperators, and clients to ensure a balanced focus which meets both management concerns and long-term research objectives.

Administrative

- The existing Memorandum of Understanding (MOU) with the Army Corps of Engineers (COE) regarding the Long Term Resource Monitoring Program (LTRMP) at EMTC requires revision. Revision of the MOU should be preceded by discussions on assessments levied on the interagency fund transfers and on clearer and less burdensome interactions between the COE and the EMTC in the production of products, services, and scientific information through the LTRMP.

- The Center's process for monitoring all types of costs by fund, project and organizations within the Center is working well. No changes are recommended.

- Procedures relating to yearend financial closeout, obligating and payment processes, reimbursable agreements, collections, travel, imprest funds, procurement, property, and safety are working smoothly. No changes are recommendations.

Overall, EMTC employees have a sound understanding of personnel issues. Recommendations and required actions for human resources include the following:

Required Actions
-- Managers should ensure that all performance appraisals are completed and performance standards for 1997 are developed for all EMTC employees.

Recommendations
-- The Center Director should ensure that all EMTC employees receive training on the DOI Awards and Recognition Program. Staff from BRD headquarters can provide training assistance, as needed.

-- (1) Develop a mission statement that accurately reflects the new role of EMTC and (2) resume holding monthly staff meetings for all EMTC employees for the purpose of sharing information and to provide status reports on individual projects, as appropriate.

6. ***Management Review Committee Report on the Long Term Resource Monitoring Program - Environmental Management Technical Center.***

The Executive Summary and Recommendations of the report, dated March 11, 1997, are presented below:

Executive Summary

The Management Review Committee (MRC) wishes to commend the Environmental Management Technical Center (EMTC) for seeking guidance on the Long Term Resource Monitoring Program (LTRMP), as well as to express appreciation for the opportunity to review this important program. The MRC acknowledges the initiative of the Center Director in seeking management and science reviews.

The MRC strongly believes that the LTRMP provides many benefits to the region and should be continued. As the Science Review Committee (SRC) report highlighted, the Program conducts high quality scientific monitoring and research on the river and is meeting its original congressional mandates.

Some specific accomplishments include: recruiting and focusing scientific expertise on the Upper Mississippi River (UMR) system, developing an analytical laboratory, providing an international conference and regional workshops. In addition, the EMTC has greatly increased the level of technological expertise in the region, including spatial data base development and analysis, remote sensing, and photo interpretation.

The MRC's primary focus was to look at ways the Program can or should be adjusted to better meet the needs and expectations of partner agencies and the river community. In this spirit, the MRC collectively identified 14 recommendations that should assist the EMTC in its efforts to build upon the Program's past successes.

Recommendations

1. The LTRMP should continue beyond FY 2002 with a permanent authorization and annual appropriations that are cost indexed. The CIA should be an integral part of the LTRMP and not separately distinguished from the overall program.

2. The SRC recommendations should be pursued. They provide a sound scientific basis upon which to shape the future of the Program. The MRC believes that the SRC recommendations must be reviewed and approved by LTRMP partners prior to implementation.

3. The USGS (BRD) should implement, with strong emphasis on input from EMTC employees and the river community, a strategic planning process that yields a clear statement of the vision for the EMTC and how the LTRMP will be conducted consistent with that vision. This recommendation should be implemented with the development of a vision statement by April 15, 1997, and a strategic plan report by September 30, 1997.

4. In the view of the MRC, the Program priorities should focus on monitoring and analysis. Investment in technology should be appropriate to accomplish these efforts.

5. Consistent with USGS processes, the EMTC should continue to negotiate an LTRMP work plan with the Analysis Team (A-Team) that will identify specific products, costs, and a completion date for each product. Products not provided should be explained to the A-Team using the Center's existing cost accounting system.

6. The EMP-CC and A-Team should strengthen and reaffirm their roles in ensuring LTRMP performance. The Program partners should revisit the roles, responsibilities, and relationships of the EMP-CC and A-Team to ensure that they are appropriate and well understood.

7. The MRC recommends the EMTC use the opportunities afforded by the requirements of the National Performance Review to ensure effective team-based participatory management of the Center.

8. To the extent that there is cost savings achieved in LTRMP tasks, that savings should be applied to advancing other LTRMP work activities and the redirection of funds should be coordinated with Program partners.

9. A technical career path should be implemented for scientific staff who do not wish to pursue a management career path.

10. Provide a simplified (non-technical) health of the river report on an annual basis to partners and customers.

11. Annual component reports should be produced and distributed within three months of the end of the data collection year.

12. Develop and implement a plan in coordination with Program partners that improves their technical expertise and ability to use hardware/software capabilities to maximize use of LTRMP products.

13. Increase the use of information-sharing bulletins to expedite Program findings to managers, policy makers, and others.

14. The MRC, as currently constituted, should be reconvened in 18 months to review the implementation of the recommendations.

Summary of Other Corps of Engineers Environmental Restoration Authorities

Attachment

5

SUMMARY OF OTHER CORPS OF ENGINEERS ENVIRONMENTAL RESTORATION AUTHORITIES

	Section 1135	Section 206	Section 204
Purpose	To restore fish and wildlife habitat impacted by previous Corps projects. Modification may be structural or operational. Must be feasible, cost effective, and consistent with authorized project purpose.	Aquatic ecosystem restoration. *No relationship to a previous Corps project is required.* Must be cost effective and improve the quality of the environment.	To protect, restore, or create aquatic and wetland habitat in connection with dredging of a Federal navigation project.
Cost share %	75/25 of TOTAL project costs	65/35 of TOTAL project costs	75/25 of project costs above the base plan
Work-in-kind	No more than 80% of sponsor cost share may be in-kind	Entire sponsor cost share may be work-in-kind	No work-in-kind credit is provided
Sponsor eligibility	Large non-profits acceptable; small not for profits acceptable if no O+M	Section 221 Flood Control Act of 1970; legally constituted taxing body	Section 221 Flood Control Act of 1970; legally constituted taxing body
Authorization	WRDA 1986	WRDA 1996	WRDA 1992
Eligibility criteria	P.L.84-99 **ineligible** May not be formulated for recreational purposes	P.L.84-99 eligible May not be formulated for recreational purposes	P.L.84-99 eligible May not be formulated for recreational purposes
Maximum individual project size ($)	$5 million Federal limit	$5 million Federal limit	No per project $ limit. Annual average project cost = $2 million
Total program funds authorized	$25 million	$25 million	$15 million

SUMMARY OF OTHER CORPS OF ENGINEERS ENVIRONMENTAL RESTORATION AUTHORITIES (Continued)

	Section 1135	Section 206	Section 204
Total program funds available by FY	Fiscal Year Appropriation Amount (In millions) 91 $2.5 92 7.5 93 7.5 94 8.13 95 8.0 96 10.85 97 17.0 98 21.175	Fiscal Year Appropriation Amount (In millions) 98 $6.0	Fiscal Year Appropriation Amount (In millions) 91 $2.5 92 7.5 93 7.5 94 8.13 95 8.0 96 10.85 97 17.0 98 21.175
Project processing and approval authority	PRP[1/] for all projects; HQUSACE approval $300K - $5 million feasibility report required; Division approval Under $300K no feasibility report required; no additional approval required	PRP[1/] for all projects; HQUSACE approval $300K - $5 million feasibility report required; Division approval Under $300K no feasibility report required; no additional approval required	IAR[2/] for all projects; MSC approval $200K - $5 million feasibility report required; Division approval Under $200K no feasibility report required; no additional approval required
Benefits and costs	Monetary and non-monetary benefits must justify the monetary and non-monetary costs. Economic benefits must be associated with improvements to fish and wildlife resources. Habitat benefits must be quantified.	Monetary and non-monetary benefits must justify the monetary and non-monetary costs. Economic benefits must be associated with improvements to fish and wildlife resources. Habitat benefits must be quantified.	Monetary and non-monetary benefits must justify the monetary and non-monetary costs. Economic benefits must be associated with improvements to fish and wildlife resources. Habitat benefits must be quantified.
Operations and maintenance	The sponsor becomes responsible for all O+M	The sponsor becomes responsible for all O+M	The sponsor becomes responsible for all O+M

[1/] PRP – Preliminary Restoration Plan
[2/] IAR – Initial Appraisal Report

Attachment

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