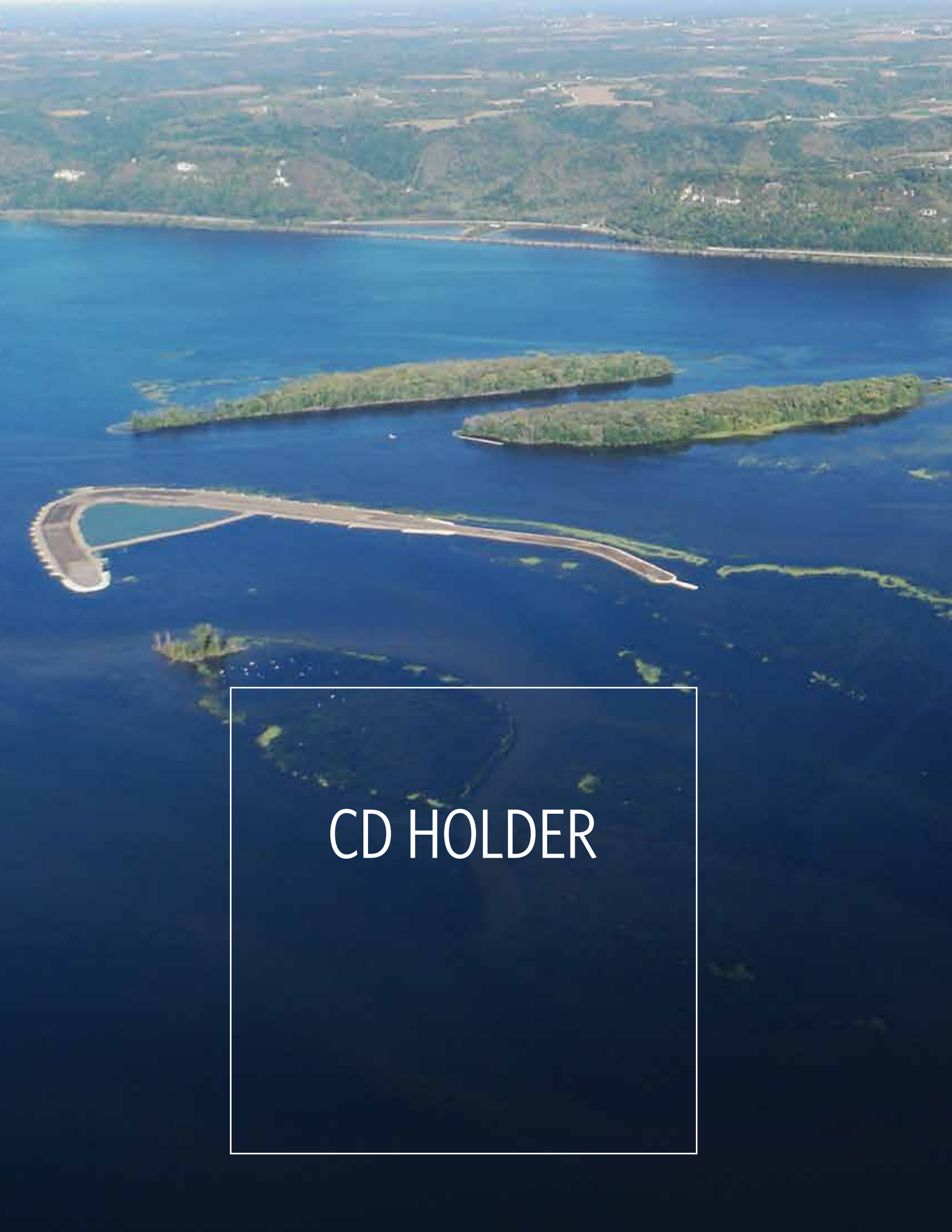
Upper Mississippi River Restoration

Leading · Innovating · Partnering

2016 REPORT to CONGRESS

U.S. ARMY CORPS OF ENGINEERS

ROCK ISLAND, ST. PAUL, AND ST. LOUIS DISTRICTS



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2016

REPORT TO CONGRESS
UPPER MISSISSIPPI RIVER
RESTORATION PROGRAM

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http://www.mvr.usace.army.mil/Missions/Environmental-Protection-and-Restoration/Upper-Mississippi-River-Restoration/

U.S. Army Corps of Engineers

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In addition to those agencies and individuals specifically named, the Corps would also like to express appreciation to the many members of the public and nongovernmental organizations for their review and thoughtful contributions to the report.

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OCT 27 2016

Office of the District Engineer

The Upper Mississippi River Restoration (UMRR) Program is widely recognized as the first large river ecosystem restoration and scientific monitoring program in the country. Now 30 years strong, the UMRR Program is a record of national and international leadership for other large river restoration programs, which emulate the program's innovative approaches to habitat restoration and cutting-edge science, monitoring and research.

The mighty Mississippi River is a treasured part of our national heritage. What the next chapter holds for this iconic waterway and its diverse but endangered ecosystem will depend in large part on continued collaborative efforts of the UMRR Program.

Congress authorized the UMRR Program in the 1986 Water Resources Development Act to address the ecological needs on the Upper Mississippi River System (UMRS) and fulfill their directive to manage the river as both a nationally significant ecosystem and navigation system.

Since its inception, the UMRR Program has completed 55 projects, restoring critical fish and wildlife habitat on 102,000 acres in Minnesota, Wisconsin, Iowa, Illinois and Missouri. From 2005 through 2015, the program's Habitat Rehabilitation and Enhancement Projects benefited nearly 35,000 acres of critical habitat - comprising nearly 50 percent of the wetland acres restored by the Corps nationally. The UMRR Program plans, designs and constructs habitat projects within the high-energy and complex UMRS, while delivering projects at an impressively low average cost of $3,000 per acre.

The UMRS benefits from a deeply rooted history of interagency and interdisciplinary partnerships. While the Corps is ultimately responsible for the UMRR Program implementation, no one agency or program can manage this multi-use ecosystem alone. Rather, successful management requires thoughtful coordination among numerous entities with varying but related mandates, missions and interests. Through the UMRR Program, five federal agencies, five states, numerous nongovernmental organizations and community members all work toward a common goal – a healthy and resilient river.

As with the three previous Reports to Congress in 1997, 2004, and 2010, this report was developed in coordination with the partnership described above. This evaluation provides an opportunity to reflect on the UMRR's considerable accomplishments and assesses how 30 years of evolving legal authorities, management actions and policy decisions have shaped the program.

On behalf of the Corps' St. Paul and St. Louis District Commanders, who share responsibility for implementing the UMRR Program, I would like to recognize the significant contributions this program has made to the restoration and understanding of the natural environment of the UMRS. Many challenges still confront us, but the foundation laid by the UMRR Program over the past 30 years will serve us well as we look to the future.

Craig S. Baumgartner
Colonel, US Army
Commander & District Engineer

EXECUTIVE SUMMARY

"The face of the water, in time, became a wonderful book …
Throughout the long 1,200 miles there was never a page that was void of interest."
– Mark Twain

The mighty Mississippi River is a treasured part of our national heritage. What the next chapter holds for the iconic waterway and its diverse but endangered ecosystem will depend in large part on continued collaborative efforts of the Upper Mississippi River Restoration (UMRR) Program.

The Upper Mississippi River System (UMRS) is an economic engine, which helps drive a global economy and serves as the main artery for transportation of the country's agricultural exports. It is also a tremendously significant ecosystem, supporting commercial and recreational fishing, hunting, boating, and other activities. Tourism and outdoor recreation in the Upper Mississippi River corridor alone translates into $24.6 billion to the region's economy, creating an estimated 421,000 jobs.

Humans are not unique in their dependence on Upper Mississippi River; it is also a globally significant flyway used by more than 326 species of birds and as a home for at least 260 species of fish, 37 species of mussels, 47 species of reptiles and amphibians, and 50 species of mammals, including a number of rare and endangered species. The Upper Mississippi River ecosystem includes 318,750 acres designated as Ramsar Wetlands of International Importance.

Our ability to maintain a healthy economy is directly tied to the ecological health of the river. Starting in the mid-1800's, alternations to make large-scale commercial navigation possible resulted in profound changes to the natural landscape. For decades, the diverse purposes of the river were at odds, with navigation and nature serving as a source of conflict for river stakeholders. Recognizing the dual federal role of providing commercial navigation while also managing the Upper Mississippi River National Wildlife and Fish Refuge, Congress passed the Water Resources Development Act of 1986, designating the Upper Mississippi River System as both a "nationally significant ecosystem" and a "nationally significant commercial navigation system." In that same legislation, Congress established UMRR to provide stewardship of the environmental needs of the river.

The UMRR Program is widely recognized as the first large river ecosystem restoration and scientific monitoring program in the country. UMRR has established a record of leadership. Now 30 years strong, many national and international restoration programs emulate UMRR's innovative approach to habitat projects, planning processes, and cutting-edge science, monitoring, and research.

UMRR's geographic extent compasses 2.7 million acres of river floodplain along the Congressionally-defined navigable portions of the Upper Mississippi, Illinois, Minnesota, Black, Saint Croix, and Kaskaskia Rivers. It is the only major river system in North America to run directly north-to-south, serving as an internationally-recognized flyway utilized by 40 percent of America's migratory waterfowl. Today, the river serves a complex system of human and biota uses, including commercial navigation and water supply, and is a popular tourism and recreation destination.

While we have made great progress, the existing and new stressors on the system will continue to cause degradation. Fish and wildlife habitat has been declining in quantity, quality, and diversity for decades, at an estimated degradation rate of one to three percent annually. What this means is, at these rates,

the ecosystem is declining at one to four times faster than it is currently being restored. The highly invasive Asian carp are among the most notorious stressors in this battle, but climate change, soil erosion, island erosion, and nutrient run-off are less headline-grabbing, silent threats to the river.

Accomplishments Since 2010 Report to Congress

UMRR Program Accomplishments

Throughout its 30 years of service to the Nation, the UMRR Program has led the country in innovation, leadership, and partnership to fulfill its restoration mission. In addition to constructing critical habitat restoration projects and understanding the river ecosystem, the program has completed important milestones on this journey.

2015-2025 UMRR Strategic Plan – This 10-year plan outlines the UMRR Program's key approaches to enhancing restoration and advancing knowledge necessary for a healthier and more resilient Upper Mississippi River ecosystem that sustains the river's multiple uses. It focuses on the program's efforts to continue delivering products and services that are nationally significant, regionally relevant, internationally engaged, and technically sound. This strategic plan enhances the UMRR Program's longstanding commitment to internal and external communication and collaboration among the many organizations and individuals that are working for a better Upper Mississippi River ecosystem.

Advisory Groups Charter – The UMRR Program is charged in its authorizing legislation to work in consultation with the Department of the Interior and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The UMRR Coordinating Committee, the Analysis Team, and the Habitat and Rehabilitation and Enhancement Project (HREP) Planning and Sequencing Framework Teams are the crucial partnership forums that facilitate the implementation of the program.

Ecosystem Objectives Report (2011) – This report builds on the extensive knowledge of the needs of the Upper Mississippi River ecosystem and lays out the needs of the ecosystem by floodplain and geomorphic reach. This information augments the 2000 Habitat Needs Assessment to identify high priority areas for restoration.

Habitat Rehabilitation and Enhancement Project (HREP) Accomplishments

Since 1986, UMRR has completed 55 projects, improving critical fish and wildlife habitat on 102,220 acres in Minnesota, Wisconsin, Iowa, Illinois, and Missouri. Since 2005, the UMRR Program's habitat rehabilitation and enhancement projects (HREPs) benefitted nearly 35,000 acres of critical habitat, comprising nearly 50 percent of the wetland acres restored by the Corps nationally! Despite the complexity of the high-energy Upper Mississippi, UMRR plans, designs, and constructs habitat projects that successfully generate the intended ecological responses and at an impressively low average cost of $3,000 per acre.

The UMRR habitat projects slow or reverse the negative impact of sedimentation and other problems by restoring and protecting high value fish and wildlife habitat. A variety of techniques are used to address the unique circumstances of each particular area. These techniques include:

- Dredging to remove sediment from selected backwaters and side channels to restore aquatic habitat.
- Constructing dikes and levees to keep silt-laden water out of prime habitat areas and to control water levels for optimal plant growth for waterfowl feeding.
- Building islands to decrease wind-generated disturbances, thereby reducing turbidity and stimulating small aquatic plant growth that provides habitat for small animals.
- Altering water flow to side channels and backwaters to prevent inflows of turbid water during flood events and increase dissolved oxygen levels during drought events.
- Modifying wing and closing dams to restore main channel habitat.
- Restoring diverse and healthy floodplain forests.

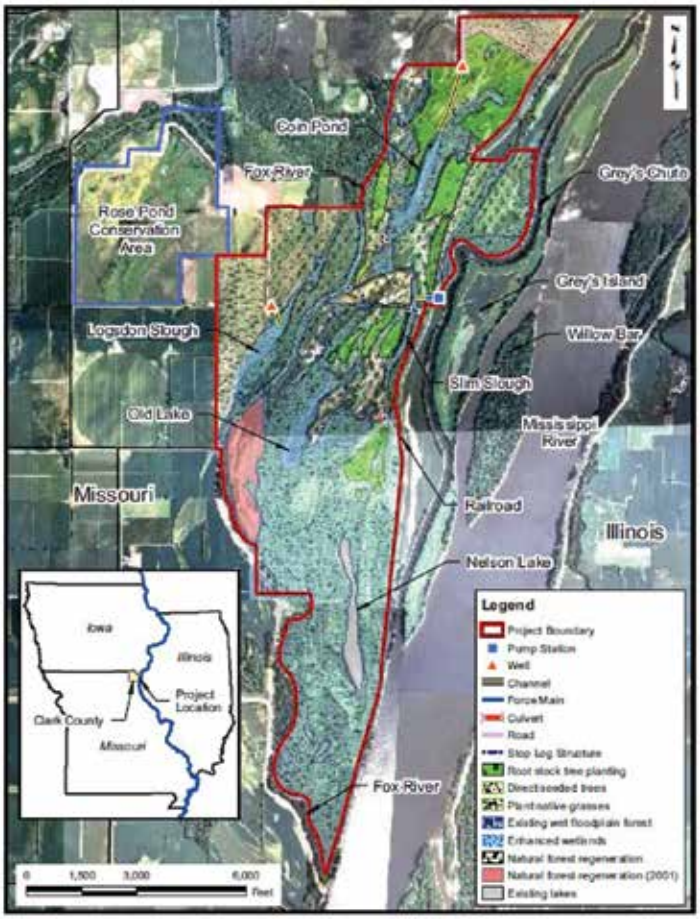
The UMRR Program closely monitors habitat projects to refine techniques and to ensure optimal results. Restoration practitioners use analyses of completed projects in designing similar projects in other areas of the river system. Resource managers and researchers in other regions of the country are also learning from UMRR projects. The construction of habitat projects is one of the most vital components of the UMRR. The projects reflect a strong commitment to maintaining the river as a multi-use resource and will have an important positive effect on the fish and wildlife resources of the river.

The UMRR Program tracks the successes and monitors progress on each habitat project. Since its 2010 Report to Congress, UMRR created a new database that integrates all information related to the program and its habitat projects. It is a key resource allowing UMRR to track and share key information on all project phases and stages.

Completed Habitat Rehabilitation and Enhancement Projects (HREPs)

Since 2010, UMRR has restored over 26,610 acres of important, high-quality habitat through seven projects that provide protection, nesting, and feeding areas for a highly diverse set of fish, birds, mussels, reptiles and amphibians, and mammals, including a number of rare and endangered species.

The **Fox Island** habitat project (Pool 20) connects a large tract of contiguous forest habitat critical for bird migration and creates 2,020 acres of high-quality wetland and floodplain habitat for resident and migratory waterfowl, shorebirds, and wading birds. U.S. Fish and Wildlife Service purchased this former agricultural land following the major 1993 flood to increase river connectivity and wildlife habitat in the floodplain. UMRR is providing the tools necessary for the Service to transition this area back into a mosaic of bottomland forest, wetlands, and grasslands to provide significant benefits to a wide variety of important wildlife species.

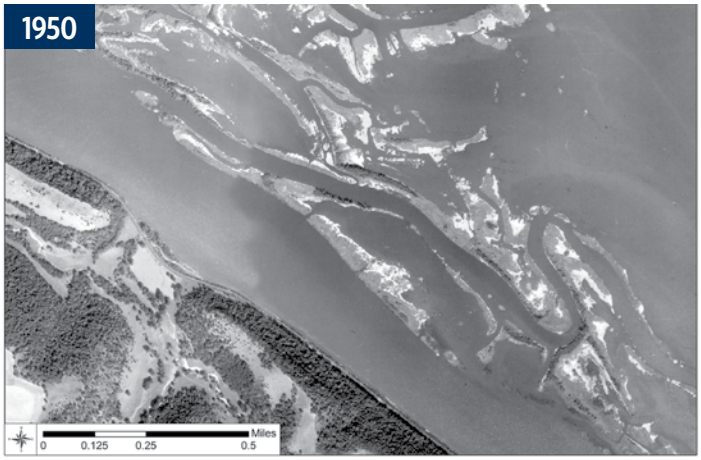


The **Lake Odessa** habitat project (Pools 16 & 17) reduces the influence of sedimentation (a primary degrading influence) and restores fish nursery and migratory bird habitat on 6,400 acres, by strengthening the existing levee, creating new spillways, installing water control structures to provide desired water levels, reforesting hardwood trees, and recreating ephemeral wetlands.

The **Rice Lake** habitat project (La Grange Pool) provides an important food source for waterfowl and improves habitat for herons, egrets, shorebirds, eagles, and other native fish and wildlife species on 6,180 acres, by providing control structures to mimic natural water fluctuations and protecting the area from floods. Rice Lake has historically been excellent fisheries and mid-migration waterfowl habitat. However, summer flood spikes and loss of deep-water habitat and mast trees have reduced habitat quality for resident and migratory waterfowl.

The **Capoli Slough** habitat project (Pool 9) is a prime example of UMRR's many restoration success stories. In the 1940's and 1950's, the area consisted of numerous islands and deep-water areas that provided habitat for a wide variety of species. By 1950 (photo #1), the islands were showing signs of erosion and the deep areas were filling with sediment. Photo #2 shows that the islands and deep-water was nearly completely lost, as well as the plants and animals that once thrived there. This project repaired

the damage and reestablished the islands and deep-water habitat (photo #3) that were there previously. The environmental response to the project, restoring 1,570 acres, was remarkable with significant improvements in the amount of desirable aquatic vegetation, water quality, diversity of habitat resulting in dramatic increases in the numbers and quality of fish, waterfowl, and many other species.



The **Batchtown** habitat project (Pool 25) improves the quality and diversity of wetland habitats used extensively by migratory waterfowl and other birds, by protecting the 3,490-acre site from fluctuating water levels and high sedimentation. The resulting site is a mosaic of backwater wetlands, marshes, and channels. The Batchtown area was once a prime habitat site for large numbers of migrating waterfowl, but the habitat had degraded due to siltation and inadequate water level control. This project received the 2014 Chief of Engineers Environmental Award in recognition of its innovative features and designs.

The **Calhoun Point** habitat project (Pool 26) provides 2,170 acres of breeding, nesting, and feeding habitats for many forms of waterfowl and wildlife species and recreates productive spawning and nursery areas for riverine fishes through a suite of levees and water control structures. Located at the confluence of the Mississippi River and the Illinois Waterway, Calhoun Point is a prime resting and feeding area for migratory waterfowl. It is an important site for endangered salt meadow grass.

The **Swan Lake** habitat project (Pool 26) restores a significant 4,780-acre backwater lake complex, increases water clarity, and restores submerged and emergent vegetation that provides important habitat for fish and macroinvertebrates. Swan Lake is the largest backwater complex in Pool 26 of the Mississippi River and one of the largest on the Illinois Waterway. This UMRR project allows water level management to reduce river-induced sediment deposition and restore floodplain forest connectivity, and the constructed islands reduce turbidity from wind-generated wave action.

Development of Habitat Rehabilitation and Enhancement Projects (HREPs)

UMRR is currently constructing five projects to benefit another 14,440 acres. Since 2010, UMRR has completed feasibility studies for seven projects that restore 22,990 acres of important habitat; some of the projects have been or are currently in construction. UMRR partners are in the process of developing feasibility reports for an additional 11 projects that, when constructed, would benefit an additional 20,020 acres. These projects, listed in Table ES-1, address critical fish and wildlife habitat needs in the Upper Mississippi River ecosystem and are described in more detail in Chapter 2.

From 2011 until 2016, UMRR had a remarkable rate of fiscal execution with an average annual obligation rate of 97 percent. During the last three years of this reporting period, this rate improved to 99 percent.

The Upper Mississippi River System proves that commercial navigation and ecosystem restoration can co-exist in relative harmony, as illustrated by the Pool 11 Islands habitat projects located just north of Dubuque, Iowa. This picture shows a thriving rehabilitated ecosystem on the left, functioning side-by-side with the main navigation channel and a 15-barge tow on the right.

Table ES-1: Accomplishments Since 2010: Restoring the Upper Mississippi River Ecosystem Health and Resilience

Project Name	Location	Acres Benefitted
UMRR has constructed seven projects, benefiting 26,610 acres of important, high-quality habitat		
Capoli Slough	Pool 9	1,570
Fox Island	Pool 20	2,020
Lake Odessa	Pool 17	6,400
Rice Lake	La Grange Reach	6,180
Batchtown	Pool 25	3,490
Calhoun Point	Pool 26	2,170
Swan Lake	Pool 26	4,780
UMRR is actively constructing five projects benefitting 14,400 acres of important, high-quality habitat		
Harpers Slough	Pool 9	3,510
Huron Island Stage 1 (Construction Complete - 100%) Stage 2 (Under Construction - 85%) Stage 3 (Contract to be Awarded - 35%)	Pool 18	2,530
Pool 12 Overwintering Stage 1 (Construction Complete - 100%) Stage 2 (Under Construction - 85%) Stage 3 (Contract Awarded - 10%)	Pool 12	1,280
Pool 25 and 26 Islands	Pool 25	3,940
Ted Shanks	Pool 24	3,140
UMRR has completed feasibility studies for seven projects that will restore 22,990 acres of important high-quality habitat		
Capoli Slough (constructed)	Pool 9	1,570
Emiquon	La Grange Reach	5,810
Fox Island (constructed)	Pool 20	2,020
Huron Island (in construction)	Pool 18	2,530
Pool 12 Overwintering (in construction)	Pool 12	1,280
Rice Lake (constructed)	La Grange Reach	6,180
Clarence Cannon	Pool 25	3,600

Table ES-1: Accomplishments Since 2010: Restoring the Upper Mississippi River Ecosystem Health and Resilience (continued)

Project Name	Location	Acres Benefitted
UMRR is evaluating 11 projects through feasibility reports that, collectively, could restore 20,020 acres of important high-quality habitat		
Conway Lake	Pool 9	1,170
Lake Winneshiek	Pool 9	2,800
Lower Pool 10 Island and Backwater Complex	Pool 10	1,410
McGregor Lake	Pool 10	580
North and Sturgeon Lakes	Pool 3	4,350
Beaver Island	Pool 14	1,680
Boston Bay	Pool 18	920
Delair Division	Pool 24	1,730
Keithsburg Division	Pool 18	1,400
Piasa and Eagle's Nest Islands	Pool 26	1,380
Rip Rap Landing	Pool 25	2,600

Table ES-2 — UMRR's high obligation rate results from its ability to manage risk by utilizing the unique capabilities and geographic location of the three Corps Districts, U.S. Fish and Wildlife Service, U.S. Geological Survey and five state natural resource agencies.

Fiscal Year	Total obligated
2011	93.6 percent
2012	93.8 percent
2013	97.1 percent
2014	98.8 percent
2015	99.4 percent
2016	99.4 percent
Average (2014-2016)	**99.2 percent**
Average (2011-2016)	**97 percent**

Long Term Resource Monitoring (LTRM) and Research Element Accomplishments

The combination of long term monitoring and research has significantly enhanced knowledge of the complex and diverse Upper Mississippi River ecosystem. In addition, these efforts uniquely position UMRR to contribute to large-scale ecosystem restoration nationally and internationally.

The datasets and tools produced by UMRR in the past six years provide an unprecedented amount of information regarding the Upper Mississippi River floodplain ecosystem that is invaluable to restoration, monitoring, and managing the river system. UMRR uses the new data to identify opportunities to restore critical habitats for native plants and animals as well as to refine specific restoration project techniques.

With long term data collected for nearly three decades, UMRR's database is one of the most extensive and comprehensive on any large river system in the world. Long term resource monitoring make it possible to detect actual changes in status and trends of ecological health indicators against the background of long term cycles and variation. Short-term studies cannot provide that information. Continued long term monitoring is imperative for understanding and managing ecosystem responses to ongoing and future stresses such as invasive species, climate

change, and land use in the watershed. UMRR restoration practitioners must understand these dynamics and interactions in order to reduce uncertainty in predicting the effects of various restoration alternatives.

Standardized monitoring of the ecosystem's key features in six study reaches provides valuable information over the wide range of environmental and human-use gradients that exist on the Upper Mississippi River. Using long term resource monitoring, UMRR evaluates the river ecosystem's status and trends through quantitative assessments of the fundamental biological, chemical, and physical indicators. Significant findings and developments since 2010 include:

Ecosystem health – While the Upper Mississippi River ecosystem still retains the underlying features that define river ecosystem integrity, a general gradient of river health exists that ranges from a relatively healthy system in the northern reaches to a system that is much less healthy in the southern reaches.

- The northern portion of the Upper Mississippi River ecosystem is clearly experiencing an ecological shift from a turbid, less vegetated condition to a clearer, more vegetated condition. Since 2005, fish species associated with high water quality, such as weed shiners, yellow perch, largemouth bass, and young-of-year bluegills have rebounded. Habitat projects and natural variation triggered this response. See page 48 for more information.
- The ecosystem is more degraded in the southern portions of the river. Any side channel restoration project would generate significant positive fish and wildlife responses spanning large spatial scales. Side channel restoration will increase habitat connectivity, providing access to refuge and high-energy food sources. See page 23 for more information.
- Since 2010, UMRR completed an extensive evaluation of the ecological health indicators used in its assessments of the Upper Mississippi River ecosystem, recommending new indicators that are more community-based rather than single-species indicators.

Landscape indicators – UMRR developed landscape ecological indicators and a graphical web browser that allows decision makers to easily obtain landscape-related indicators and maps. This provides restoration practitioners with a greater understanding of the Upper Mississippi River landscape ecology and the ecological consequences of modifying landscape patterns.

Systemic data layers – UMRR acquired, processed, and published online four new data layers for the entire Upper Mississippi River ecosystem that are extremely valuable for flood inundation modeling, hydrologic and environmental modeling, planning and designing restoration projects, and predicting and communicating the effects of water level management projects. They include:

- The third decadal land cover/land use data set (collected in 2010 and 2011) with associated aerial photography.
- Airborne Light Detection and Ranging (LiDAR) data (floodplain elevations).
- Bathymetry data (riverbed elevation).
- Topobathy, which merges the LiDAR and bathymetry datasets to form a seamless elevation data layer.

New tools – UMRR published new, user-friendly internet-based mapping and query application tools allowing users to easily access and download fisheries, water quality, vegetation, invertebrate, land cover, and bathymetric data monitored over the life of UMRR. Figure 3-5 on page 47 shows an example output

Asian carps, not even present in the river 100 years ago, are now so dominant that they make up 35 to 70 percent of the fish biomass in some parts of the Upper Mississippi River ecosystem. The high-quality habitat created by UMRR enhances the resilience of native species to invasive species and other stressors.

of the spatial data query tool. In addition, UMRR has increased the public accessibility of its long term water quality monitoring data by serving a new graphical browser for stratified random sampling.

New fisheries information tool – UMRR simplified a complex database of fisheries' monitoring information to provide easy comparisons of fish abundance between study reaches, among species within study reaches, and even between functional levels of organization, such as native and nonnative fish assemblages and reproductive guilds. This can illustrate changes in fish community responses in comparison to longer term averages for any given year.

WHY THE UMRR PROGRAM MATTERS FOR THE UPPER MISSISSIPPI RIVER SYSTEM

UMRR Partners ...

The Upper Mississippi River ecosystem benefits from a deeply-rooted history of interagency and interdisciplinary partnerships. While the Corps is ultimately responsible for UMRR's implementation, no one agency or program can manage this multi-use ecosystem alone. Rather, successful management requires thoughtful coordination among numerous agencies, organizations, and individuals with varying but related mandates, missions, and talents. Through UMRR, five federal agencies, five states, numerous nongovernmental organizations, and community members all work toward a common goal – a healthy and resilient river. On average, its partners contribute $1 million annually to UMRR's efforts.

The UMRR Coordinating Committee serves as the primary venue for partners to discuss a broad range of policy, technical, and budget related issues. The Committee's quarterly meetings serve as an important forum for communicating and coordinating with a broad range of federal, state, and other non-federal habitat project sponsors on issues related to restoration, research, and monitoring.

UMRR Leads ...

The UMRR Program leads the country in innovation, leadership, and partnership to fulfill its restoration mission. UMRR facilitates interactive dialogue and engagement to inform and solicit input from the public and large river ecosystem experts throughout the Upper Mississippi River watershed, the Nation, and the world.

The Upper Mississippi River Wildlife and Fish Refuge attracts as many visitors annually as the Yellowstone National Park!

UMRR Innovates ...

As the Nation's first large river restoration and monitoring program, UMRR has a proud history of pioneering innovative restoration techniques. The second edition of the UMRR Environmental Design Handbook, published in 2012, seeks to share our understanding of the biological responses to project designs with restoration practitioners, while also conveying new information about the most effective restoration and management approaches. For example, UMRR has learned that slightly lowering island elevations provides a more natural seasonal connectivity between channels and backwaters during smaller flood events. By contrast, islands with elevations higher than flood stage may support establishment and maturity of hard mast trees.

Since 2010, UMRR has developed a suite of new and improved models to help interpret long term resource monitoring data and predict conditions under a range of scenarios and potential management interventions. The models include comprehensive hydrology, spatial floodplain inundation simulations, two-dimensional hydrodynamics, wind fetch, submersed aquatic vegetation and floodplain vegetation.

The Corps created a new UMRR database that integrates and geo-references information related to the program's 90 habitat projects. The database includes several important features that give quick access to UMRR data and information – all while ensuring data quality and consistency.

UMRR's Plan for The Next Six Years: What UMRR Will Deliver for the 2022 Report to Congress

Over the next six years, UMRR will pursue habitat restoration and scientific long term resource monitoring and investigations as envisioned in the 2015-2025 UMRR Strategic Plan. This includes:

- Identifying the most pressing restoration opportunities, designing critical habitat projects that address site-specific habitat needs and restore larger ecological processes and functions, and using innovative and effective restoration techniques and approaches.
- Increasing knowledge of the Upper Mississippi River ecosystem for the purposes of understanding its current health and resilience and predicting future conditions in order to inform and enhance river restoration and management.

Habitat Rehabilitation and Enhancement Project Planning

Over the next six years, UMRR will be in a position to complete construction on a total of nine projects improving another 23,330 acres, begin construction on six projects, complete 13 feasibility reports, and develop feasibility reports on an additional seven projects. These projects are outlined in Table ES-3.

UMRR Regional Manager Marvin Hubbell and other program partners brief Representative Ron Kind (Wisconsin) and Secretary of Interior Sally Jewell on the importance of the Upper Mississippi River ecosystem and the role that UMRR plays to restore and monitor its health and resilience.

Table ES-3 Planned Habitat Restoration Accomplishments for 2017-2022

Project Name	Location	Acres Benefitted
UMRR will complete construction on nine projects benefiting 23,330 acres of important, high-quality habitat		
Conway Lake	Pool 9	1,170
Harpers Slough	Pool 9	3,510
North and Sturgeon Lakes	Pool 3	4,350
Beaver Island	Pool 14	1,680
Delair Division	Pool 24	1,730
Huron Island	Pool 18	2,530
Pool 12 Overwintering	Pool 12	1,280
Pools 25 and 26 Islands	Pool 25	3,940
Ted Shanks	Pool 24	3,140

Table ES-3 Planned Habitat Restoration Accomplishments for 2017-2022 (continued)

Project Name	Location	Acres Benefitted
UMRR will initiate active construction on six projects that will benefit 11,590 acres of important, high-quality habitat		
McGregor Lake	Pool 10	580
Beaver Island	Pool 14	1,680
Delair Division	Pool 24	1,730
Keithsburg Division	Pool 18	1,400
Clarence Cannon	Pool 25	3,600
Rip Rap Landing	Pool 25	2,600
UMRR will complete feasibility studies for 13 projects that will benefit 26,890 acres of important, high-quality habitat		
Conway Lake	Pool 9	1,170
McGregor Lake	Pool 10	580
North and Sturgeon Lakes	Pool 3	4,350
Beaver Island	Pool 14	1,680
Delair Division	Pool 24	1,730
Keithsburg Division	Pool 18	1,400
Crains Open River Islands	Open River	590
Glades Godar Wetlands	Alton	5,770
Harlow and Open River Islands	Open River	1,260
Piasa and Eagle's Nest Islands	Pool 26	1,380
Red's Landing Wetlands	Pool 25	1,620
Rip Rap Landing	Pool 25	2,600
Wilkinson Open River Islands	Open River	2,760
UMRR will initiate feasibility planning on seven projects that will benefit 23,340 acres of important, high-quality habitat		
Lake Winneshiek	Pool 9	2,800
Clear Lake	Pool 5	320
Boston Bay	Pool 18	920
Steamboat Island	Pool 16	440
Turkey River Bottoms	Pool 11	3,370
Snyder Slough	Pool 11	1,990
Oakwood Bottoms	Open River	13,500

Long Term Resource Monitoring and Research Element Planning

The 2015-2025 UMRR Strategic Plan calls for continued rigorous, scientific analyses to further increase understanding of the Upper Mississippi River's large, complex and dynamic ecosystem. This includes implementing adaptive management in more deliberative ways and keeping track of biological responses to restoration.

The monitoring, research, and analyses undertaken by UMRR are critical to enhancing our understanding of the Upper Mississippi River ecosystem. With this information, we will more effectively target critically needed ecosystem restoration. In the time until the next Report to Congress, many significant initiatives will be undertaken or completed. The most important of these initiatives are described below.

UMRR samples water quality parameters each winter to assess the distribution of suitable winter habitat for fish and identify areas where habitat restoration is needed for fish to survive over the winters when the river's surface is frozen.

Complete the habitat needs assessment II – UMRR will finalize the second comprehensive habitat needs assessment as described on page 21, incorporating learned information about the river's fundamental ecological characteristics and the influence of in-river and watershed factors on fish and wildlife habitat. This assessment will serve as a foundational guide to identifying and selecting the third generation of habitat projects.

Mike Steuck of the Iowa Department of Natural Resources displays largemouth bass collected from the recently constructed Sunfish Lake habitat project in Pool 11, explaining to Assistant Secretary of the Army for Civil Works Jo-Ellen Darcy and Major General Michael Walsh about how the project provides the habitat needed for fish to survive harsh winters that frequently occur on the Upper Mississippi.

Measure ecological resilience – An ecosystem's resilience is its ability to return to its current state after disturbances. For example, ecosystems can exist in multiple states such as a healthy, clear-water state with high-quality habitat or a turbid state with little to no vegetation and low-quality habitat. Better understanding the factors influencing ecological health and resilience of the Upper Mississippi River will result in more effective restoration efforts.

Quantify ecosystem health: third status and trends report – The continued accumulation of long term resource monitoring data is necessary to be able to assess, and detect changes in, the fundamental health and resilience of the Upper Mississippi River ecosystem and detect trends over time. This includes monitoring and evaluating the river's key ecological components: water quality, aquatic vegetation, fish, bathymetry, and land cover/land use.

Enhance knowledge and analytical capabilities – UMRR will continue to conduct research about the factors controlling the dynamics and interactions of important ecological components. Scientific research, analysis, and modeling is focused on gaining critical, management-relevant information about the Upper

Mississippi River ecosystem's structure and function and on increasing certainty related to predicting ecological responses to management actions.

Collect and analyze the land cover/land use – UMRR will begin collecting digital aerial photos in 2020 for this dataset. These decadal datasets and aerial photo mosaics, accomplished through the collection and interpretation of systemic aerial photography every 10 years, are key components in this monitoring effort. These data are heavily used in restoration project formulation.

Monitor and evaluate key ecological components – Assesses changes in the Upper Mississippi River's ecological conditions and determines how those changes relate to management actions, natural variation, and the overall ecological integrity of the Upper Mississippi River. Future analyses will expand and build upon these data to also examine long term dynamics and interactions among the various indicators.

One visible signal that UMRR's habitat project successfully restore fisheries' abundance is the fact that the Bassmaster Elite held an unprecedented three tournaments in Pool 8 near La Crosse, Wisconsin just within the past five years. Eight of the top 10 finishers in 2013 focused on/spent most of their time fishing around structures built by the UMRR's Pool 8 Islands habitat project.

UMRR Report to Congress Requirements

Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662), as amended, requires UMRR to submit a Report to Congress every six years. The first Report to Congress in 1998 resulted in a permanent authorization for UMRR as well as changes to the cost-share requirements for habitat restoration projects not on national wildlife refuge lands. Section 1103 requires that each Report to Congress:

A) Contain an evaluation of the UMRR habitat rehabilitation and enhancement projects and long term resource monitoring elements;

B) Describe the accomplishment of each UMRR element;

C) Provide updates of a systematic habitat needs assessment; and

D) Identify any needed adjustments to UMRR's authorization.

Recommendations

The UMRR Program partners believe the program continues to carry out the vision of Congress for the 1,200 mile Upper Mississippi River System in exemplary fashion. The 2015-2025 Strategic Plan continues to guide partner organizations' collective work toward that vision. The environmental enhancements and progress made by UMRR and its partners could be undone without the continuation of this unified effort.

The UMRR program partners recommend no adjustments to the authorization in this Report to Congress, and the Corps will continue to work with its partners to address challenges to implementation.

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UMRR is Fulfilling Congress' Vision for a "Nationally Significant Ecosystem and Nationally Significant Commercial Navigation System"

UMRR is Authorized from Conflict to Collaborative River Management

Conflict over the expansion of Lock and Dam 26 in the mid-1970s eventually sparked a new era of Upper Mississippi River management, integrating navigation and ecosystem purposes to sustain the river's multiple economic and ecological uses. In 1974, the Corps submitted an environmental impact statement (EIS) recommending construction of two 1,200-foot replacement locks at Lock and Dam 26. This recommendation came in the years following Congress' adoption of many of the modern environmental laws, such as the Clean Water Act and the National Environmental Policy Act. It also came as many citizens were expressing concern regarding the ecological impacts of the navigation system.

Following the release of the EIS, a coalition of rail companies and environmental groups filed suit to block the project and a federal court suspended the design work. The primary argument in the lawsuit was that the EIS was inadequate as it did not consider the systemic effects of the lock replacement on the river system and its multiple uses. Congressional members and federal and state agencies found the lack of information on the river itself made it difficult to evaluate ways to manage the river while balancing the demands of competing uses.

Seeking to balance this concern with the navigation system needs, in 1978, Congress authorized construction of a new dam with a single, 1,200-foot lock and directed the Upper Mississippi River Basin Commission to conduct a study and make recommendations related to the potential for further navigation capacity expansion as well as the ecological effects associated with such an action. In 1982, the Commission presented its findings and recommendations in a landmark document, the Comprehensive Master Plan for the Management of the Upper Mississippi River System.

Among other things, the Master Plan recommended that Congress authorize a second, 600-foot lock 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. While Congress did not ultimately adopt all of the Commission's recommendations, it did authorize many key elements in the Water Resources Development Act of 1986 (Public Law 99-662). Section 1103 of that law authorized both a second 600-foot lock at Lock and Dam 26 as well as the habitat restoration and long term resource monitoring known today as the Upper Mississippi River Restoration (UMRR) Program.[1]

Section 1103 authorized the Corps, in consultation with the Department of the Interior and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, to undertake the original six programmatic elements of UMRR, including:

- 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.
- Monitoring of traffic movements.

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

- Express Congress' desire "to ensure the coordinated development and enhancement of the Upper Mississippi River System."
- Declare the river as 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 the Interior.
- Designate the Upper Mississippi River Basin Association as "caretaker" of the Master Plan.
- Establish the cost-share requirements for habitat projects.

[1] Congress and the Administration originally referred to the program as the Upper Mississippi River System Environmental Management program (EMP) until 2006, when Congress and the Administration began referring to the program as Upper Mississippi River Restoration (UMRR) in their budgeting and appropriations documents.

Congress authorized UMRR to be the first federal program to combine ecosystem restoration, monitoring, and science on a large river system. UMRR has focused primarily on two of the six initially authorized elements: 1) habitat rehabilitation and enhancement projects and 2) long term resource monitoring, research, and analysis. These two elements have comprised the essence of UMRR from the beginning and are described in more detail in Chapters 2 and 3 of this report, respectively.

In the 1999 Water Resources Development Act, Congress combined the authority for a computerized inventory and analysis system with the monitoring element and added applied research. The other elements of the original UMRR programmatic authorization have either been completed, have expired or been deleted, or are not being pursued. In particular, the authority to construct recreation projects expired at the end of the 15-year authorization, having never been pursued as successive Administrations deemed recreation projects to be a low priority for the Corps. While the authority to monitor navigation traffic remains, the Corps has not employed this element of UMRR's authorization since 1990. Instead, the Corps conducted extensive traffic analyses as part of its 2004 Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study. Finally, the authority to undertake a study of the economic impacts of recreation was deauthorized in the 1999 Water Resources Development Act, having been completed in 1993.

Congress Supports and Strengthens UMRR's Capabilities

In contrast to the typical Corps project for which feasibility studies precede construction authorization, Congress used the Comprehensive Master Plan for the Management of the Upper Mississippi River System as the basis for determining that an ecosystem restoration and long term resource monitoring program on the Upper Mississippi River was in the federal interest. UMRR is truly an ongoing program and not simply a collection of authorized projects.

This is re-enforced in UMRR's authorizing legislation, as amended, including its extension to a continually authorized program. The authorization is included as Attachment A. UMRR is unique in that its authorization is dual purpose; its conception is born from interagency, collaborative deliberation; and Congress made UMRR's authorization continuous to address long term environmental maintenance needs of the system under ongoing stresses caused by the construction and operation of the nine-foot navigation channel.

UMRR has a strong foundation of interagency partnership that is vital to its success, creating a common, unifying collaboration for which agencies continue to come together and contribute in-kind and cost-share resources and expertise in an effort to restore the Upper Mississippi River ecosystem's health.

In January 1986, the Corps published a foundational document entitled the General Plan to guide UMRR implementation. That document was followed by six Annual Addenda, 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 that set forth UMRR accomplishments and recommended continued funding.

The original UMRR authorizing legislation in Section 1103 of the 1986 Water Resources Development Act has been amended four times since its enactment in subsequent water resource development acts. Section 405 of the 1990 Act (Public Law 101-640) extended the original UMRR authorization period an additional five years, through FY 2002. In addition, Section 107 of the 1992 Act (Public Law 102-580) included amendments that 1) allowed some limited flexibility in how funds are allocated between the habitat rehabilitation and enhancement projects and long term resource monitoring and 2) modified the cost-sharing provisions to assign sole responsibility for operation and maintenance of habitat projects to the agency that manages the lands on which the project is located. The most important change, reauthorizing UMRR as a continual and expanded program, came in Section 509 of the 1999 Act (Public Law 106-53, with corrections made in Public Law 106-109).

In taking this action, Congress recognized that, as long as stresses related to the construction and operation of the nine-foot navigation channel and other human activity persist, there would be an ongoing need to address the resulting impacts to the ecosystem.

The 1999 Act also:

- Increased UMRR's annual authorized appropriations to $33.17 million (an increase of $14.215 million).
- Increased UMRR's non-federal cost-share from 25 percent to 35 percent of total habitat project cost.
- Called for an UMRR independent technical advisory committee.
- Directed the Corps to develop a "habitat needs assessment."

The new cost-share formula was modified to match the Corps' non-federal requirement for its other ecosystem restoration projects. At the same time, the Corps modified its land acquisition policy to allow for non-federal partners to receive cost-shared credit for the purchase and/or costs of lands, easements, rights-of-way, relocation of utility or other existing structures, and disposal areas (LERRDs), even if previously acquired.

Since the 2010 Report to Congress, the agencies have worked to continuously improve UMRR's implementation, transparency, accountability, and the organizing and maintaining of institutional knowledge. Pictured here is the UMRR's Coordinating Committee signing the joint charter for UMRR's interagency consultative bodies.

The 2007 Water Resources Development Act (Public Law 110-114) included provisions allowing nonprofit organizations to cost-share habitat projects; non-federal contributions to include in-kind services; and nutrient research and remediation as part of long term resource monitoring.

This report is UMRR's fourth report to Congress. UMRR is required to submit these reports every six years and to include information detailing accomplishments and any recommendations for modifications to policy or legislation necessary to improve UMRR's implementation. The first report in 1997 described the accomplishments of UMRR's first 12 years, set forth the partner agencies' vision of UMRR's future, and described the broad public support for its continuation, setting the foundation for Congressional approval of UMRR's continual authority.

In 2004, the second UMRR Report to Congress focused on the program's maturation and accomplishments since the 1997 report; described some challenges related to program implementation; and offered recommendations to Congress, the Corps, and partners regarding legislative, administrative, and policy adjustments. The report concluded that Congress, through legislation and funding, had provided UMRR's partnership with the necessary tools to establish a successful restoration and scientific program, improving the health and knowledge of the Upper Mississippi River ecosystem.

The third, 2010 Report to Congress described UMRR's accomplishments from 2004 through 2010 and articulated the Corps' response to Congress regarding a potential transition of UMRR to the Navigation and Ecosystem Sustainability program if it should occur. In 2012, the Administration formally submitted these transition recommendations to Congress. Primarily, this included the need to ensure that any transition not result in the reduction of ecosystem restoration and long term resource monitoring on the Upper Mississippi River. These recommendations are described in more detail in the Conclusions and Recommendations Chapter of this report.

Other recommendations provided in the 2010 UMRR Report to Congress were to 1) ensure that UMRR continues to function as an effective and efficient program, 2) develop an implementation issues assessment to address policy and program implementation issues, and 3) develop a strategic plan for habitat project implementation. UMRR subsequently completed all three of the recommended actions.

Accomplishments Since 2010: UMRR Achieves a Unifying Vision

With any large collaborative interagency partnership, the creation of a shared strategic vision is fundamentally important to promoting continued engagement in UMRR implementation and ensuring that all partners are working toward a common purpose with the same underlying assumptions and core principles. While UMRR had previously completed strategic plans related to its long term resource monitoring element, it completed the first strategic plan for the entire program. The 2015-2025 UMRR Strategic Plan includes a vision, mission, goals, assumptions, guiding principles, and criteria for evaluating success:

Vision: A healthier and more resilient Upper Mississippi River ecosystem that sustains the river's multiple uses.

Mission: To work within a partnership among federal and state agencies and other organizations; to construct high-performing habitat restoration, rehabilitation, and enhancement projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; to engage other organizations to accomplish UMRR's vision.

Goals:

1) Enhance habitat for restoring and maintaining a healthier and more resilient Upper Mississippi River ecosystem.
2) Advance knowledge for restoring and maintaining a healthier and more resilient Upper Mississippi River ecosystem.
3) Engage and collaborate with other organizations and individuals to help accomplish the UMRR vision.
4) Utilize a strong, integrated partnership to accomplish the UMRR vision.

Assumptions (underlying foundation for goals, objectives, strategies):

1) Conditions in the Upper Mississippi River result from a combination of tributary inputs from the watershed, natural and man-made structures within the river corridor, and management of river flow. Human actions over time, within the river and its watershed, have produced stresses to the river's condition and degraded its ecological health.
2) Existing stresses (e.g., point and nonpoint source pollution, navigation, flood control structures, invasive species) are likely to remain, and new stressors are likely to emerge. Thus the river will continue to degrade without continued management and rehabilitation designed to minimize the effects of stresses. Managing stresses that originate within the watershed will require coordination with other relevant agencies, programs, and land managers to address these challenges at their sources.
3) The man-made infrastructure within the river corridor that supports navigation and other human uses will remain in place for the foreseeable future, but modifications to structures or operations may occur.
4) UMRR's datasets (and other information) will be used to evaluate progress in advancing ecosystem and management objectives, identify future restoration needs, and determine if the Upper Mississippi River is recovered to a quality sufficient to support a healthy and resilient river ecosystem.

Guiding principles – Core principles to guide implementation of the Strategic Plan are to:

1) Deliver innovative, high-quality projects, products, and services that create value to UMRR partners and serve as a knowledge base for the Upper Mississippi River and other river systems nationally and internationally.
2) Promote focused research and analyses of monitoring data to predict how management actions will affect river structure and function and use habitat projects to help evaluate those predictions and improve management capabilities.
3) Make decisions using the best available science, data, and other information that will benefit current and future generations of humans and biota.
4) Routinely disseminate information about UMRR activities and outcomes to program partners and other organizations and individuals to promote transparency and knowledge sharing.
5) Apply the principles of adaptive management to continually learn and improve as a program and in implementing restoration and science techniques.
6) Maintain and support the effective interagency and interdisciplinary partnership through communication and collaboration of the UMRR Coordinating Committee, Analysis Team, and habitat project planning and sequencing teams to ensure high-quality program delivery.
7) Serve as a dedicated partner to other agencies and programs in the integrated, multi-purpose management of the Upper Mississippi River and its watershed.

Defining success:

1) Restoration projects that enhance the health and resilience of the Upper Mississippi River and demonstrate progress in achieving this Strategic Plan's goals and objectives.

2) A highly-integrated program in which research and monitoring informs restoration and management efforts and in which restoration efforts are readily available for scientific use.
3) The ability to detect and communicate the status and trends of the Upper Mississippi River as related to indicators of ecosystem health and resilience as well as management objectives.
4) A highly-engaged regional partnership that is supportive of UMRR and its outputs.
5) The Upper Mississippi River Restoration is recognized as a premier program in large river restoration and science and is a source of guidance for similar programs nationally and internationally.

UMRR's vision and mission statement provide a context for decision-making about resource allocation, as well as the focus for UMRR's restoration and science work. Partners use this plan to frame discussions regarding UMRR's implementation within their agencies as well as with external audiences. The partners subsequently developed A Guiding Document for Implementing the 2015-2025 UMRR Strategic Plan that identifies the specific actions to best achieve the goals and objectives.

Since 2010, UMRR has celebrated several significant milestones that no other large river ecosystem program has achieved. Pictured here is the Assistant Secretary for the Army of Civil Works Jo-Ellen Darcy exclaiming the value that UMRR provides to the Nation and the expressing appreciation for the incredible working relationships among its partnership.

Accomplishments Since 2010: Success Through Interdisciplinary and Interagency Implementation

The Upper Mississippi River region has a rich tradition of partnership that has been critical in sustaining and enhancing the river's many economic, ecological, and social values. This partnership is responsible for UMRR's original conception, initial authorization and subsequent permanent continuing authority, and has contributed greatly to the program's maturation into a well-respected and effective restoration and science program. Congress affirmed its support for this collaborative approach in the 1986 authorizing legislation, where it directs the Corps to implement UMRR "in consultation with" the Department of Interior and the five basin states.

UMRR Facilitates a United Partnership Seeking Desired Ecological Outcomes

UMRR partner contributions include, but are not limited to, in-kind engineering and technical expertise for habitat project selection and formulation; non-federal cost-share funding to construct habitat projects; ongoing operation and maintenance of habitat projects; implementation of long term monitoring of the river's status and trends; and scientific analyses that investigate the complex relationships among the river's ecological components and watershed drivers. This partnership is instrumental to the successful implementation of UMRR and is used to shape the formulation of ecosystem restoration programs elsewhere in the country.

Since the 2010 Report to Congress, UMRR has continued to enhance interagency implementation through increased communication and coordination. Maintaining open lines of communication and trust among the implementing partners and stakeholders is essential to effectively addressing implementation challenges. Significant accomplishments related to interagency implementation of UMRR include the following:

UMRR advisory groups charter – The May 2013 UMRR Coordinating Committee adoption of a UMRR charter sets forth the roles and responsibilities of consultative, interagency bodies. While implementing partners were comfortable with their respective roles, they agreed that a charter would be valuable in communicating to Congress, the Administration, and other internal and external audiences regarding UMRR's structure and function.

Targeted collaborative forums – Through several ad hoc collaborative forums, UMRR partners consider policy and budget questions and improve implementation. Some of the topics discussed in these forums include allocation of limited resources under reduced funding scenarios, planning for special events,

resolving implementation issues, setting a strategic vision for implementation in 2015-2025, and evaluating the applications of adaptive management and resilience concepts to the Upper Mississippi River ecosystem.

Enhanced program integration – UMRR facilitates integrated discussions among restoration practitioners, habitat project planners and engineers, and scientists to better understand the river ecosystem and how restoration techniques and approaches can generate the desired ecological responses. The Corps and U.S. Geological Survey have co-hosted annual meetings starting in 2012 that alternate between long term resource monitoring-specific technical meetings and science coordination meetings that involve both the program's science partners and restoration practitioners. These meetings have generated important discussions about how restoration, monitoring, and research can better enhance the Upper Mississippi River's ecological health.

Solutions to implementation challenges – From 2011 to 2013, the UMRR Coordinating Committee facilitated comprehensive discussions about a variety of implementation challenges. These discussions resulted in consensus recommendations from UMRR partners. Ultimately, 12 of these issues were included in the 2013 Implementation Issues Assessment, which communicates partner recommendations to the Administration, the Corps, partners, and external stakeholders. Figure 1-1 lists the suite of the Assessment's recommendations.

Continued transparency – UMRR engages leadership of implementing federal and state agencies in order to ensure transparency and accountability, address concerns and questions, and facilitate continued support. On September 18, 2014, the Corps hosted a summit that brought together leadership from UMRR's implementing partner agencies to discuss important implementation issues and highlight ongoing work and recent accomplishments. The discussions were very productive and resulted in concrete follow-on actions. Primary issues discussed were the opportunities and challenges: 1) for state partners to maintain and enhance their ongoing, active participation and leadership in UMRR's implementation, 2) to continually work with navigation interests and other river uses to promote the Upper Mississippi River's ecological importance, and 3) for non-federal partners to execute the Corps' newly-revised project partnership agreements. The latter issue is discussed further in Chapter 5.

Continued process improvement – UMRR pursues continuous process improvements to enhance project execution efficiencies and proactively examine opportunities to further reduce planning costs and times. Interdisciplinary and interagency teams of federal and state agencies, nonprofit organizations, and private entities worked together in UMRR's early years to develop the best approach to building restoration projects on the river and

monitoring and evaluating the river's key ecological indicators. These interdisciplinary, interagency teams have continued to work together through the years to refine and continuously improve UMRR's restoration and science techniques. This has included streamlining the planning process and level of review in some cases, while still clearly documenting and communicating major milestones and decisions, and ensuring proper internal agency coordination on major decision points early in the feasibility phase.

Program and project information management – UMRR updates and makes historic documents accessible and creates processes to ensure that institutional knowledge is organized and maintained properly as it is developed. The Corps and U.S. Geological Survey revamped UMRR websites to be more user-friendly and include direct links to important information. Since 2010, the Corps has developed a new database to combine key program information into a single application that integrates and geo-references habitat projects to produce priority program- and project-level reports and analyses. The database includes several important features that provide long term utility, including linking all program data together, recording programmatic history on key issues, standardizing and tailoring reporting, and ensuring data quality and consistency. As an example of its utility, the database can generate comprehensive reports about UMRR's investment within various geopolitical boundaries, providing important information for local, state, and federal elected officials.

Figure 1-1 — 2013 UMRR Implementation Issues Assessment Recommendations

Fulfilling a recommendation of the 2010 Report to Congress, UMRR completed the 2013 Implementation Issues Assessment to address a variety of outstanding issues and challenges, with the goal of enhancing program implementation. For each issue, the Assessment provides a concise overview, outline of relevant policy, and an articulation of partner recommendations, including specific action items. UMRR implementing partners found this to be an important opportunity to have comprehensive discussions about the issues and to reach consensus for how best UMRR should to advance or resolve them. This also process created a better awareness and understanding of the issues among partners. The 12 resulting recommendations included:

- ✓ Advance habitat projects that include land acquisition from willing sellers, where that is the most efficient and effective option.
- ✓ Maintain UMRR's current delegated authority policy.
- ✓ Implement new and innovative restoration techniques and approaches, in an effort to enhance the program's capacity to address the partner-identified ecosystem goals and objectives.
- ✓ Include more explicit and consistent consideration of state and federal agencies' Upper Mississippi River-related priorities in the program's habitat project planning and prioritization.
- ✓ Expand the criteria for constructing habitat projects at full federal expense.
- ✓ Consider habitat projects that have a nonprofit cost-share sponsor.
- ✓ Improve habitat project evaluations.
- ✓ Pursue options to better enable U.S. Fish and Wildlife Service and the states to completely and effectively implement habitat project operation and maintenance.
- ✓ Seek to increase long term resource monitoring resources, while also preparing strategies to guide implementation.
- ✓ Develop more deliberate and explicit approaches to implementing adaptive management.
- ✓ Evaluate emerging trends and issues that might affect UMRR's restoration, monitoring, and research efforts.
- ✓ Maintain and enhance the states' ongoing, active participation and leadership in the UMRR that are essential to program's success.

With any large collaborative interagency partnership, the creation of a shared strategic vision is fundamentally important to promoting continued engagement in UMRR implementation and ensuring that all partners are working towards a common purpose with the same underlying assumptions and core principles. While UMRR had previously completed strategic plans related to its long term resource monitoring element, it completed the first strategic plan for the entire program. The 2015-2025 UMRR Strategic Plan includes a vision, mission, goals, assumptions, guiding principles, and criteria for evaluating success.

UMRR's Interagency Partnership Enhances Outcomes

As the federal agency authorized to implement UMRR, the Corps is ultimately responsible for management and execution of the program. As a result, UMRR has been shaped in many ways by Corps policies and procedures. At the same time, the Corps pursues this mission in a genuine spirit of cooperation with its agency partners and river stakeholders. Through interagency consultative and coordination bodies, UMRR's partnership works together to consider and address a range of policy and budget issues, to define program priorities and direction, and to raise and resolve technical questions. Habitat projects are selected, planned, and designed in a collaborative manner among project planners, engineers, natural resource managers, and scientists. Long term resource monitoring, research, and analysis are also implemented in coordination with UMRR's partners.

UMRR also benefits tremendously from its partnerships with other federal agencies, nongovernmental organizations, industry, and the public. For example, nongovernmental organizations are actively engaged in UMRR's implementation and public outreach, contributing to its effectiveness. In addition to involvement in these collaborative mechanisms, individual federal and state agencies have specific responsibilities for implementing UMRR and nonprofits and the general public offer support in a variety of ways:

The Corps has overall responsibility for all aspects of UMRR implementation. In brief, this includes overseeing and integrating UMRR's habitat restoration and science; supporting the partner-based forums; preparing budget submissions; recommending annual allocations within the program; developing, constructing, and evaluating habitat projects; and producing a wide range of reports.

U.S. Fish and Wildlife Service, through its Upper Mississippi River refuges, ecological services field offices, and fisheries resource offices, participates in planning, design, and construction of habitat projects located both on and off of refuge lands. The Service is responsible for all operation and maintenance of projects on lands it manages, and is a key partner in pre- and post-project monitoring on its sponsored projects. The Service's research and monitoring also informs UMRR science and habitat projects. The Corps transfers funds to the U.S. Fish and Wildlife Service to support its involvement in the planning, design, and monitoring of habitat projects, as well as in the preparation and issuance of the Service's Coordination Act reports (Public Law 85-624).

U.S. Geological Survey provides science leadership and daily administration of UMRR's long term resource monitoring and other science efforts, through its Upper Midwest Environmental Sciences Center in La Crosse, Wisconsin. This work includes planning, coordination, and administration, as well as executing research, data analysis, modeling and decision support, data maintenance and access, and scientific research. In serving these roles, USGS coordinates closely with the Corps, state field stations, and interagency coordination bodies. The Corps transfers funds to the U.S. Geological Survey to provide leadership for implementing this element. Approximately half of those funds are then provided to the states to implement the work of the six UMRR long term monitoring field stations (see Figure 1-2 for a map of the field stations).

The five Upper Mississippi River states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, participate in all aspects of UMRR, including the program's various coordinating committees and all stages of habitat project implementation and long term resource monitoring. The states are responsible for 35 percent of construction costs and 100 percent operation and maintenance for habitat projects located on lands they manage, and the states provide water quality permitting and certification for projects. In addition, the states staff and operate the six field stations with UMRR funding and contribute a variety of in-kind services to the design and execution of the program's monitoring, research, and analysis. The six state-operated field stations are located on the Upper Mississippi River in Pool 4 (Lake City, Minnesota), Pool 8 (La Crosse, Wisconsin), Pool 13 (Bellevue, Iowa), Pool 26 (Alton, Illinois), and the Open River reach (Jackson, Missouri), as well as the La Grange Pool of the Illinois River (Havana, Illinois). See Figure 3-1 for a map of these field stations.

In permanently authorizing UMRR as a continuing program, Congress recognized that, as long as stresses related to the construction and operation of the nine-foot navigation channel and other human activity persist, there would be an ongoing need to address the resulting impacts to the ecosystem.

Other federal and state environmental protection, agriculture, and transportation agencies are also involved in UMRR's implementation. These include, but are not limited to, the U.S. Environmental Protection Agency, the U.S. Department of Agriculture Natural Resources Conservation Service, and state water quality programs. These agencies and programs contribute staff expertise to assist in formulating UMRR's habitat restoration and scientific monitoring and research efforts by providing valuable information and insights.

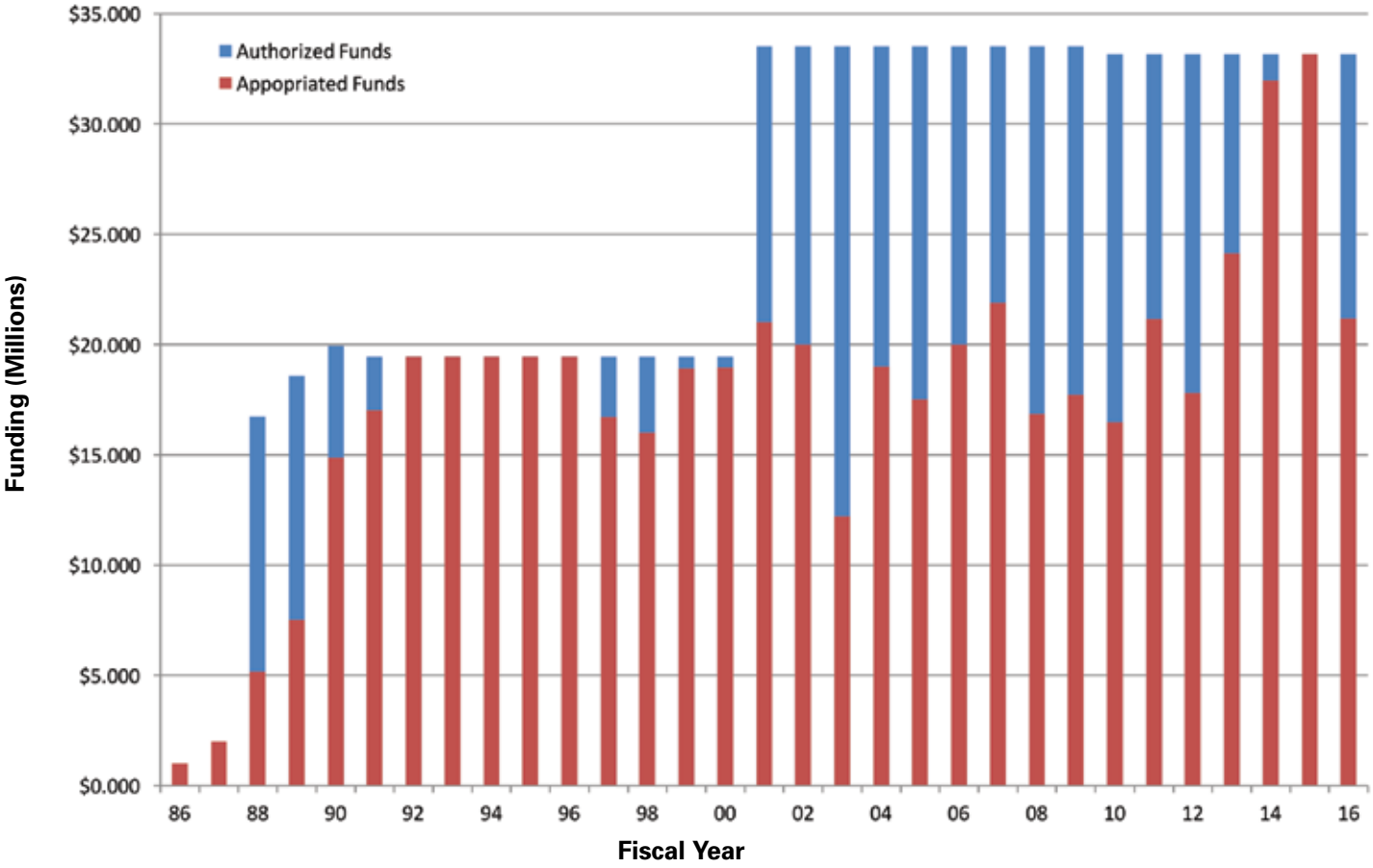
Nonprofit organizations actively engage in UMRR's implementation in a variety of ways, from providing comments on specific project proposals to engaging in more regional, programmatic matters. Some nonprofits, such as The Nature Conservancy, Ducks Unlimited, and the National Audubon Society, have also expressed interest in serving as nonfederal cost-share sponsors of habitat projects. The nonprofits would be responsible for a 35 percent cost-share and all operation and maintenance of any such project.

The general public's engagement occurs at varying levels and through various venues. In UMRR's early years, the public was actively involved in the program's authorization in 1986 and subsequent reauthorization as a continuing authority in 1999. The public participates in UMRR through the involvement of local governments; sport, conservation, and nonprofit organizations; and individual participation. In addition, the public is typically involved at the local level in planning for habitat projects, often providing important information about the river functions and processes at site-specific locations.

UMRR Optimizes Appropriations and Leverages Resources

In the 1999 Water Resources Development Act, Congress increased the program's annual authorized appropriation from $19 million to $33.52 million, an increase of $14.215 million. This $33.52 million amount included $22.75 million for the planning, construction, and evaluation of habitat projects; $10.42 million for long term resource monitoring, computerized data inventory, analysis, and applied research on the Upper Mississippi River (including water quality issues affecting the Mississippi River); and $350,000 for an independent technical advisory committee (expired in FY 2009). Given the expiration of the advisory committee, UMRR's current annual authorized appropriation is $33.17 million. The authorization allows the Corps to transfer up to 20 percent of an annual appropriation

Figure 1-3 — UMRR Funding History (Authorized vs. Funding Received)[2]



[2] Since Fiscal Year 2012, Congress has appropriated additional funding to the Corps for its various missions. The Corps allocated some of this additional funding to UMRR and is reflected in the graph above.

between the planning, construction, and evaluation of habitat projects and long term resource monitoring, computerized data inventory, analysis, and applied research.

Congress has allocated $531.05 million to UMRR since its inception, with $147.22 million allocated since the 2010 UMRR Report to Congress. In comparison, UMRR's total authorized funding amount from inception through FY 2016 is $783.65 million. In the last six years, Congress has increased its funding support for the program to levels closer to UMRR's full authorized amount (see Figure 1-3). In FY 2014 and FY 2015, UMRR received $31.968 million and $33.17 million, respectively. The additional funding increased UMRR's ability to execute habitat projects at optimal cost efficiency schedules and allowed the program to expedite critical habitat restoration and research priorities. Table 1-1 shows UMRR's annual obligation rate from 2011 to 2015.

The recent increase in UMRR appropriations would not be possible without its well-deserved reputation as an innovative and effective restoration and monitoring program. UMRR has consistently delivered cost-effective habitat projects that generate national and regional ecological and economic benefits. Since 2010, the Administration has directed UMRR to more explicitly explain the connection between the insights gained through long term resource monitoring and research and restoration and management. This integration theme is illustrated throughout the 2015-2025 UMRR Strategic Plan as well as in this report.

UMRR's authorizing legislation requires that a non-federal sponsor share the construction cost of habitat projects, unless the project is located on lands managed as a national wildlife refuge. In particular, the Corps provides 65 percent of the funding for non-refuge projects and the non-federal sponsor, typically a state agency, funds 35 percent. Projects that are located on lands managed as a national wildlife refuge are 100 percent federally funded through the Corps' appropriations. In the 2007 Water Resources Development Act, the definition of non-federal sponsors was expanded to include nonprofit organizations.

In accordance with Section 107(b) of the 1992 Water Resources Development Act, operation and maintenance of habitat projects is the responsibility of the agency that manages the land, typically the U.S. Fish and Wildlife Service or a state natural resource agency. In addition, each completed project is monitored to determine whether the project is performing as designed and whether the anticipated physical and chemical responses are occurring. A limited number of projects are selected for intensive monitoring of biological responses, such as plant growth or changes in fish populations. Though UMRR does not monitor public use of project areas, anecdotal information and data from partners suggest that public response to projects is very favorable.

While appropriations to the Corps fund the largest portion of UMRR costs, that amount does not fully reflect the actual investment made through the program. The U.S. Fish and Wildlife Service and the five Upper Mississippi River basin states make substantial investments in directly implementing UMRR. Perhaps the largest cost for the agencies is in operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) for habitat projects located on the lands they manage. Between FY 2010 and FY 2015, the Service spent an annual average of nearly $255,000 on OMRR&R on its UMRR habitat projects (about $3.60 per acre). The Service also participates in programmatic planning efforts and other activities.

The five Upper Mississippi River basin states also make substantial investments in UMRR. Since its inception, the states have spent an estimated $23.3 million in support of UMRR. This includes non-federal cost-share and OMRR&R for habitat projects, as well as various in-kind support for planning, coordinating, and implementing all components of UMRR. Of this amount, about $3.9 million was expended since the 2010 Report to Congress.

Table 2-2 — UMRR's high obligation rate results from its ability to manage risk by utilizing the unique capabilities and geographic location of the three Corps Districts, U.S. Fish and Wildlife Service, U.S. Geological Survey, and five state natural resource agencies.

Fiscal Year	Total Obligated
2011	93.6 percent
2012	93.8 percent
2013	97.1 percent
2014	98.8 percent
2015	99.4 percent
2016	99.4 percent
Average (2014-2016)	**99.2 percent**
Average (2011-2016)	**97 percent**

UMRR is Meeting the Challenge: Improving the Upper Mississippi River Ecosystem Health and Resilience

The Upper Mississippi River Restoration (UMRR) Program uniquely and effectively combines ecosystem restoration with scientific monitoring and research to restore and maintain a healthier and more resilient Upper Mississippi River ecosystem. Integrating a broad range of restoration techniques that strive to use or mimic the river's natural processes, UMRR habitat projects enhance and protect important fish and wildlife habitat, restore the river's floodplain structure and function, and counteract the factors degrading habitat and other ecosystem functions and processes. While these projects are implemented solely to create fish and wildlife habitat, they have wide-ranging economic and social benefits to local communities, the Midwest, and Nation as they create and support highly-skilled labor and engineering jobs, improve the quality of safe drinking water, and provide high-quality recreational and tourism opportunities.

Since 1986, UMRR has directly improved highly-valuable fish and wildlife habitat on more than 102,000 acres, distributed over 55 different projects in Minnesota, Wisconsin, Iowa, Illinois, and Missouri. UMRR has 18 projects in some form of planning and design and five under construction that together will enhance nearly 80,000 habitat acres once constructed. Figure 2-1 shows the location of UMRR habitat projects constructed since the program's inception as well as projects currently in some phase of planning, design, or construction. From 2005 to 2015, UMRR has benefitted nearly 35,000 acres of ecologically-significant habitat, accounting for more than 50 percent of the reported wetland acres restored by the Corps nationally.

UMRR has established a highly-effective interdisciplinary approach to project planning and implementation using a highly-skilled team of biologists, engineers, and scientists. This collaborative approach to developing habitat projects has proven to be efficient with project feasibility report completion averaging about two to three years. It is very common that UMRR habitat projects will complete feasibility studies, plans and specs, and have a construction award within five years. Despite the complexity of the high-energy Upper Mississippi River, UMRR is able to deliver these important projects at an impressively low average cost-per-acre of $3,000. UMRR's annual obligation rate demonstrates the program's ability to manage risk by utilizing the capabilities and geographic location of the three Corps Districts, U.S. Fish and Wildlife Service, and five state natural resource agencies. The restoration accomplishments since the 2010 Report to Congress are listed in Table 2-1, with the ecological benefits described in text that follows.

UMRR habitat projects benefit from the program's long standing emphasis on learning and improving. Since 2010, UMRR has evaluated the effectiveness of 22 completed habitat projects by comparing pre- and post-project monitoring information with other research and knowledge of the ecological conditions. This effort has proven tremendously valuable for improving knowledge about the river system, restoration design, and construction techniques. In addition, the evaluations enhance monitoring capabilities and increase the ability to detect direct and indirect physical, chemical, and biological responses to habitat projects. This information is discussed later in this chapter.

Accomplishments since the 2010 Report to Congress

UMRR has restored over 26,610 acres of important, high-quality habitat in the past six years, providing protection, nesting, and feeding areas for a highly-diverse set of fish, birds, mussels, reptiles and amphibians, and mammals, including a number of rare and endangered species. The UMRR partnership completed seven habitat rehabilitation and enhancement projects (HREPs) since 2010 that also enhance important ecological services.

Completed Projects

Capoli Slough – The habitat project (Pool 9) is a prime project that restores 66 percent of the natural island complex and increases diversity fox habitat used extensively by migratory waterfowl, shorebirds, turtles, frogs, fish, mussels, beavers, mink, and others for food, shelter, and resting. The primary project features within the 1,570-acre site include 11 new islands, a riffle (rock-lined) channel, and deep-water habitat. The new islands serve to protect and enhance existing islands that together reduce wind fetch and enhance water quality.

Fox Island – The habitat project (Pool 20) connects a large tract of contiguous forest habitat critical for bird migration and creates 2,020 acres of high-quality wetland and floodplain habitat for resident and migratory waterfowl, shorebirds, and wading birds. Project features include planting mast-producing hardwood trees to reduce forest fragmentation and enhance forest species diversity, enhancing and expanding existing wetlands (including the excavation of a channel), and restoring native grassland. One notable feature of this project is its creation of a 30-acre area 1.5 feet above existing elevation to facilitate the success of planted hard mast trees. UMRR planted an additional 240 acres of trees at the existing elevation. Future UMRR monitoring of this site will enhance our understanding of how restoring topographic diversity affects the success of the tree plantings. This type of forest habitat is critical for bird migration and, in combination with the restored wetlands, Fox Island provides important habitat for

resident and migratory waterfowl, shorebirds, and wading birds. The area is also home to two species of endangered turtles.

Lake Odessa – The habitat project (Pools 16 and 17) restores fish and migratory bird habitat on 6,400 acres, using enhanced levees with spillways to reduce the influence of flooding and sedimentation. Lake Odessa had traditionally been a prime area for significant duck production and is an important flyway stopover for migratory birds in the fall. Waterfowl habitat was enhanced by restoring wetlands and improving water control structures, allowing managers to mimic natural water fluctuations. Fish overwintering and nursery habitat were benefitted by restoring water depth and access to protected areas. Hardwood forests, impacted by the 1993 flood, were also restored.

Rice Lake – The habitat project (La Grange Pool) provides an important food source for waterfowl and improves habitat for herons, egrets, shorebirds, eagles, and other native fish and wildlife species on 6,180 acres, by providing control structures to mimic natural water fluctuations and protecting the area from floods. Rice Lake has historically been excellent fisheries and mid-migration waterfowl habitat, but summer flood spikes and loss of deep-water habitat and mast-producing trees has reduced the quality and quantity of habitat available to resident and migratory wildlife and fish species. Summer flood spikes can kill the vegetation growth on low-lying areas that are important for migratory waterfowl in the fall months. Sedimentation has resulted in the loss of deep-water habitat used by fisheries for various life stage needs, including overwinter survival.

Rice Lake features include pump stations, other water control structures, and a spillway to allow the management of water levels necessary for wetland restoration as well as for the egress of fish. The Rice Lake project recreated wetland habitat important to herons, egrets, shorebirds, eagles, and other species. The restored wetlands are comprised of native plants that serve as an important food source for waterfowl.

Batchtown – The habitat project (Pool 25) improves the quality and diversity of wetland habitats used extensively by migratory waterfowl and other birds, by protecting the site from fluctuating water levels and high sedimentation. The 3,420-acre site is a mosaic of backwater wetlands, marshes, and channels. It is managed as both part of the U.S. Fish and Wildlife Service's Two Rivers National Wildlife Refuge and the Illinois Department of Natural Resource's Mississippi River Fish and Wildlife Area. The Batchtown area, once a prime habitat site for large numbers of migrating waterfowl, had degraded due to siltation and inadequate water level control. Project features include pump stations and control structures to allow for the management of water levels and trapping of sediment as well as reforestation.

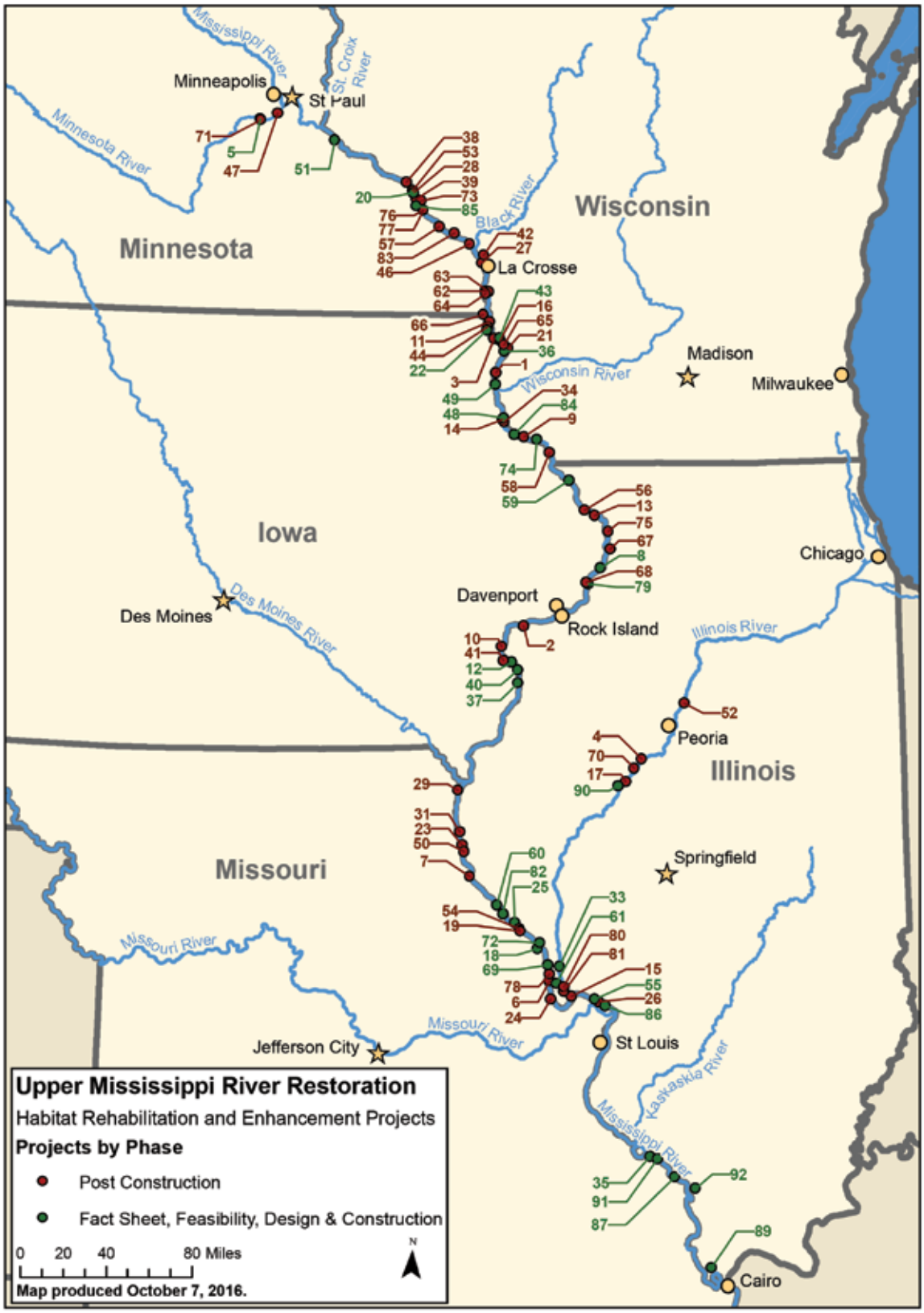
UMRR received the 2014 Chief of Engineers Environmental Award in recognition of the innovative features and designs of the Batchtown habitat project, as well as for complete supply chain management, community engagement, and employee involvement. Pictured here are Col. Anthony Mitchell (Corps of Engineers St. Louis District Commander) and Sabrina Chandler (U.S. Fish and Wildlife Service Upper Mississippi River Refuge Manager) celebrating that award.

These features combine to increase the quality and diversity of wetland habitats. The Batchtown project received the 2014 Chief of Engineers Environmental Award in recognition of its innovative features and designs.

Swan Lake – The habitat project (Pool 26) restores a significant 4,780-acre backwater lake complex, increases water clarity, and restores submerged and emergent vegetation that provides important habitat for fish and macroinvertebrates. Swan Lake is the largest backwater complex in Pool 26 of the Mississippi River and one of the largest on the Illinois Waterway and it has experienced significant degradation from sedimentation and altered hydrology. This UMRR project allows water level management to reduce river-induced sediment deposition and restore floodplain forest connectivity, and the constructed islands reduce turbidity from wind-generated wave action.

Calhoun Point – The habitat project (Pool 26) rehabilitates and enhances important wetland and aquatic habitats for bird, fish, and other species. This 2,170-acre Fish and Wildlife Management Area is located in Calhoun County, Illinois, at the confluence of the Illinois and Mississippi Rivers. It is a prime site for migrating waterfowl and a feeding area for herons from two nearby rookeries. Sedimentation since 1938 has resulted in the

Figure 2-1 — Distribution of UMRR Habitat Projects



UMRR Projects	Site #
Ambrough Slough	1
Andalusia Refuge	2
Mississippi River Bank Stabilization	3
Banner Marsh	4
Bass Ponds, Marsh, and Wetland	5
Batchtown	6
Bay Island	7
Beaver Island	8
Bertom McCartney Lakes	9
Big Timber	10
Blackhawk Park	11
Boston Bay	12
Brown's Lake	13
Bussey Lake	14
Calhoun Point	15
Capoli Slough	16
Chautauqua Refuge	17
Clarence Cannon	18
Clarksville Refuge	19
Clear Lake, MN	20
Cold Springs	21
Conway Lake	22
Cottonwood Island	23
Crains Island	91
Cuivre Island	24
Delair Division	25
Dresser Island	26
Emiquon	90
East Channel	27
Finger Lakes	28
Fox Island	29
Gardner Division (Long Island Division)	31
Glades Godar Wetlands	33
Guttenberg Waterfowl Ponds	34
Harlow Island	35
Harpers Slough	36
Horseshoe Lake	89
Huron Island	37
Indian Slough	38
Island 42	39
Keithsburg Division	40
Lake Odessa	41
Lake Onalaska	42
Lake Winneshiek	43
Lansing Big Lake	44

UMRR Projects	Site #
Long Lake	46
Long Meadow Lake	47
Lower Pool 10 Island and Backwater Complex	48
McGregor Lake	49
Monkey Chute	50
North and Sturgeon Lakes	51
Oakwood Bottoms	92
Peoria Lake	52
Peterson Lake	53
Pharrs Island	54
Piasa - Eagle's Nest Islands	55
Pleasant Creek	56
Polander Lake	57
Pool 11 Islands	58
Pool 12 Overwintering	59
Pool 24 Islands	60
Pool 25 and 26 Islands	61
Pool 8 Islands Phase I	62
Pool 8 Islands Phase II	63
Pool 8 Islands Phase III	64
Pool 9 Islands	65
Pool Slough	66
Potters Marsh	67
Princeton Refuge	68
Red's Landing Wetlands	69
Rice Lake, IL	70
Rice Lake, MN	71
Rip Rap Landing	72
Small Scale Drawdown	73
Snyder Slough Backwater Complex	74
Spring Lake, IL	75
Spring Lake Islands	76
Spring Lake Peninsula	77
Stag and Keaton Islands	78
Steamboat Island	79
Stump Lake	80
Swan Lake	81
Ted Shanks	82
Trempeleau	83
Turkey River Bottoms Delta and Backwater	84
Weaver Bottoms	85
West Alton Tract	86
Wilkinson Island	87
Produced October 7, 2016	

reduction of the water surface acreage from 600 acres to 450 acres and has severely degraded deep-water habitat. The project features include a low elevation berm to reduce excessive sedimentation, water control structures and interior berms to improve water level management, and dredging to restore deep-water habitat and floodplain connectivity. In addition, hard mast trees were planted to restore valuable floodplain habitats degraded by the 1993 flood.

Projects Under Construction

UMRR is also currently constructing five projects that will increase habitat abundance, quality, and diversity on 14,400 acres. These projects have the following fish and wildlife and ecological benefits:

Harpers Slough – The habitat project. entails constructing seven island and three emergent wetlands over 3,510 acres as well as protecting five additional islands from eroding wave forces. The project protects and enhances aquatic habitat provide homes, food, and resting places for a wide range of river wildlife, including shorebirds, turtles, mussels, beavers, and otters. Since the creation of the nine-foot navigation channel, several of the natural islands have eroded in this area allowing stronger wind and wave action in the backwaters and significantly reducing habitat quality.

Huron Island – The habitat project offers an important opportunity to protect and improve the quality and diversity of habitat for fish, wildlife, and resident and migratory birds in an area where habitat is at risk of being completely lost due to constant degrading stresses from sedimentation and increased water levels. The project includes more than 2,530 acres of interconnected backwaters, secondary channels, and floodplain habitat.

Pool 12 Overwintering – The 1,280 acre habitat project will increase the amount and depth diversity of deep-water habitat in backwater lake complexes, while decreasing the influences of sedimentation and increasing areal coverage of forest stands with hard mast-producing trees. Prior to this project, Pool 12 had very little overwintering habitat and had become a limiting factor for the survival of riverine fish.

Pools 25 and 26 Islands – The habitat project will restore and rehabilitate 3,940 acres of wetland and aquatic habitats to provide breeding, nesting, feeding, and refuge from predators for many forms of waterfowl, mammals, and reptiles, while creating new productive fish spawning, overwintering, and nursery areas. The project includes hard mast and floodplain forest restoration, implementation of water control structures, and restoration of backwater connection to the river.

Ted Shanks – The habitat project seeks to alleviate the effects of sedimentation and altered hydrology by restoring and protecting high-value fish and wildlife habitat through dredging, dike and levee construction, islands creation, and the reestablishment of controlled connections to the river. The Ted Shanks project encompasses 3,140 acres and is an incredibly important stopover for waterfowl. Virtually every species of waterfowl passing through Missouri within a migrating season will visit Ted Shanks.

Completed Feasibility Studies

Since 2010, UMRR has completed feasibility studies for seven projects that will restore 22,990 acres of important habitat. These projects seek to mimic natural riverine processes and functions to both restore the abundance and quality of habitat while improving the ecological health and resilience. Five projects with completed feasibility reports were also constructed or are currently in construction within the past six years. These include Capoli Slough, Fox Island, Huron Island, Pool 12 Overwintering, and Rice Lake and are described above. In addition, these following projects were designed with the intended ecological benefits:

Emiquon Preserve – The 5,810 acre habitat project would add the reliable water control management necessary to promote vegetation growth, control nuisance fish species, and restore the area's natural hydrology and floodplain connectivity. The Nature Conservancy purchased the preserve after decades of row crop production at the site in order to restore important fishery and wildlife habitat. [Note: The project is currently on hold due to legal requirements associated with the project partnership agreements and unique challenges involving previous land easements on the site. More detailed information about the issues associated with the agreements is provided in Chapter 5 of this report.]

Clarence Cannon – The 3,600 acre habitat project is designed to restore and improve the quality and diversity of wetland ecosystem resources by decreasing habitat fragmentation, restoring native forest and emergent wetland vegetation, creating floodplain topographic diversity, providing seasonal connectivity between the project area and the Mississippi River, and improving water conveyance management capabilities.

Additional feasibility reports are underway and are shown in Table 2-1.

Since 2010, UMRR habitat project sponsors have continued to perform operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) necessary to sustain the projects' habitat quality and other intended benefits. Project OMRR&R

Table 2-1 — Accomplishments Since 2010: Restoring the Upper Mississippi River Ecosystem Health and Resilience

Project Name	Location	Acres Benefitted
UMRR has constructed seven projects, benefiting 26,610 acres of important, high-quality habitat		
Capoli Slough	Pool 9	1,570
Fox Island	Pool 20	2,020
Lake Odessa	Pool 17	6,400
Rice Lake	La Grange Reach	6,180
Batchtown	Pool 25	3,490
Calhoun Point	Pool 26	2,170
Swan Lake	Pool 26	4,780
UMRR is actively constructing five projects benefitting 14,400 acres of important, high-quality habitat		
Harpers Slough	Pool 9	3,510
Huron Island Stage 1 (Construction Complete - 100%) Stage 2 (Under Construction - 85%) Stage 3 (Contract to be Awarded - 35%)	Pool 18	2,530
Pool 12 Overwintering Stage 1 (Construction Complete - 100%) Stage 2 (Under Construction - 85%) Stage 3 (Contract Awarded - 10%)	Pool 12	1,280
Pool 25 and 26 Islands	Pool 25	3,940
Ted Shanks	Pool 24	3,140
UMRR has completed feasibility studies for seven projects that will restore 22,990 acres of important high-quality habitat		
Capoli Slough (constructed)	Pool 9	1,570
Emiquon	La Grange Reach	5,810
Fox Island (constructed)	Pool 20	2,020
Huron Island (in construction)	Pool 18	2,530
Pool 12 Overwintering (in construction)	Pool 12	1,280
Rice Lake (constructed)	La Grange Reach	6,180
Clarence Cannon	Pool 25	3,600

Table 2-1 — Accomplishments Since 2010: Restoring the Upper Mississippi River Ecosystem Health and Resilience (continued)

Project Name	Location	Acres Benefitted
UMRR is evaluating 11 projects through feasibility reports that, collectively, could restore 20,020 acres of important high-quality habitat		
Conway Lake	Pool 9	1,170
Lake Winneshiek	Pool 9	2,800
Lower Pool 10 Island and Backwater Complex	Pool 10	1,410
McGregor Lake	Pool 10	580
North and Sturgeon Lakes	Pool 3	4,350
Beaver Island	Pool 14	1,680
Boston Bay	Pool 18	920
Delair Division	Pool 24	1,730
Keithsburg Division	Pool 18	1,400
Piasa and Eagle's Nest Islands	Pool 26	1,380
Rip Rap Landing	Pool 25	2,600

ensures that construction features are working properly, and is the full responsibility of the agency or organization that manages the lands on which the project is located for the life of UMRR.

The U.S. Fish and Wildlife Service (Service) is the sponsor on more than 70 percent of UMRR's habitat projects, and thus, plays a significant role in managing these projects to achieve a healthier and more resilient Upper Mississippi River ecosystem. Since the 2010 UMRR Report to Congress, the Service's annual average expenditures on OMRR&R for UMRR habitat projects is nearly $250,000, with annual expenditures ranging between $141,500 and $334,000 in those years. For example, the Service 1) rehabilitated the water control structure, outside levees, and water supply lines at Guttenberg Ponds and 2) replaced and retrofitted water control pumps at Batchtown at a cost of $150,000. The Service anticipates that the annual expenditure rate will increase to more than $968,000 by 2021 and reach $1.17 million by 2025. The five Upper Mississippi River basin states collectively spent more than $1.036 million on OMRR&R since the 2010 Report to Congress. While nonprofit organizations were determined eligible to serve as cost-share sponsors of UMRR's habitat projects in 2012, the Service and five Upper Mississippi River states remain the only cost-share sponsors to-date and thus the only entities with OMRR&R responsibilities under UMRR.

Degrading influences to the Upper Mississippi River ecosystem persist

Despite UMRR's significant successes in improving the Upper Mississippi River ecosystem's health, we are at a critical chapter in our river's history, fighting stressors that are both natural and man-made. The highly-invasive Asian carp are among the most notorious stressors in this battle, but climate change, soil erosion, island erosion, sedimentation, and nutrient run-off are silent threats to the river that often do not receive as much attention. Fish and wildlife habitat has been declining in quantity, quality, and diversity for decades. Based on the Corps' experience in constructing and monitoring of habitat projects, we estimate that habitat within the Upper Mississippi River is degrading at a rate of one to three percent annually. At these rates, the ecosystem is declining one to four times faster than currently restoration efforts.

In the past six years, UMRR has gained a better understanding of the factors affecting the river's ecological health and resilience. The program has developed and enhanced analytical tools, while also performing scientific analyses to better understand the ecological consequences of tributary inputs, changes in the landscape and climate, and the emergence of invasive species. The planned projects listed above have already incorporated these insights by designing habitat rehabilitation features so

that they also restore ecological processes and functions, having greater positive influences at larger spatial extents.

Topobathy – UMRR created a new topobathy dataset, which informs predictions of the amount of time an area is flooded, which is a critical factor for establishment and growth of hardwood trees. Figures 3-3 and 3-4 in Chapter 3 illustrate examples of a mapping output of topobathy data and an application of topobathy data to inform habitat restoration.

Ecological drivers – UMRR has gained a much greater understanding of the interconnected relationships of influential drivers to the valued benefits derived from the Upper Mississippi River ecosystem, informing how habitat projects can have the greatest impact on sustaining the river's ecological services and uses.

Models and maps – UMRR enhanced and expanded its analytical capabilities through the development of models, geospatial tools, and imagery (maps) that all assist in project formulation. Comprehensive hydrological models, spatial floodplain inundation simulations, two-dimensional hydrodynamic models, wind fetch models, and floodplain and submersed aquatic vegetation models allow UMRR to assess the effectiveness of project alternatives, providing benefits to the river at system, reach, pool, and local scales. Upgrades to the wind and wave fetch models (see Figure 2-2) and Habitat Suitability Models (see Figure 2-3) provide substantial utility to project planners.

Continued habitat restoration and monitoring are necessary

UMRR's role is to enhance and protect important fish and wildlife habitat, counteract the factors degrading the river ecosystem, and provide the information needed to assess ecosystem changes in the Upper Mississippi River. Program partners have made tremendous progress in determining how those changes

Figure 2-2 — Wind fetch and wave action models together determine the spatial extent of projects including "shadow effects."

The loss of islands have created wide open spaces for wind generated waves that churn up sediments and erode shorelines and remaining islands. This has resulted in poor water quality and a tremendous loss of habitat. UMRR's habitat projects intervene, slowing down wind and wave forces. This allows sediments to settle to the river bottom and light to encourage plants to germinate, creating cleaner water and high-quality habitat again. The figure shows that, immediately following island construction in 2008 and 2011, wind fetch decreases significantly each year. Figure 2-7 shows the corresponding response of aquatic vegetation.

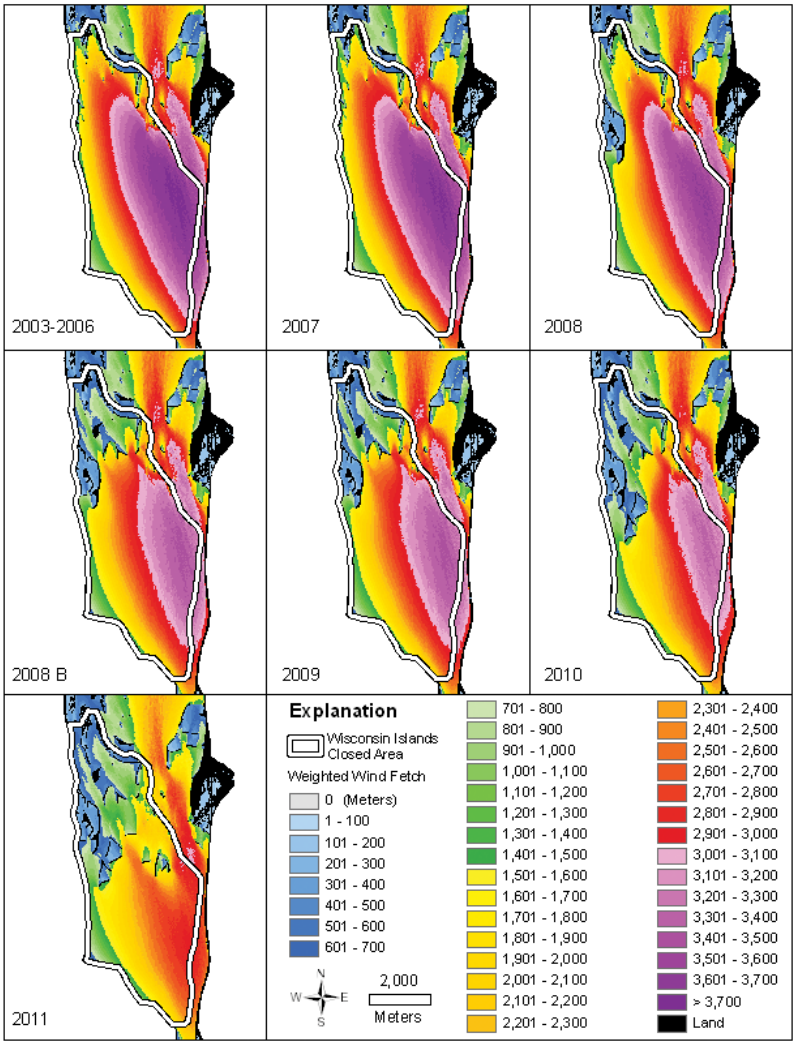
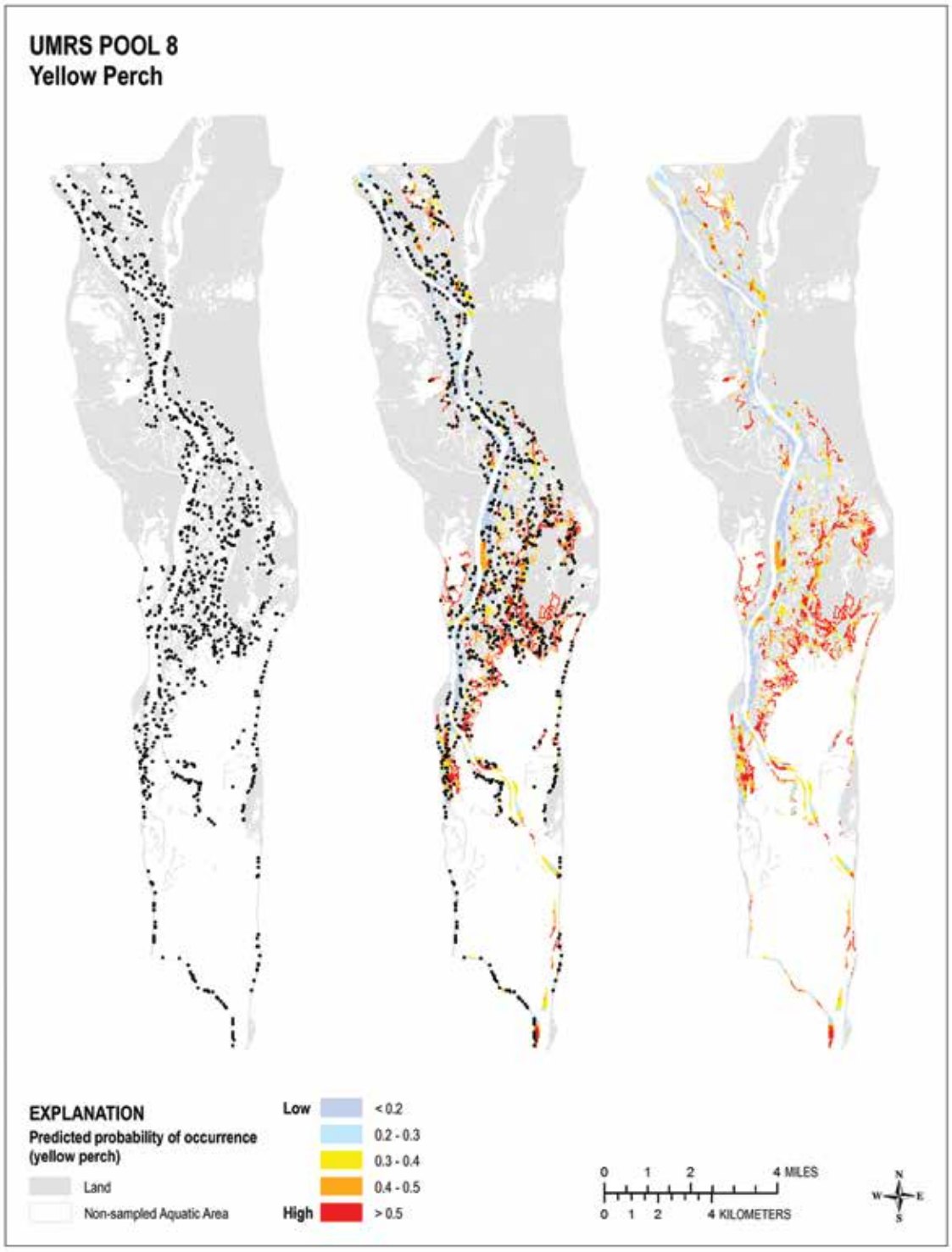


Figure 2-3 — Habitat Suitability Models Provide Substantial Utility in Project Location and Planning

Habitat suitability models are used to 1) provide context of habitat quality within a pool or reach for identifying optimal project placement and 2) predict and evaluate biological responses to restoration measures. UMRR frequently uses these models to predict biological responses to its restoration measures by characterizing the necessary habitat conditions to support indicator species or communities. UMRR models inundation, water depth, current velocity, and sheer stress to determine probable occurrence of certain species. This image shows the habitat suitability for yellow perch in Pool 8. [Note: The black dots indicate sampling locations.]



relate to management actions, natural variation, and the overall ecological integrity of the system. This increased understanding of system dynamics is informing the design of the 11 UMRR habitat projects currently in planning stages and will result in greater benefits to localized habitat needs, while improving the ecological processes and functions of the system. The UMRR projects currently in planning are listed in Table 2-1.

UMRR's primary focus has always been to improve the abundance and quality of habitat for fish and wildlife. This focus remains a central theme in the 2015-2025 UMRR Strategic Plan. A primary objective of this plan is to address key ecological needs at various spatial scales through habitat projects that reflect best available knowledge and advance the UMRR's vision for a healthier and more resilient Upper Mississippi River ecosystem that sustains the river's multiple uses. Strategies for achieving this objective are to:

1) Identify and select habitat projects that will most effectively and efficiently advance UMRR's vision, utilizing an interagency, science-driven, systemic planning approach.
2) Plan, design, and construct habitat projects to best, and most efficiently, address their defined objectives and advance the UMRR's vision, using structural and non-structural measures and considering ecological benefits at various spatial scales.
3) Perform operation and maintenance on UMRR's habitat projects to ensure key features are working properly and effectively advancing the projects' goals and UMRR's vision.

Habitat Needs Assessment II

An interagency team of fish and wildlife biologists, river managers, project planners and engineers, and scientists is updating the Habitat Needs Assessment that will reflect that vast amount on knowledge gained in habitat and ecosystem restoration. Over the past six years, **UMRR has strategically invested in preparing for the forthcoming process of selecting the third generation of habitat projects.** To a great extent, this has involved a better understanding the key ecological drivers affecting the river's ability to support fish and wildlife habitat as well as its ecosystem health and resilience. To do this, UMRR has defined and updated indicators of ecosystem health, built and improved analytical capabilities to assess the river's health at various spatial scales, and created meaningful connections between habitat projects and systemic ecosystem processes and functions. UMRR is using all of this learned information to update the Habitat Needs Assessment for the Upper Mississippi River ecosystem. Some of this work UMRR has completed includes:

1) *Setting ecological goals and objectives* for restoring the quality and abundance of fish and wildlife habitat and the ecological health of the Upper Mississippi River in order to optimize federal investment. A 2011 report depicts the desired ecological conditions that UMRR habitat projects are designed to achieve.
2) *Defining the factors affecting ecological resilience* of the Upper Mississippi River in order to place the Habitat Needs Assessment in the broader context of ecosystem health. An ecosystem's resilience is its ability to remain in its current state (whether desirable or undesirable) while undergoing disturbances. It is essential that we understand the relationships among watershed and in-river influences affecting the fundamental components of the Upper Mississippi River ecosystem in order to either augment resilience where the river is in a desired state or overcome resilience in areas where the river is in an undesirable state. While UMRR's habitat projects are very likely strengthening the river's ecological resilience, to-date the direct relationships between specific restoration techniques and resilience has not been established.
3) *Consolidating new understandings about environmental responses to restoration* techniques and approaches. UMRR published the 2012 Environmental Design Handbook to communicate insights gained regarding restoration techniques and habitat project planning since the 2006 edition. The 2012 Handbook includes a greater focus on biological responses to project designs; captures new information about innovative restoration tools; and illustrates the connections between system, floodplain reach, and site-specific ecological objectives, project criteria, and management actions. Habitat project planners and engineers rely heavily on the Handbook as a reference when developing project objectives and design criteria, saving a significant amount of resources and time.
4) *Enhancing consistency and refined sampling designs for monitoring habitat projects*, to document projects' direct and indirect effects in their immediate area, and conduct or assist in several habitat project evaluations.
5) *Utilizing habitat projects to answer larger scientific questions* about the ecosystem. Habitat projects offer incredible opportunities to learn about large river floodplain ecosystems, including how management interventions interact with the dynamic processes and functions to create a healthier and more resilient ecosystem. For example, UMRR is using Pool 12 Overwintering to evaluate the appropriate spacing and sizing in several backwater lakes to better understand the extent of fisheries benefits beyond individual backwaters, including community response and fish dispersal patterns. Specifics regarding the Pool 12 Overwintering adaptive management analyses are described in the restoration feature on page 33.

Habitat Rehabilitation: UMRR's Plan for The Next Six Years

Over the next six years, UMRR will pursue habitat restoration in a manner consistent with the 2015-2025 UMRR Strategic Plan, which calls for identifying the most pressing restoration opportunities, designing sound habitat projects that address site-specific habitat needs and restore larger ecological processes and functions, constructing and managing innovative and effective restoration techniques and approaches, and ongoing learning.

Implement habitat rehabilitation and restoration projects – In the next six years, UMRR anticipates completing construction on nine habitat projects that will cumulatively improve another 23,330 acres, initiating construction on six projects, finalizing 13 feasibility reports, and developing feasibility reports on another seven projects. These projects include:

- **Completing Construction**
  - Conway Lake in Pool 9 (1,170 acres)
  - Harpers Slough in Pool 9 (3,510 acres)
  - North and Sturgeon Lakes in Pool 3 (4,350 acres)
  - Beaver Island in Pool 14 (1,680 acres)
  - Delair Division in Pool 24 (1,730 acres)
  - Huron Island in Pool 18 (2,530 acres)
  - Pool 12 Overwintering (1,280 acres)
  - Pools 25 and 26 Islands (3,940 acres)
  - Ted Shanks in Pool 24 (3,140 acres)
- **Under Construction**
  - McGregor Lake in Pool 10 (580 acres)
  - Beaver Island in Pool 14 (1,680 acres)
  - Delair Division in Pool 24 (1,730 acres)
  - Keithsburg in Pool 18 (1,400 acres)
  - Clarence Cannon in Pool 25 (3,600 acres)
  - Rip Rap Landing in Pool 25 (2,600 acres)
- **Completing Feasibility Reports**
  - Conway Lake in Pool 9 (1,170 acres)
  - McGregor Lake in Pool 10 (580 acres)
  - North and Sturgeon Lakes in Pool 3 (4,350 acres)
  - Beaver Island in Pool 14 (1,680 acres)
  - Delair Division in Pool 24 (1,730 acres)
  - Keithsburg in Pool 18 (1,400 acres)
  - Crains Open River Islands (590 acres)
  - Glades Godar Wetlands in Alton (5,770 acres)
  - Harlow and Open River Islands (1,260 acres)
  - Piasa and Eagle's Nest Islands in Pool 26 (1,380 acres)
  - Red's Landing Wetlands (1,620 acres)
  - Rip Rap Landing in Pool 25 (2,600 acres)
  - Wilkinson Open River Islands (2,760 acres)
- **Initiating Feasibility Reports**
  - Lake Winneshiek in Pool 9 (2,800 acres)
  - Clear Lake in Pool 5 (320 acres)
  - Boston Bay in Pool 18 (920 acres)
  - Steamboat Island in Pool 16 (440 acres)
  - Turkey River Bottoms in Pool 11 (3,370 acres)
  - Snyder Slough in Pool 11 (1,990 acres)
  - Oakwood Bottoms in the Open River (13,500 acres)

SUCCESS STORY

Even just one side channel project in the southern river reach would generate positive fish and wildlife responses spanning large spatial extents.

What we know: UMRR's habitat projects targeted in areas with the least habitat richness (number of different habitat types in a defined area) have the greatest systemic benefits. In the Upper Mississippi River ecosystem, this means areas having less than five percent of the floodplain in side channels, less than five percent in floodplain lakes, and/or less than 10 percent in shallow-water areas such as wetlands. This largely reflects the amount and proximity of additional aquatic habitat types adjacent to the main channel, such as side channels, floodplain lakes, and other off-channel habitats, that provide refuge and high-energy food sources for species that move across the Upper Mississippi River's large floodplain. UMRR's restoration practitioners will use the data to locate specific areas where restoration could improve aquatic habitat richness. Mapped habitat richness and connectivity shows great variation in the impounded (locked) portion of the Upper Mississippi River, but consistently low levels throughout the unimpounded (open) portion, below L&D 27 to the confluence of the Ohio River. While restoration of islands and other terrestrial habitats in the impounded area should be targeted in areas with the least habitat richness and connectivity, side-channel restoration may be needed in nearly every area throughout the unimpounded reach. Even just one side channel project in the unimpounded reach to increase habitat richness and connectivity would generate positive fish and wildlife responses at larger spatial scales.

What we want to know to inform restoration: A comparison of habitat richness measures at various spatial scales with the abundance and diversity of species, including the factors that limit their growth, may lend important insights about how to best configure specific habitat types and at which spatial scales to target restoration for improved fish and wildlife habitat.

How we will learn it: Restoration practitioners and ecological researchers are teaming together to design models and other information to target UMRR's habitat projects. UMRR's long term resource monitoring, including decadal land cover / land use, provides a scientific foundation for assessing habitat richness and connectivity as well as measuring changes in the abundance and diversity of fish species.

Fun fact! 80 percent of the river in the unimpounded reach of the Upper Mississippi River is disconnected from the floodplain by a series of levees. The remaining 20 percent of floodplain provides refuge for native fish during large-scale floods and serve as a corridor of forest habitat for migratory birds and resident wildlife.

On the left, a historical image of the Upper Mississippi River near Harpers Ferry, Iowa shows its natural complex network of braided channels and wetlands in black and white. The blue overlay shows the current distribution of water in the floodplain, due to the nine-foot navigation channel. Channel training structures and levees have disconnected much of the lower portion of the Upper Mississippi River from its floodplain, decreasing the quantity, quality, and diversity of available fish and wildlife habitat. This is illustrated just above the confluence of the Mississippi and Ohio Rivers in the image on the right.

Why this knowledge and restoration are important: The diversity of aquatic habitats in the Upper Mississippi River ecosystem supports one of the most diverse fish assemblages on the planet, with more than 150 species, and high rates of biological productivity. However, the river's habitat diversity and connectivity have been negatively affected by modifications that support commercial navigation and flood control. Restoration practitioners can identify specific targets for restoration of side channel, floodplain lake, and shallow water areas to increase the size, connection (adjacency), and configuration of various habitat types at multiple spatial scales simultaneously in ways that will best support abundant and diverse fish and wildlife species. While the Upper Mississippi River ecosystem has maintained fragments of riverine landscape diversity, there is significant variation along the river in terms of habitat availability at the local, pool, and geomorphic and floodplain scales. This multi-scale assessment of habitat diversity patterns provides a systemic and quantitative approach to defining potential restoration opportunities.

UMRR takes an interagency, interdisciplinary approach to habitat project implementation throughout the development of each habitat project's feasibility study. This collaborative partnership leverages extensive, diverse experience and knowledge of the Upper Mississippi River ecosystem at no additional cost to the program.

Complete the habitat needs assessment II – UMRR will finalize the second comprehensive habitat needs assessment as described on page 21, incorporating learned information about the river's fundamental ecological characteristics and the influence of in-river and watershed factors on fish and wildlife habitat. This assessment will serve as a foundational guide to identifying and selecting the third generation of habitat projects.

Develop innovative analytical decision support tools – UMRR will examine ways to 1) use the knowledge gained from more detailed models at smaller scales to inform simplified models at larger spatial scales and 2) integrate models to understand complex dynamics and interactions among various ecosystem components and watershed drivers. For example, expanding the hydraulic models into the floodplain can improve our understanding of the interactions between the floodplain and the river as well as material transport and nutrient processing.

Employ adaptive management – UMRR will utilize habitat projects to better understanding how the ecosystem responds to various restoration techniques and approaches, including hypothesis testing to inform the design and evaluation of restoration actions at various spatial extents, quantify progress in achieving ecological objectives, and determine the rate of progress for restoring the ecosystem over time.

Coordinate with candidate cost-share nonprofit organizations – UMRR recognizes that the ability for nonprofits to serve as a non-federal cost-share sponsor on UMRR's habitat projects could substantially increase the program's restoration opportunities, particularly in the southern river reaches where there is a considerably higher proportion of private land and therefore fewer options for U.S. Fish and Wildlife Service and the states to sponsor projects. UMRR plans to continue work with nonprofit organizations to facilitate conversations about mutual priorities for habitat projects and address a variety of implementation questions for any nonprofit-sponsored habitat project that receives an approved fact sheet. On April 5, 2012, Corps Headquarters issued implementation guidance confirming that Section 2003 of the 2007 Water Resources Development Act allows nonprofit organizations to serve directly as non-federal sponsors of the Corps' civil works water resources projects, including UMRR's habitat projects. UMRR explored many implementation questions when it partnered with The Nature Conservancy in developing plans the Emiquon Preserve project on the Illinois River. Through this process, UMRR developed guidelines that should help facilitate planning on future potential projects by communicating about the legal requirements associated with sponsoring a project such as long-standing OMRR&R obligations. Legal requirements associated with the project partnership agreements present significant challenges to nonprofit organizations, and are described in more detail in Chapter 5 of this report.

The Making of a Habitat Project

Habitat needs are rigorously and comprehensively evaluated

UMRR employs a dynamic, collaborative, science-based process for defining restoration opportunities. UMRR's habitat project selection is based directly on advancing five system-wide ecological objectives, which include managing for:

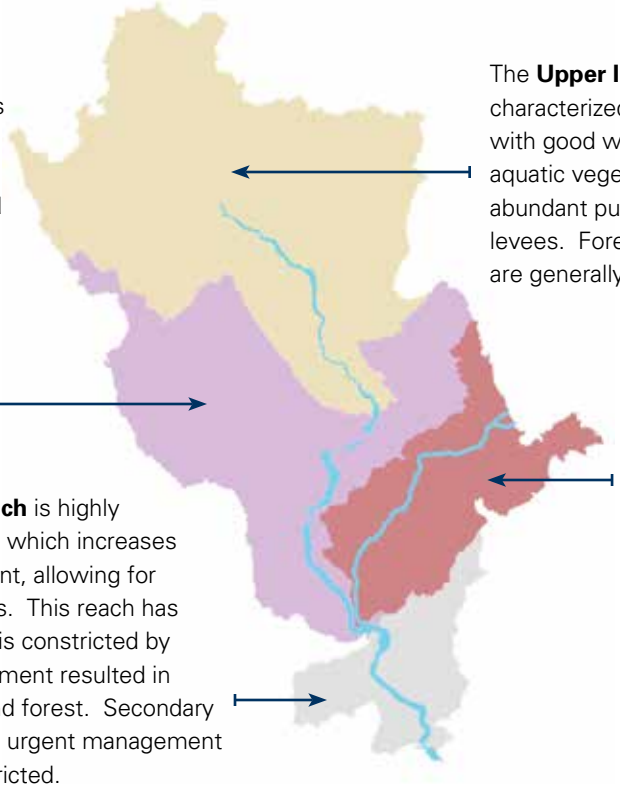
1) A more natural hydraulic regime.
2) Functions that shape diverse and dynamic channels and floodplain.
3) More natural materials transport and processing functions.
4) Diverse and dynamic pattern of habitats to support native biota.
5) Viable populations of native species and diverse plant and animal communities.

These five system-wide goals apply throughout the Upper Mississippi River's 2.75 million-acre large river floodplain ecosystem. The river's physical, chemical, and biological characteristics change downstream and laterally across the floodplain. Varying hydrologic and geomorphic conditions

Figure 2-4 — Characterization of the four Upper Mississippi River ecosystem floodplain reaches.

Water clarity decreases and river stage variation increases in the **Lower Impounded Floodplain Reach.** Over half of this reach is separated from its floodplain by levee and drainage districts. Land use is predominantly row crop agriculture with public land concentrated in a few of patches.

The **Upper Impounded Floodplain Reach** is characterized as an island-braided channel ecosystem with good water quality with relatively abundant aquatic vegetation, sand and gravel substrates, abundant public land with high public use, and a few levees. Forests are even-aged and low diversity, but are generally contiguous throughout the entire reach.

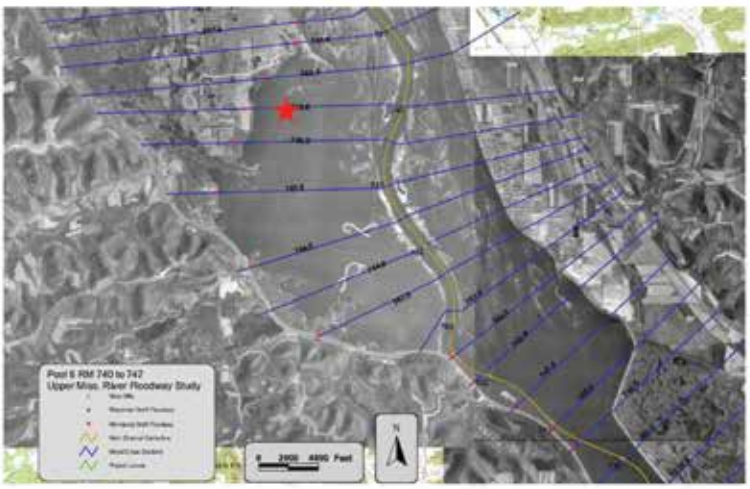


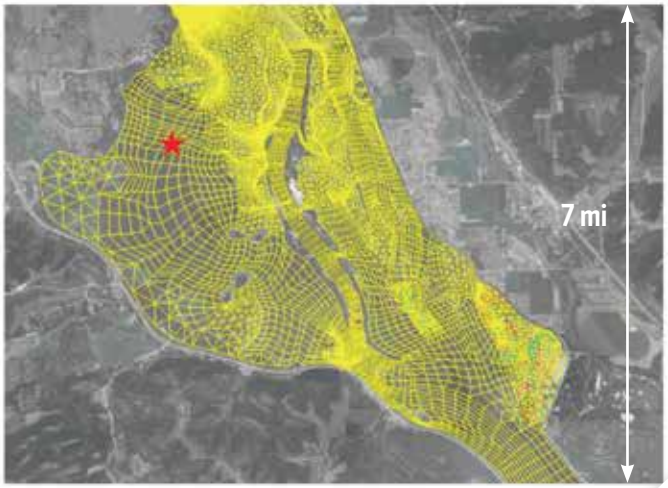
The **Open River Floodplain Reach** is highly influenced by the Missouri River, which increases river flow by more than 50 percent, allowing for navigation without lock and dams. This reach has a straight, sandbed channel that is constricted by large levees. Floodplain development resulted in substantial loss of many lakes and forest. Secondary channel aquatic habitat loss is an urgent management concern. Public use is fairly restricted.

The **Illinois Floodplain Reach** has two distinct segments. The upper segment is highly urbanized, with a steep gradient. The lower segment has an exceptionally low gradient, which promoted the formation of seasonal lakes with notoriously high populations of waterfowl, freshwater mussels, and fish. The entire reach is significantly degraded from urban pollution, high sedimentation, and invasive species.

Figure 2-5 — Comparison of One- and Two-Dimensional Hydraulic Models

Both one-dimensional and two-dimensional hydraulic models are used during project planning and design. The choice of model type depends on the complexity of the river reach, project objectives and constraints,and data availability. The one-dimensional model on the left and the two dimensional model on the right were run for the same river discharge. The simpler and less expensive one-dimensional model can only predict changes in water surface elevation in a longitudinal (downstream to upstream) direction, while the two dimensional model can simulate water surface elevation in both the longitudinal direction and lateral, or cross valley direction. In this backwater, predicted water depth using the one-dimensional model located at the red star was 40 percent greater than predicted in the two-dimensional model.





SUCCESS STORY

Understanding thresholds to restore hardwood forests

What we know: The health of the Upper Mississippi River floodplain forest is largely dependent on the extent and timing of prolonged flooding. Much of the hardwood forests have been lost due to the construction of the nine-foot navigation channel, which permanently raised the water table. At Huron Island, the navigation channel raised water levels about eight feet and eliminated the low water periods. UMRR has found that floods lasting about 40 percent of the growing season suffocate many of the hardwood trees and prevent understory trees from establishing and growing, resulting in uniformly low species diversity in both the understory and overstory communities as well as a loss of mast-producing trees highly valued by wildlife. Using the Huron Island habitat project, UMRR developed a topographic diversity index to predict the likely forest community response to restoration of Huron Island, located in Pool 18. The index integrates geographic information system (GIS) and hydrologic analysis to compare how project alternatives would perform under various flood scenarios. The results are then used to assess how the physical changes affect survival and distribution rates of plant communities.

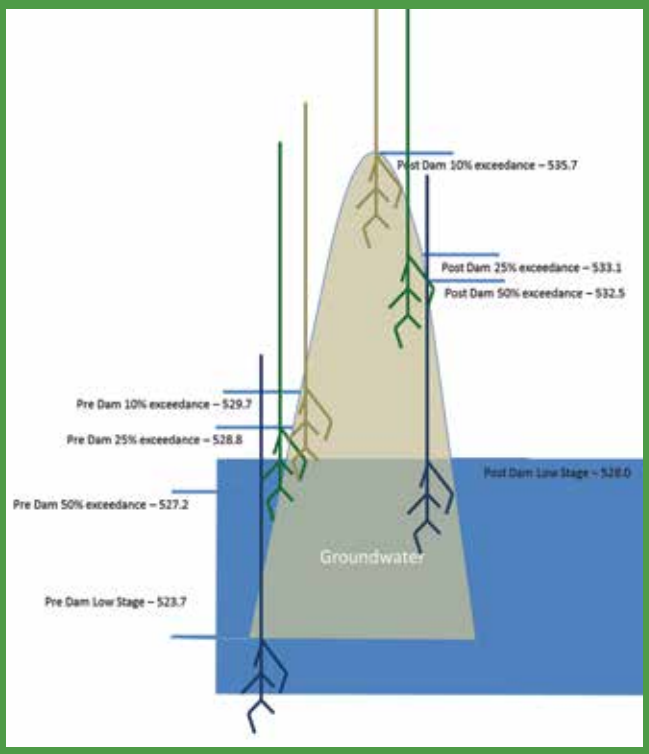
What we want to know and apply to restoration: While specifically created for Huron Island, the topographic diversity index can be very valuable in designing UMRR's future restoration projects and in analyzing the health and resilience of Upper Mississippi River's floodplain forests at a regional scale. As UMRR strives to enhance the ecosystem's resilience to flooding and other stresses, it will become especially important to design habitat projects with the appropriate topography to restore the health of floodplain forests.

How we will learn it: UMRR will evaluate tree responses to Huron Island's project features (i.e., soil mix and berm height) and compare the actual results to the topographic diversity index's predicted outcomes. In addition, UMRR's project monitoring will continue to document trends in hydrology (including flood pulses) and forest resilience and regeneration that will inform future analyses regarding floodplain topographic diversity and associated habitat benefits.

Fun fact! The Upper Mississippi River ecosystem is an internationally recognized flyway for more than 325 bird species, including 40 percent of America's migratory waterfowl, on their round-trip journey each year along the Mississippi Flyway, from Canada and northern United States to the Gulf of Mexico and in Central and South America.

Why this knowledge and restoration are important: Historically characterized as a rich mosaic of braided channels that flowed past countless islands and through abundant lakes and wetlands where diverse riparian plant communities flourished, the Upper Mississippi River's floodplain is a critically important source of food and shelter for an abundant array of birds, fishes, mammals, and other wildlife. Migratory waterfowl and songbirds depend on nuts from oak and hickory trees as a food source that is rich with protein, carbohydrates, vitamins, and calcium on their long travels along the Mississippi Flyway. The construction and ongoing operation of the nine-foot navigation channel, as well as land use changes in the watershed and floodplain, inundated much of the original floodplain forest, which is now dominated by flood-tolerant species, such as silver maple. These changes also make the floodplain more susceptible to invasive plants, such as reed canary grass. Neither of these species are valuable for native wildlife species.

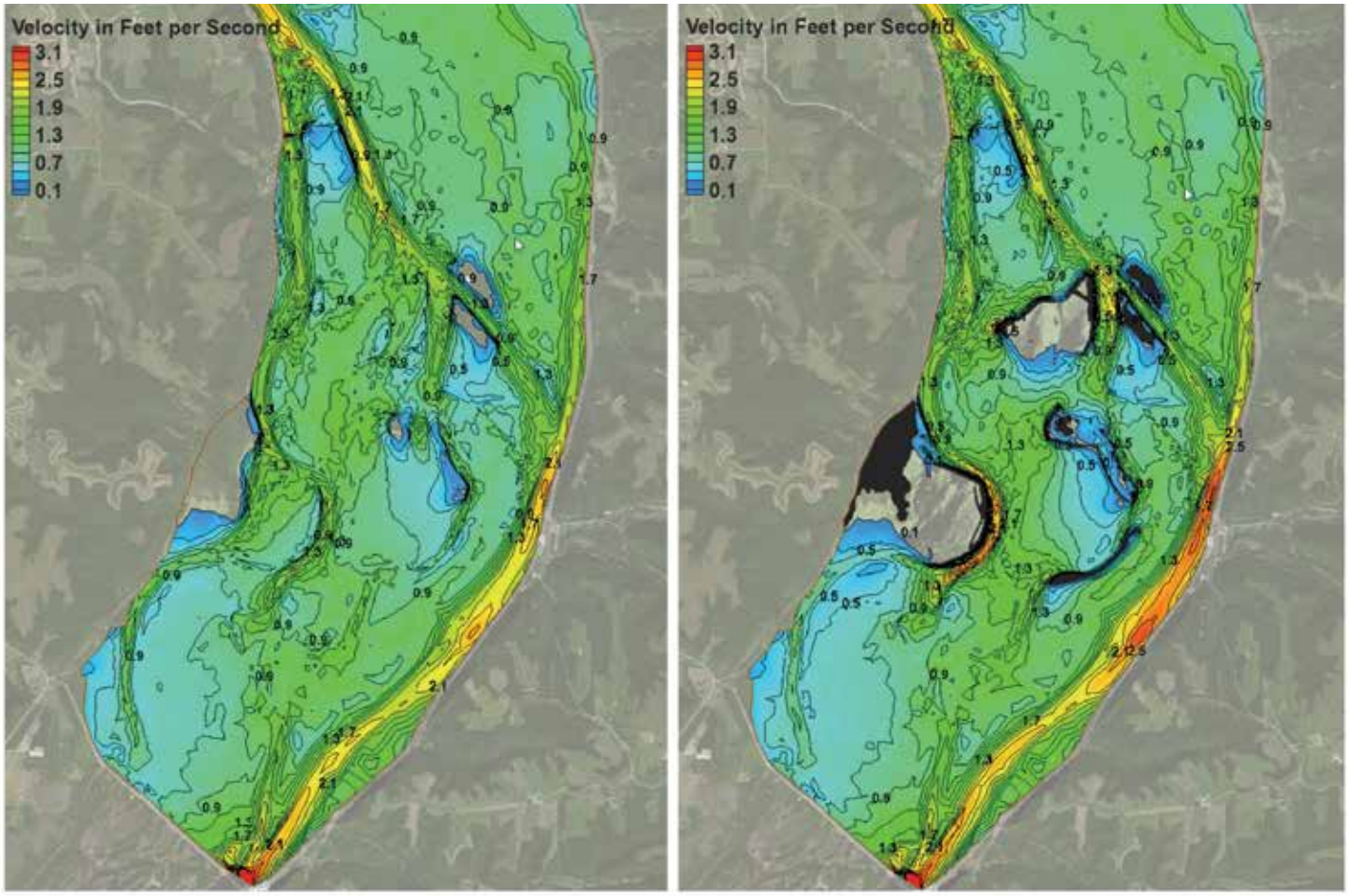
UMRR's islands and other similar features are designed to facilitate growth of healthy forests with diverse tree species that are protected from the impacts of prolonged floods. Restoration of topographic diversity promotes mast tree establishment, production, and resilience, generating a healthy age distribution and diverse array of floodplain trees essential to supporting neotropical migratory birds and other floodplain-dependent wildlife. Forest cover is also critical for wildlife dispersion, migration, survival, nesting, and foraging, while also providing a buffer against undesirable species. The topographic diversity index provides a scientific, quantitative understanding of how spatial variation in flood duration drives forest establishment, health, and regeneration.



While specifically created for the Huron Island project, this topographic diversity index can be very valuable in restoring hardwood forests in future UMRR habitat projects. This is incredibly important to migratory waterfowl and songbirds that depend on nuts from oak and hickory trees as a food source rich with protein, carbohydrates, vitamins, and calcium on their long travels along the Mississippi Flyway. The left side of this figure shows how flooding affected islands. By contrast, the right side of this figure shows how much higher those same flood are since the 9-foot navigation channel was constructed.

Figure 2-6 — Two-Dimensional Hydraulic Model Comparison of Selected Project Alternative for Harpers Slough

Existing condition under high flow | **Proposed design under high flow**



from north to south differentiate the river into four floodplain reaches and interact to form unique habitat characteristics that support distinctive plant and animal communities. A map and a description of the four floodplain reaches is provided in Figure 2-4. Key floodplain restoration objectives include maintaining and restoring aquatic and associated terrestrial habitat, reducing nutrient loading, and restoring habitat connectivity.

In UMRR's early years, the Corps' Upper Mississippi River District-based federal-state interagency coordinating teams thoroughly evaluated habitat and ecological conditions of the river and identified restoration opportunities within their respective jurisdictions, based on their potential to improve fish and wildlife habitat requirements as well as ecological processes and functions. In some instances, these opportunities were developed into habitat projects and provided UMRR with substantial experience in designing innovative construction techniques. Cutting-edge research on the river's ecological condition coupled with long term resource monitoring provided the foundation for a systemic, comprehensive evaluation of the river ecosystem in the 2000 Habitat Needs Assessment, which ultimately identified habitat needs and restoration objectives in each pool or river reach.

The second Habitat Needs Assessment will incorporate four recently acquired systemic data sets that were not available when the original Assessment was completed in 2000, including bathymetry, LiDAR, topobathy, and 2010 land cover/land use imagery. In addition, advancements in geographic information systems (GIS) technology, modeling techniques, and knowledge about the river's key processes will greatly enhance Habitat Needs Assessment's findings and value in project identification and planning.

An ancillary, but important, objective of the Beaver Island project is the creation of highly-valued habitat for freshwater mussels. Upon discovering 886 mussels of 17 different species living in the project area, UMRR designed the project to protect an important mussel bed in the area and to incorporate a mixture of cobble, gravel, sand, silt, and clay that allows mussels to dig their foot into the substrate and escape from falling water levels. The ultimate success of the Beaver Island project in increasing mussel abundance and species diversity will inform whether management can help revitalize mussel populations and re-establish the associated ecological services that they provide. Mussels are an incredibly important part of the Upper Mississippi River ecosystem, filtering nutrients and providing habitat to fish and invertebrates and food to fish and wildlife such as muskrat.

UMRR has gained considerable awareness and knowledge of emerging influences affecting the Upper Mississippi River ecosystem that will be incorporated into the Assessment. For example, because UMRR's long term monitoring data provides a baseline condition, UMRR has a greater understanding of how changes in weather patterns alter water flows, how the invasion of reed canary grass affects floodplain forests, and how Asian carp affect native fish populations. New restoration opportunities will consider how emerging influences will affect UMRR's ability to restore and monitor the river as well as how UMRR's restoration efforts might help to enhance, inhibit, or off-set the advancement of these influences.

UMRR optimizes habitat projects

UMRR identifies and screens habitat projects based on their merit using the system-wide ecological goals for the Upper Mississippi River ecosystem and the floodplain reach objectives along with the results of the 2000 Habitat Needs Assessment. The UMRR Habitat Rehabilitation and Enhancement Project Planning and Sequencing Framework (established in 2003) provides a systemic, comprehensive, structured decision-making approach to project selection that is transparent and accessible to potential project sponsors (including nonprofit organizations) and the public. It ensures a consistent process for screening and selecting habitat projects and is designed to allow UMRR habitat projects to restore important local habitat needs of native fish and wildlife while also addressing the most pressing degraded ecosystem functions and processes at the system and floodplain reach scales. UMRR uses this information to develop fact sheets for the most promising restoration opportunities for consideration

Table 2-3 — UMRR Restoration Techniques and Related Objectives

Technique	Objectives
Dredge backwaters	Alter flow patterns and velocity Improve floodplain structural diversity Increase deep-water fish habitat for overwintering Provide access for fish movement Provide dredged material to support revegetation and island building
Manage water levels using dikes and water control structures	Restore more natural hydrologic cycles in project area Promote growth of aquatic plants as food for waterfowl Reduce backwater sediment loads Consolidate bottom sediments Control rough fish
Build islands	Decrease wind and wave action Alter flow patterns and sediment transport Improve aquatic plant growth Improve floodplain structural diversity Provide nesting and loafing habitat for waterfowl and turtles Promote growth of woody vegetation
Protect shorelines	Prevent shoreline erosion Maintain floodplain structural diversity Create fish habitat Reduce sediment loads to backwaters Create barriers to waves and currents
Modify secondary channels and river training structures	Improve fish habitat and water quality by altering inflows and diversifying substrate thickness Stabilize eroding channels Reduce sediment load to backwaters by reducing flow velocities Maintain water temperature and provided rock substrate
Water aeration	Improve habitat and water quality by introducing oxygenated water

Other Restoration Techniques

Seed island	Isolated wetlands
Upland sediment control	Weirs
Land acquisition	Rock sills
Riffle pools	Sediment traps
Potholes	Mussel substrates
Notched wing dams	Bottomland forest restoration
Anchor tree clumps	Vegetative plantings

Mudflats are often hard to find, but are highly valued by birds. The Clarence Cannon habitat project restored mudflat habitat that are now being enjoyed by Least sandpipers (pictured here).

and approval to proceed with individual feasibility reports. This approval provides the required authority needed to initiate project planning and development, culminating in individual project feasibility reports.

While the ecological merits of proposed projects are the most important factors in determining restoration priorities, the ultimate sequencing of habitat projects must also consider administrative factors such as available funding, construction capability, geographic distribution, and project sponsorship. Project implementation does not proceed rigidly in a strict order of numerical rankings, but rather requires some flexibility to ensure efficient and optimal execution. The Corps works in consultation with project sponsors and interagency partners to resolve unforeseen complexities (e.g., high water events), respond to unanticipated opportunities, and remain flexible.

Habitat projects provide cost-effective, sustainable solutions to river management

To the extent possible, UMRR strives to use or mimic natural riverine processes, providing benefits to the river at local, pool, reach, and system scales. Project designs must consider many complex factors including site-specific and reach restoration goals and objectives; hydraulic, geotechnical, civil, and structural engineering aspects; constructability; aesthetics; and level of risk and uncertainty. Other important site-specific considerations include habitat scarcity, area of influence, special status species (i.e., threatened and endangered species), water quality considerations, sustainability, and national significance. Planners and engineers work with biologists to determine the optimal project designs using mathematical and analytical modeling, maps and aerial photography, and monitoring information.

Project objectives and criteria – Project features and design criteria are selected to meet project restoration objectives. The process of developing project restoration objectives and criteria can be somewhat iterative as each is informed by the other. Design criteria add specificity and quantitative measurable attributes to project objectives, in terms of acceptable ranges or thresholds. The criteria are used to refine project objectives that site-specific restoration actions are designed to achieve. For example, an objective for increasing the establishment and growth of submersed aquatic vegetation requires specific criteria for light penetration, water depth and clarity, water velocity, and wind fetch. Another example are the criteria for appropriate water flow, depth, and dissolved oxygen required to meet objectives for creating high-quality fish overwintering habitat. Criteria also help project planners and designers identify monitoring and modeling needs and establish measures for success. Criteria related to geomorphology, biogeochemistry, and hydrology and hydraulics parameters are particularly important for planning and designing purposes as the responses of habitat and biota are directly driven by those factors, which are also directly altered by restoration actions on the main stem of the river.

Interagency expertise and capacity – Interagency and multidisciplinary project delivery teams are convened at the onset of project planning and design and are composed of technical specialists familiar with the project areas and restoration planning. This collaborative partnership leverages extensive, diverse experience and knowledge of the Upper Mississippi River ecosystem at no additional cost to the program.

The project delivery teams consider unique and important ecosystem characteristics, factors limiting natural processes and the distribution and abundance of biota, project objectives, and performance criteria to develop management actions.

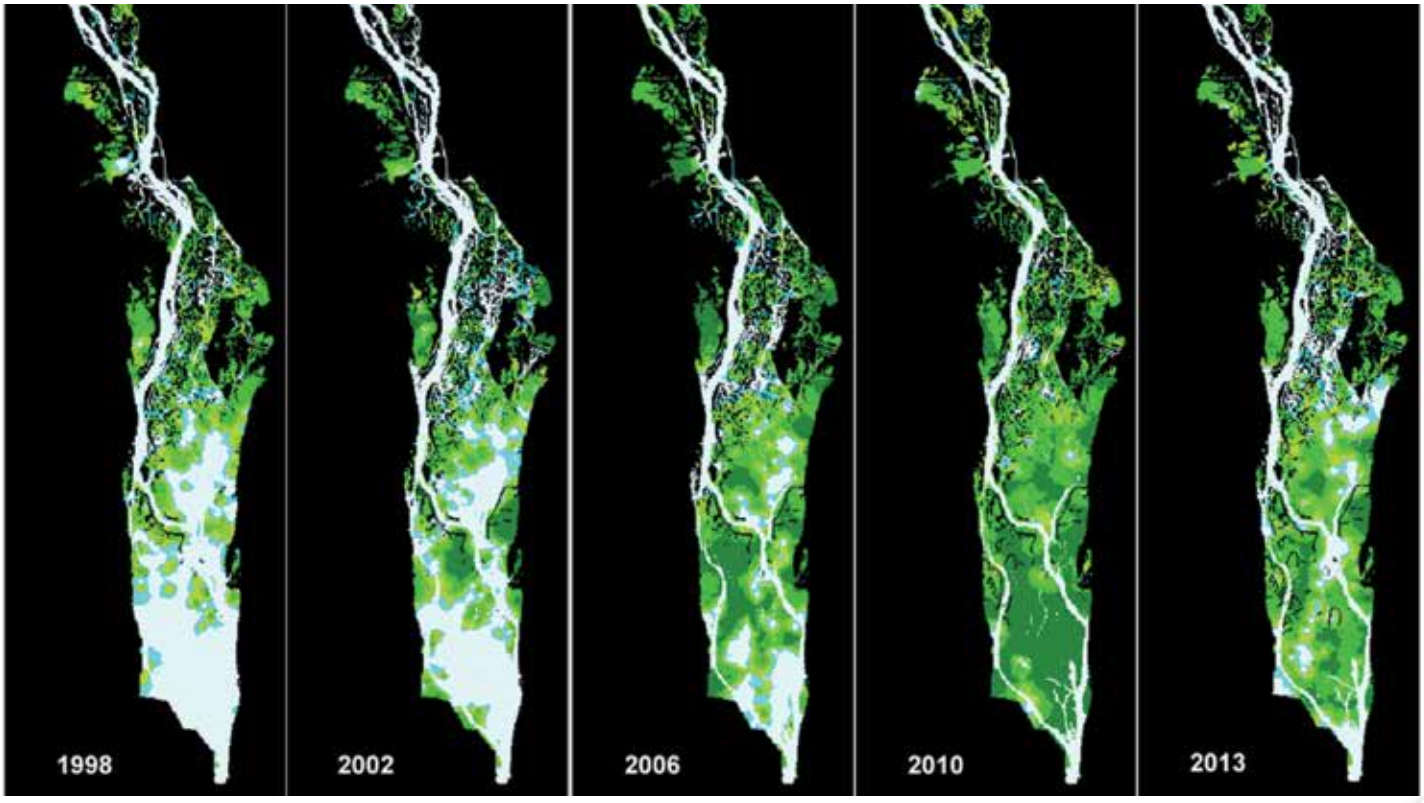
In UMRR's early years, pre-project monitoring data was often limited and performance data for similar projects was not available for comparison or refinement of design features. Over time, learning from constructed projects, status and trends in long term resource monitoring, and research and analysis of the Upper Mississippi River ecosystem have improved

restoration designs and approaches and resulted in better projects that provide greater and enhanced benefits at a lesser cost. For example, UMRR has learned that slightly lowering island elevations provides a more natural seasonal connectivity between channels and backwaters during smaller flood events. Islands with elevations higher than flood stage may support establishment and maturity of hard mast trees. This contrasting approach to island designs shows that the engineering aspects must reflect the desired habitat benefits and ecological conditions.

Engineering and planning models – Due to climate and land use changes, it is more critical than ever for projects to provide habitats that are sustainable over a wide range of hydrologic and climate conditions. In combination with expert knowledge of the river ecosystem and design techniques and approaches, engineering and planning models are effective tools for estimating outcomes of project alternatives under a wide range of river flow conditions. Many types of engineering models are used to predict river flow speed, elevation, and direction in response to various management actions. UMRR planners use a mix of engineering and planning models to identify relationships among ecological components, define design features and intended outcomes, inform pre- and post-project monitoring (e.g., where and what is monitored), and to communicate among the interagency project planning team and other relevant decision-makers about project alternatives. In addition, a variety of analytical tools, including interactive maps and one-and two-dimensional models, are used to predict and compare the chemical, physical, and biological responses to various project alternatives. In addition, a variety of analytical tools, including interactive maps and one- and two-dimensional models, are used to predict and compare the chemical, physical, and biological responses to various project alternatives.

Figure 2-7 — Recovery of Submersed Aquatic Vegetation in Pool 8

UMRR began construction on Pool 8 Islands in 1989. Spanning three phases, construction of all 27 islands was completed in 2011. Islands are important for fish and wildlife because they slow water velocity and wind fetch (see Figure 2-3) to the point at which aquatic plants can flourish, increasing the available oxygen in the water for fish and creates refuge for waterfowl. The series of images below show UMRR's success in building islands that fostered the substantial growth in submersed aquatic vegetation (shown in green) in areas where these features had been lost.



Mathematical and analytical modeling of river flow patterns, simulations of wind-driven wave action, and sediment transport has advanced significantly and is now used extensively in project planning and design. In addition, new Light Detection and Ranging (i.e., LiDAR, remote sensing technology) and bathymetry (i.e., underwater depths) data sets as well as increased data points in the long term resource monitoring database, including the 2010-2011 land cover/land use data set, are essential to informing project design.

One-dimensional hydraulic models simulate velocity and water surface elevation longitudinally; two-dimensional models simulate hydraulic conditions longitudinally and across the river valley, including conditions in the main channel, secondary channels, backwaters, and floodplains. Figure 2-5 on page 25 compares the differences of one- and two-dimensional hydraulic model construction. These models are used to determine habitat benefits associated with various project alternatives and analyze whether a project design alternative might improperly raise water levels above the federal 100-year flood standard or more restrictive state floodplain standards. Two-dimensional models also serve as effective communications tools to the public and decision-makers when overlaid on a map of the project area. Figure 2-6 on page 27 compares the Harpers Slough habitat project's selected alternative with the existing condition, illustrating its usefulness in determining flow patterns with or without the project features and evaluate the potential impacts on 100-year flood levels.

Habitat evaluation procedures, process-based hydraulic models, wind fetch and wave action geographic information system (GIS) tools, regional species' models (e.g., bluegill overwintering), and regional community models are used most frequently to predict and compare the potential benefits of alternative habitat project designs. As the technology becomes more sophisticated, so does UMRR's research capabilities and its expectations for estimating and evaluating project outcomes. As the need arises, improvements to existing models are evaluated and new models and other tools are created that utilize the program's continually expanding knowledge of the river.

The Corps effectively constructs projects

Habitat projects employ a variety of techniques to accomplish project-specific, reach, and systemic goals and floodplain reach objectives for improving the river's ecological health and resilience, including island creation, shoreline protection, water level management, backwater dredging, river training structures, secondary channel modification, flow modification for aeration, floodplain restoration, and tributary delta restoration. Table 2-3 lists the restoration techniques that UMRR's habitat projects often employ to achieve their related ecological objectives.

UMRR employs private contractors to construct the project features. Throughout project construction, the Corps facilitates on-site meetings with the project sponsor and interagency biologists and engineers involved in the project formulation to ensure that the project features are constructed as designed and to consult on whether any modifications are required due to unanticipated events, such as flooding. In addition, the Corps monitors the physical, chemical, and biological responses to project features to ensure that the project is functioning as intended.

Project sponsors ensure long-lasting benefits of habitat projects

Operations, maintenance, rehabilitation, repair, and replacement (OMRR&R) of construction features is essential to the ongoing and ultimate success of an individual habitat project, as well as UMRR's overall effectiveness at restoring the Upper Mississippi River's ecological health and resilience. **While project OMRR&R receives relatively little attention beyond the partnership, it is integral to ensuring that the restoration features are working properly and are effectively advancing the project's site-specific and systemic ecological objectives well after the project is constructed.** The benefits of continued, effective OMRR&R are increasingly showcased as the program builds its understanding of the interactions among its habitat projects at larger spatial scales, including possible cumulative effects within a pool, floodplain reach, or throughout the entire system.

Given the amount of restoration work with 55 constructed UMRR habitat projects, project sponsors face resource constraints with managing their respective cumulative OMRR&R obligations. Because this issue is longstanding issue, the Corps, U.S. Fish and Wildlife Service, and the five Upper Mississippi River states have agreed to design future habitat projects that minimize OMRR&R while balancing first construction costs and better estimating OMRR&R costs for planning purposes, including using improved forecasts of flood intensity and frequency rates. The goal is to reduce costs and required active management of habitat projects, by allowing natural river processes to create and sustain habitat. Examples of management techniques that require minimal OMRR&R practices include rock weirs, islands, forestry, or other hard features that are resistant to erosive river currents and seed islands that create habitat diversity.

SUCCESS STORY

Adaptive management defines optimal habitat for highly-valued recreational fish

What we know: Many important recreational fish such as sunfish, bass, bluegill, and walleye rely on off-channel backwater habitat to survive winter conditions. Construction of the nine-foot navigation channel and increased sedimentation over time have significantly reduced water depths in many backwaters and side channels. Elevated concentrations of nitrogen and phosphorus have created more eutrophic conditions, limiting oxygen available to the fish. Together, these changes limited and impaired habitat use. Through experimentation, field sampling, and monitoring of completed projects, UMRR has conclusive evidence that fish populations positively respond to restoration, specifically dredging and flow manipulation, and determined the optimal criteria for water depth, temperature, current, and dissolved oxygen to create high-quality habitat. These criteria are the most critical habitat factors for creating high-quality fish habitat beneath ice cover (overwintering habitat). Besides dredging to restore water depth, the most effective restoration is achieved through rock structures that protect habitat while allowing for the appropriate flow of water into the area.

What we want to know: The Pool 12 Overwintering habitat project's adaptive management analysis currently underway is testing several hypotheses in an effort to answer: a) what is the optimal spacing of suitable backwaters for overwintering habitat that will generate the greatest geographic area of influence?, and b) how much overwintering habitat is necessary to restore or re-establish a healthy centrarchid population? The hypothesis will answer specific questions related to pool-wide fish community response, the effects of backwater lakes on fish communities, and fish dispersal from backwater lakes. The abundance, biomass, and condition (relative weight) of these fishes will be assessed.

How we will learn it: The size and distance between the Pool 12 Overwintering habitat project's backwater lakes are ideal for this scientific analysis. Iowa DNR has invested substantially in pre-project monitoring studies to better understand fish use of backwaters during winter and their spring dispersal patterns, and to quantify preferred habitat conditions within backwaters and the area of influence beyond the restored backwaters. Radio tracking and pool-wide population monitoring will help answer the question of how many backwater restoration sites are necessary to achieve pool-level fishery response, as well as the appropriate spacing of sites. Fish abundance, biomass, condition, and growth will be evaluated from pool-wide and backwater fish community surveys. Fish dispersal will be evaluated by radio telemetry tracking fish moving out from wintering sites in the spring. The project's location allows the UMRR's long term resource monitoring data in the adjacent Pool 13 to serve as a pool-scale control. Post-project monitoring will compare fish community responses in restored and control lakes and it will compare pool-wide fish community response in Pool 12 to Pool 13, which will not have additional restoration.

This bluegill is being tracked using radio telemetry to observe its movement throughout the backwaters in the Pool 12 Overwintering project area.

Fun fact! Pre-project monitoring that tracks individual fish has already indicated that some fish populations are less mobile than previously suspected.

Why this knowledge and restoration is important: This analysis will build on UMRR's long term resource and project monitoring data and experience to better inform UMRR's future overwintering habitat restoration, by reducing uncertainties and making the projects more cost-effective and successful. With this knowledge, UMRR restoration practitioners will be able to answer more management-related questions about overwintering habitat, more effectively target future overwintering projects, and quantify ecological benefits. The Pool 12 Overwintering adaptive management should lend greater insights about the cause-and-effect relationships between targeted habitat restoration and Upper Mississippi River fish populations. This project is an important opportunity to expand beyond the project-by-project evaluation approach to increase learning about the area of influence of restoration techniques and approaches.

Large river ecosystem restoration was essentially non-existent when UMRR began, making its first several habitat project designs true experiments. Those projects were implemented in ways not previously imagined but are still proving successful. Today, UMRR's projects provide sophisticated, cost-effective, and sustainable solutions to rehabilitate fish and wildlife habitat and restore complex riverine functions and processes.

Adaptive management minimizes risk, improves future outcomes, and increases knowledge of the river floodplain ecosystem

Understanding how the ecosystem responds to various restoration techniques and approaches has always been a central theme and a top priority for UMRR. As restoration techniques and approaches mature and more is learned about the river ecosystem, restoration achievements have become greater and even more cost-effective.

Project performance – At its core, adaptive management is an iterative process that includes setting learning objectives, designing and implementing restoration projects, evaluating responses, reevaluating decisions if objectives are not met, communicating results, and integrating learned information into future restoration alternatives and hypotheses. A majority of UMRR's adaptive management efforts have been focused at the project-scale and on physical and chemical responses – i.e., adjusting project designs based on ecological criteria, evaluating local effects of individual projects, assessing operation and maintenance activities to achieve project goals, and enhancing future restoration efforts through lessons learned from completed projects. Ultimately, this type of adaptive management analysis helps create projects that will efficiently and successfully achieve their management objectives by reducing uncertainties related to their performance.

Answering scientific questions – While UMRR's current understandings of the river system are fairly advanced relative to other large aquatic ecosystems, the 2015-2025 UMRR Strategic Plan calls for more rigorous, scientifically-based adaptive management analyses that will even further increase UMRR's abilities to measure project success and restore the Upper Mississippi River. In particular, the Strategic Plan calls for the program to determine quantitatively how habitat projects cumulatively result in a healthier and more resilient ecosystem for the following purposes:

a) Answer broad questions about the Upper Mississippi River ecosystem and its management, beyond the project level.

b) Identify restoration needs that would be best addressed through "new" restoration techniques.

c) Enhance communication and understanding related to project performance and uncertainties in ecosystem management.

d) Learn from past and current efforts to inform future restoration.

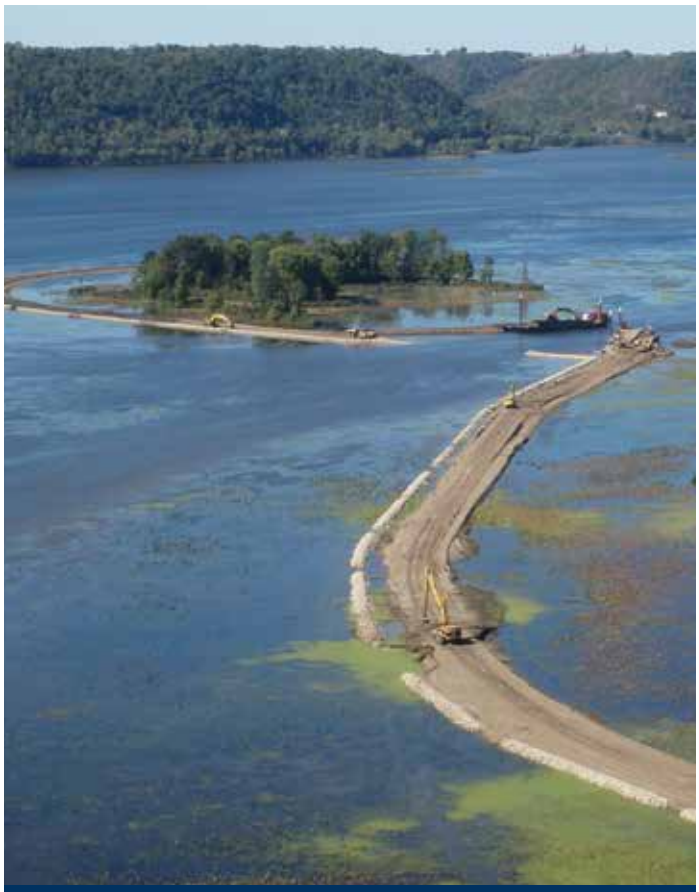
e) Improve the overall effectiveness and efficiency of particular restoration techniques.

f) Inform long term Upper Mississippi River Restoration ecosystem management.

g) Guide and optimize UMRR's investment in habitat restoration

Adaptive management analyses can be integral for providing valuable knowledge to inform the design and evaluation of restoration actions at various spatial extents, quantify progress in achieving ecological objectives, and determine the rate of progress for restoring the ecosystem over time. Questions to uncover with quantitative, scientific evidence include whether: a) UMRR's restoration efforts are creating cumulative benefits, b) responses to restoration are occurring in a direct proportion, or c) the contribution of habitat projects to enhancing the health and resilience of the ecosystem at various geographic scopes and that have cumulative multiplying beneficial influences to many, differing fish and wildlife communities. Evaluating the effects of habitat restoration at larger spatial scales also requires understanding the various stressors that affect the river's ecosystem health and resilience.

For example, UMRR is evaluating the responses of submersed aquatic vegetation to island construction in Pool 8, where it has strategically and substantially invested in a concerted effort to restore the lower half of a pool. Continued monitoring of the pool is important to evaluate the resulting ecological benefits at larger spatial scales. In Pool 8, UMRR restored 27 islands affecting almost 4,000 acres with expected benefits of reduced wave action and turbidity and increased aquatic vegetation and fish and wildlife habitat. Figure 2-7 shows the increasing trends of submersed aquatic vegetation abundance pre-and post-construction of those islands. The dark green represents most likely species occurrence and light blue as species absent. Areas that are black signify not enough samples to determine either way. While other ecological factors, such as lower tributary discharges and sediment loads, are contributing to the increase in submersed aquatic vegetation, the construction of these islands certainly made a significant impact, increasing the pool's ecological health and amount and quality of fish and wildlife habitat. The success story on page 48 with Figures 3-5 and 3-6 on subsequent pages provide the scientific evidence for this substantial recovery in aquatic vegetation.



Since 2010, UMRR has strategically invested in preparing for selecting the next generation of habitat projects by better understanding 1) the key drivers affecting the Upper Mississippi River's ecological health and resilience to stressors and its ability to support important fish and wildlife habitat, and 2) how UMRR's habitat projects can both improve site-specific habitat conditions and systemic ecological processes and functions. This includes defining and assessing ecological indicators of health and resilience, building and improving analytical capabilities, creating meaningful connections between habitat projects and systemic ecosystem processes and functions, and determining possibilities for UMRR to implement new, innovative restoration techniques necessary to provide the desired habitat conditions and other ecological benefits.

Chapter 3

ADVANCING KNOWLEDGE OF ECOLOGICAL HEALTH AND RESILIENCE

UMRR is Answering the Question: What is the State of the Upper Mississippi River Ecosystem and How Is It Changing?

The Upper Mississippi River ecosystem is continually challenged by multiple and changing stressors, and it is becoming increasingly important to understand how to protect and enhance the diverse ecological services that the river provides. The Upper Mississippi River Restoration (UMRR) Program's scientific expertise, breadth of information, monitoring protocols, analytical capabilities, and data management and dissemination infrastructure provide the critical foundation for understanding the river's natural functions and processes, human influences, and how to best address critical restoration needs. UMRR's extensive information is used for scientific evaluations of the river's ability to sustain its fundamental ecological characteristics when affected by disturbances and how restoration actions might influence ecological health and resilience. UMRR serves as a national and international model in successful development and implementation of a multi-agency collaborative monitoring and research program that transcends traditional geopolitical boundaries.

Assessing and detecting changes in the river ecosystem's health

With long term resource monitoring data of the river's key ecological components collected for nearly 30 years, UMRR is able to assess, and detect changes in, the fundamental health and resilience of the Upper Mississippi River ecosystem. The river's ecological status (i.e., range of conditions observed) and trends (i.e., change in a consistent direction over time) are evaluated through comprehensive, integrated analyses of key biological, chemical, and physical indicators. UMRR scientists evaluate complex relationships among various ecosystem components and watershed drivers through space (north-south, east-west) and time (seasonal, annual, and long term cycles and patterns) and under a wide range of conditions (drought, flood). Long term resource monitoring data make it possible to detect actual changes in status and trends of ecological health indicators against the background of long term cycles and variation. Short-term studies cannot provide that information. This information provides a baseline to compare with future conditions and estimate changes in system drivers and responses. For example, because long term resource monitoring exists, there is a baseline of the river's ecological condition that allows for a rigorous assessment of the impacts that invasive, non-native Asian carp have on native fish populations and other facets of the river ecosystem.

Continued monitoring increases UMRR's ability to detect long term changes in the river's ecosystem and provide early detection of new influences to the system. Each year of data collection is valuable as it provides information on a unique combination of conditions, such as discharge, vegetation abundance, water clarity, and fish community composition and abundance. A greater diversity of conditions monitored provides increased understanding of the interactions among the different ecosystem components and how to restore and manage them for a healthier ecosystem. As is characteristic of large rivers, the Upper Mississippi River changes annually in response to local factors and regional weather, and also varies over many years in response to underlying drivers (such as climate change) and ecological processes (erosion and sedimentation). Long term resource monitoring is the only method that can provide scientific answers regarding the causes and consequences of annual variability, long term changes in the structure and function of the river, and effects of gradual changes in the river ecosystems, as well as rare events such as extreme floods or droughts.

Long term monitoring illustrates a comprehensive story of the river ecosystem

UMRR monitors the river's fundamental ecological attributes, using scientific and highly-standardizedmethods, at six study reaches that together reflect the river's ecological gradient from north to south. This has proven to be a cost-effective and efficient monitoring approach given the Upper Mississippi River's large geographic expanse. Figure 3-1 compares the fundamental characteristics of the six long term resource monitoring study reaches. The multi-component and spatially extensive sampling design generates data on a broad range of environmental conditions and on biota at both community and species levels.

Fish, water quality, and aquatic vegetation are collected according to UMRR's monitoring design, which incorporates highly-standardized methods that generate scientifically rigorous data. Consistency in methodology makes the data comparable over time and along the length of the Upper Mississippi and Illinois Rivers. UMRR sampling occurs at the appropriate intervals to detect large-scale changes in ecological responses over time and throughout the river and over the wide range of environmental and human-use gradients.

Some components have been reduced or eliminated due to limited funding. Budget constraints, beginning in 2004, forced UMRR to eliminate the macroinvertebrate monitoring component and scale back the monitoring effort for aquatic vegetation, fish, and water quality. However, in 2007, funding was increased for the fish and water quality to partially restore some of the sampling effort to previous levels.

The Corps operates this substantial undertaking in true partnership fashion, with the U.S. Geological Survey providing scientific leadership and conducting research and analysis and the five partner states operating the six long term resource monitoring field stations which support UMRR's data collection, analysis, and reporting. In its early years, UMRR was focused on developing the infrastructure and methods to collect data in a consistent manner over space and time. UMRR has operated this system successfully for many years and is now able to emphasize scientific analysis of the status and trends of ecological health and resilience and development of research to inform habitat restoration and management.

Each year of data is valuable as it provides information on a unique combination of conditions, such as discharge, vegetation abundance, water clarity, and fish community composition and abundance.

Figure 3-1 — Comparison of Long Term Monitoring Study Reaches

Lake Pepin, located in the middle of Pool 4, is the largest lake on the Mississippi River at 21 miles long. Serving as a sediment trap, it creates a strong contrast between the upper and lower portions of the pool. This contrast is important for river science in that it provides valuable insights regarding the role of turbidity in river ecology and how to manage and restore backwaters to create healthier and more resilient fish and wildlife habitat.

Pool 26 is the only study reach in the southern, locked portion of the Upper Mississippi River. Asian carp have established here. Its backwaters are turbid with scarce vegetation. There are important opportunities in this area to learn about the potential for, and limitations to, backwater habitat restoration.

Together, Pools 8 and 13 reflect the northern, locked portion of the Upper Mississippi River. UMRR has constructed multiple, extensive habitat projects in Pool 8, but few in Pool 13. Comparison of these pools provides information on the effects of Pool 8 Island construction. UMRR is also currently implementing an extensive habitat project in Pool 12 for which Pool 13 serves as a control to when assessing project effects.

The La Grange Reach on the Illinois River experiences high nutrient input from Chicago and the watershed. Compared to other reaches, it is most affected by agriculture and levee districts and Asian carp, and has the most pronounced urban-rural gradient. It lacks vegetation, and sedimentation is a major challenge to fish and wildlife habitat.

The Open River Reach on the Mississippi River provides the best opportunity to better understand the benefits of side channel restoration and how best to design the project features.

Key accomplishments since the 2010 UMRR Report to Congress

Since 2010, UMRR has continued collecting long term monitoring data; adding 46,600 data points to the data base related to fish, water quality, and aquatic vegetation (see Table 3-1). In total, UMRR's database management system houses 305,800 monitoring records.

Four new system-wide datasets – UMRR acquired, processed, and published online four systemic data sets, covering 2.7 million acres of the Upper Mississippi River ecosystem:

- UMRR's third decadal land cover/land use data set (collected in 2010-2011) and associated aerial photography – Land cover/land use data consists of mapping different vegetation types and developed lands, documenting changes over time.
- Light Detection and Ranging (LiDAR) data – LiDAR measures surface elevation and provides extremely accurate elevation information across large geographic areas. It improves the accuracy of the land cover/land use interpretation by differentiating the actual forest canopy and tree shadows on forest floor and aids in the formulation of habitat projects.
- Bathymetry data – Bathymetry data is high valuable for restoration practitioners. It measures the riverbed elevation below the water surface, and can be displayed into a water depth map.
- Seamless elevation dataset (topobathy) – The LiDAR and bathymetric data sets, combined, form a seamless elevation dataset that extends the entire length of the Upper Mississippi and Illinois Rivers, including the entire floodplain from bluff-to-bluff. This dataset, commonly known as topobathy, is extremely valuable for flood inundation modeling, hydrologic and environmental modeling, planning and designing restoration projects, and predicting and communicating the effects of water level management projects. Figures 3-2 and 3-3 illustrate examples of a topobathy data and an application of topobathy map to inform habitat restoration.

With long term data collected for nearly three decades, UMRR's database is one of the most extensive and comprehensive on any large river system in the world.

Table 3-1 — Long Term Resource Monitoring Site Records Generated Over Time by Each Monitoring Component

The river's ecological status (i.e., range of conditions observed) and trends (i.e., change in a consistent direction over time) are evaluated through comprehensive, integrated analyses of key biological, chemical, and physical indicators at various spatial scales. The longevity of UMRR's long term resource monitoring dataset provides a scientific basis to determine the average conditions and range of variability for the suite of Upper Mississippi River ecological indicators.

	Number of site collection records	
Monitoring component	**Recent (2010-2015)**	**Since Inception (1987-2015)**
Water quality	29,000	133,000
Fish	10,300	57,300
Macroinvertebrates[3]	———	8,400
Aquatic vegetation	8,100	107,100

[3] The macroinvertebrate component was eliminated after 2004 due to declining funding on an inflation-adjusted basis and the need to address higher partnership priorities.

Data access tools – Since 2010, UMRR published a new, user-friendly internet-based mapping and query application tool allowing users to easily access and download fisheries, water quality, vegetation, invertebrate, land cover, and bathymetric data monitored over the life of UMRR. Figure 3-4 shows an example output of the spatial data query tool. In addition, UMRR has increased the public accessibility of its long term water quality monitoring data by serving a new graphical browser for stratified random sampling.

Treemap tool for fisheries – UMRR simplified a complex database of fisheries monitoring information in a squarified treemap application that visually displays status and trend information about fish biomass, abundance, and community dynamics that can be manipulated to answer particular research questions. The treemap converts fisheries' data into simplified rectangles that are arranged by hierarchy in a chart for the purposes of informing management priorities in a relatively straightforward, meaningful way that allows scientific hypothesis testing of specific research questions. This web-based tool is similar to economics tools used by investors to evaluate performance and trends in economic sectors. The treemap provides easy comparisons of fish abundance between study reaches, among species within study reaches, and even between functional levels of organization, such as native and nonnative fish assemblages and reproductive guilds. This can illustrate changes in fish community responses in comparison to longer term averages for any given year.

Figure 3-2 — Topobathy Map

Topobathy merges floodplain elevation and bathymetry to create a seamless elevation surface that allows restoration practitioners to evaluate the full range of water level effects on vegetation, fish, and wildlife. Merging the two datasets required special processing, but provides important capabilities to model the areas that transition from aquatic to terrestrial areas. UMRR's habitat projects restore these seasonal wetlands that provide important habitat for a variety of wildlife. This image shows the elevation surface of Pool 8.

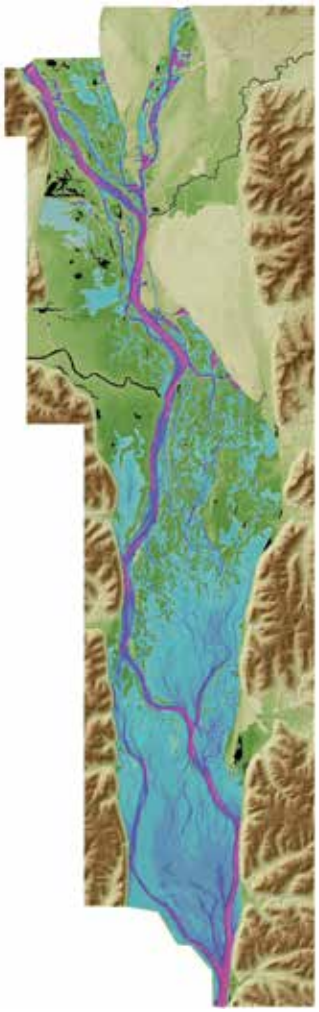


Figure 3-3 — Example of Topobathy Application for Restoration

This map illustrates how topobathy can be used to inform river management regarding the effects of flooding. The black areas are the main channel, side channels, and backwater areas that are always in an aquatic state. The darkest blue color indicates areas flooded at a slightly above average water level, and additional lighter blues indicate area flooded at increasingly higher water levels. The lightest blue shows the greatest flood event on record. The topobathy data significantly enhances river floodplain restoration efforts aiding predictions of the amount of time an area is likely to be inundated. This is important when deciding the needs for habitat projects, including placement and design of features. For example, a forest project can be designed for specific tree species based on the amount of time the project area is flooded. This image shows the middle portion of Pool 8.

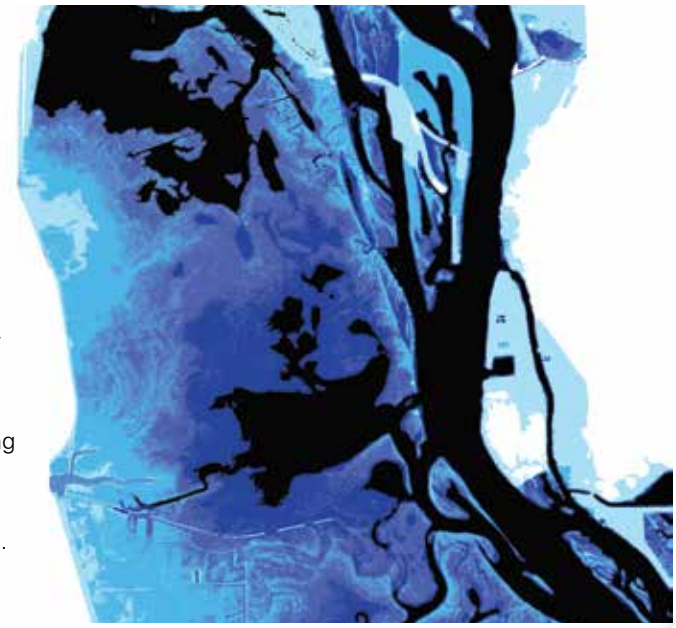
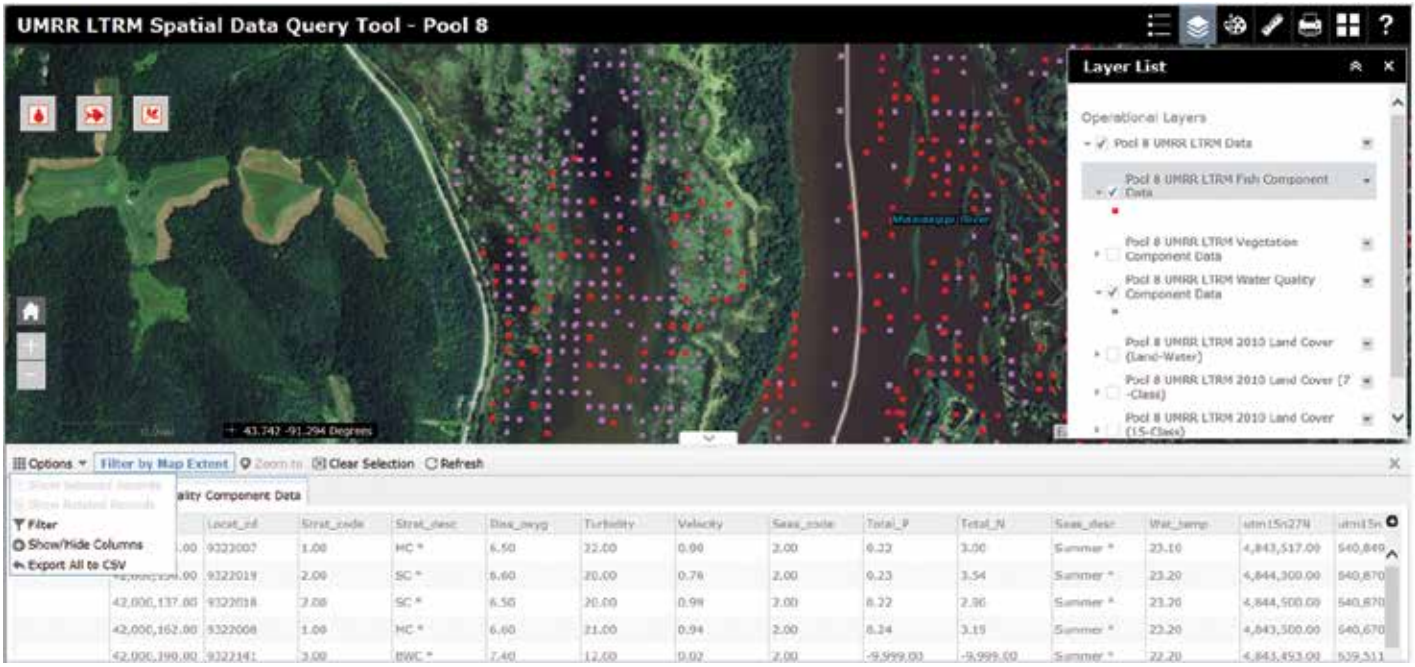


Figure 3-4 — UMRR's spatial data query tool is a publically-accessible interface for accessing its long term resource monitoring data, geospatial information, and research results in a variety of formats.

UMRR has collected millions of data points of long term resource monitoring information for nearly 30 years. This includes fisheries, water quality, vegetation, and invertebrates, as well as land cover and bathymetric data. In 2016, UMRR published a new, user-friendly internet-based mapping and query application tool that greatly enhances the ability of restoration practitioners and the public to access and download the available data.



Key findings since the 2010 UMRR Report to Congress

UMRR scientists publish their scientific findings in peer-reviewed investigations, with 45 scientific manuscripts and 23 technical reports published since 2010. See Tables 3-2 and 3-3 for a list of those publications. The results of these investigations provide decision-makers with information needed to maintain the river as a fully-functioning, large-river ecosystem that supports its many economic, ecological, and social values. In particular, since 2010, UMRR has found that:

Gradient of river health – While the Upper Mississippi River ecosystem still retains the underlying features that define river ecosystem integrity, a general gradient of river health exists that ranges from a relatively healthy system in the northern reaches to a system that is much less healthy in the southern reaches. Using long term resource monitoring data, UMRR evaluates the river ecosystem's status and trends through quantitative assessments of the fundamental biological, chemical, and physical indicators. UMRR's monitoring information indicates that most of the indicators have remained relatively stable.

- Figure 3-5 shows the overall improvements in submersed aquatic vegetation in Pools 4, 8, and 13; and Figure 3-6 shows the change in water clarity in each of the six long term resource monitoring trend pools.
- In one notable exception to this general pattern, the Upper Mississippi River from the Twin Cities to the head of Lake Pepin is more degraded on some metrics, primarily suspended solids and aquatic vegetation, than the river from below Lake Pepin. This is because Lake Pepin serves as a sink for sediment; thus the water leaving Lake Pepin is clearer than the water that enters.

Improved ecological health in the north – The northern portion of the Upper Mississippi River ecosystem has clearly experienced an ecological shift from a turbid, less vegetated condition to a clearer, more vegetated condition since 2005 that is resulting in a significant rebounding of fish species favoring clean water and abundant vegetation such as weed shiners, yellow perch, largemouth bass, and young-of-year bluegills. More information about these observations are explained in the story feature on page 48. UMRR's most substantial research

Table 3-2 — UMRR Scientific Manuscripts Published from FY 2011 to FY 2015

Year	Title	Publication
2011	Seasonal zooplankton dynamics in main channel and backwater habitats of the Upper Mississippi River	Hydrobiologia
	Temporal changes in spatial patterns of submersed macrophytes in two impounded reaches of the Upper Mississippi River	River Systems
	Spatial scaling of core and dominant forest cover in the Upper Mississippi and Illinois River floodplains	Landscape Ecology
	Are two systemic fish assemblage sampling programs on the Upper Mississippi River telling us the same thing?	River Research and Applications
	Multinomial mixture model with heterogeneous classification probabilities	Environmental and Ecological Statistics
	Population trends of flathead catfish, channel catfish, and blue catfish in impounded and unimpounded reaches of the Upper Mississippi River (1993-2007)	American Fisheries Society
	A comparison of two electrofishing methods used to monitor fish on the Illinois River, Illinois	River Research and Application
	Estimating site occupancy rates for aquatic plants using spatial sub-sampling designs when detection probabilities are less than one	Aquatic Botany
	Evaluation of single and two-stage adaptive sampling designs for estimation of density and abundance of freshwater mussels in a large river	River Research Applications
	The evaluation of a rake method to quantify submersed aquatic vegetation in the Upper Mississippi River	Hydrobiologia
2012	Spatially-explicit modeling of productivity in pool 5 of the Mississippi River	Ecologist-Developed Spatially-Explicit Dynamic Landscape Models
	An investigation of fish community and water quality compositions in an isolated side channel of the Upper Mississippi River	Journal of Freshwater Ecology
	Variation in water-mediated connectivity influences patch distributions of total N, total P, and TN:TP ratios in the Upper Mississippi River	Freshwater Science
	Threshold effects of flood duration on the vegetation and soils of the Upper Mississippi River floodplain	Forest Ecology and Management
	Past and predicted future changes in the land cover of the Upper Mississippi River floodplain	Ecological Indicators
2013	A decade of monitoring Pool 26 of the Upper Mississippi River sytem: water quality and fish data from the Upper Mississippi River Restoration Environmental Management Program	Illinois Natural History Bulletin
	Curve fit: a pixel-level raster regression tool for mapping spatial patterns	Methods in Ecology and Evolution
	Interactive effects of flooding and deer (Odocoileus virginianus) browsing on floodplain forest recruitment	Forest Ecology and Management

Table 3-2 — UMRR Scientific Manuscripts Published in FY 2011 to FY 2015 (continued)

Year	Title	Publication
2013	Influences of availability on parameter estimates from site occupancy models, with application to submersed aquatic vegetation	Natural Resource Modeling
	Treating floodplain lakes of large rivers as study units for variables that vary within lakes; an evaluation using chlorophyll a and inorganic suspended solids data from floodplain lakes of the Upper Mississippi River	River Research and Applications
	Nutrient cycling, connectivity and free-floating plant abundance in backwater lakes of the Upper Mississippi River	River Systems
	Songbird use of floodplain and upland forests along the Upper Mississippi River corridor during spring migration	The Condor
	Wetland management reduces sediment and nutrient loading to the Upper Mississippi River	Journal of Environmental Quality
	A comparison of methods to estimate shovelnose sturgeon mortality in the Mississippi River adjacent to Missouri and Illinois	North American Journal of Fisheries Management
	Development of an Asian carp size structure index and application through demonstration	North American Journal of Fisheries Management
	Evaluation of aging structures for silver carp from Midwestern U.S. rivers	North American Journal of Fisheries Management
2014	Winter browse selection by white-tailed deer and implications for bottomland forest restoration in the Upper Mississippi River valley	Natural Areas Journal
	Projected risk of population declines for native fish species in the Upper Mississippi River	River Research and Applications
	Comparing commercial and recreational harvest characteristics of paddlefish Polyodon spathula in the Middle Mississippi River	Journal of Applied Ichthyology
	Assessment of the effects of high summer water temperatures on shovelnose sturgeon and potential implications of climate change	River Research and Applications
	Thresholds in the response of free-floating plant abundance to variation in hydraulic connectivity, nutrients, and macrophyte abundance in a large floodplain river	Wetlands
	Temporary connectivity: the relative benefits of large river floodplain inundation in the Lower Mississippi River	Restoration Ecology
	Synergy between silver carp egestion and benthic fishes	Environmental Biology of Fishes
2015	Flood pulse effects on nitrification in a floodplain forest impacted by herbivory, invasion, and restoration	Wetlands Ecology and Management
	Effects of flooding on ion exchange rates in an Upper Mississippi River floodplain forest impacted by herbivory, invasion, and restoration	Wetlands
	Measuring floodplain spatial patterns using continuous surface metrics at multiple scales	Geomorphology
	Floodplain complexity and surface metrics: influences of scale and geomorphology	Geomorphology
	Ecosystem metabolism and nutrient dynamics in the main channel and backwaters of the Upper Mississippi River	Freshwater Biology

Table 3-2 — UMRR Scientific Manuscripts Published in FY 2011 to FY 2015 (continued)

Year	Title	Publication
2015	The Upper Mississippi River floodscape: spatial patterns of flood inundation and associated plant community distribution	Applied Vegetation Science
	Spatiotemporal phytoplankton patterns in the Upper Mississippi River in response to seasonal variation in discharge and other environmental factors	River Systems
	Use of exploitation simulation models for silver carp populations in several Midwestern U.S. rivers	Management of Biological Invasions
2016	Long term changes in fish community structure in relation to the establishment of Asian carps in a large floodplain river	Biological Invasions
	Contrasts between channels and backwaters in a large, floodplain river; testing our understanding of nutrient cycling, phytoplankton abundance, and suspended solids dynamics	Freshwater Science
	Long term decreases in phosphorus and suspended solids, but not nitrogen, in six Upper Mississippi River tributaries, 1991-2014	Environmental Monitoring and Assessment
	A comparison of main and side channel physical and water quality metrics and habitat complexity in the Middle Mississippi River	River Research and Applications
	Variance components estimation for continuous and discrete data, with emphasis on cross-classified sampling designs	Design and Analysis of Long Term Ecological Monitoring Studies
	A comparison of metabolic rates in off-channel habitats of the Middle Mississippi River	River Research and Applications

on this shift has focused on Pool 4; however, these changes are also being observed in Pools 8 and 13 and the relationships and ecological processes observed in Pool 4 likely apply to much of the Upper Mississippi River ecosystem. The rapid response to improved conditions due to habitat restoration natural variation suggests that the ecology might also respond rapidly to management and restoration actions in this portion of the river.

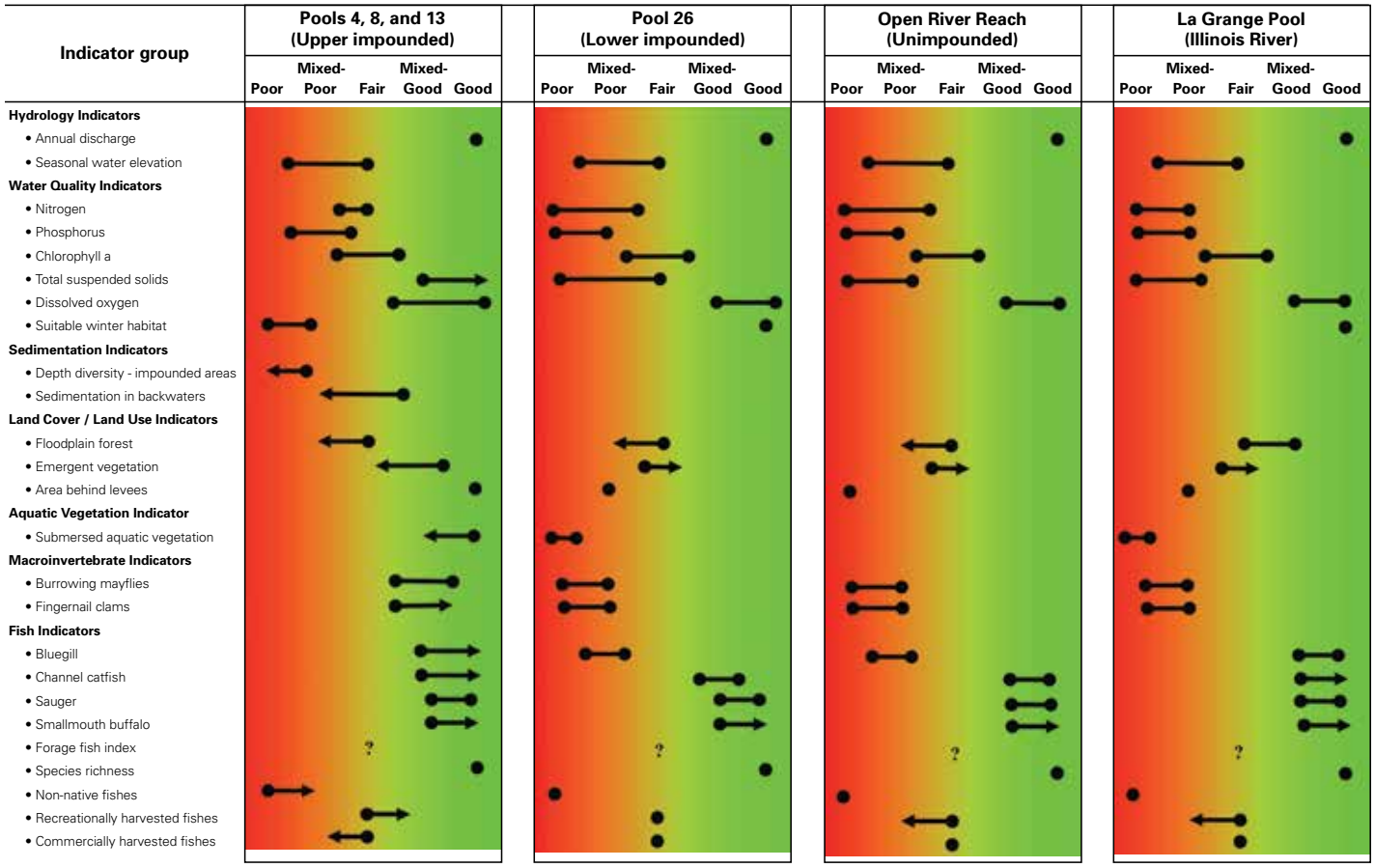
Evaluation of indicators – UMRR completed an extensive evaluation ofthe Upper Mississippi River ecological indicators in the 2008 Status and Trends Report (see Table 3-4) and has recommended a suite of new fish indicators, to use in a future assessment, that are more community-based – replacing the single-species indicators.

Landscape indicators – UMRR is substantially improving knowledge of the Upper Mississippi River's landscape ecology and bridging the gap between local, site-specific management actions to system and regional ecosystem goals and objectives. Since 2010, UMRR has made significant progress in developing landscape ecological indicators and has developed a graphical web browser that allows decision-makers to easily obtain landscape-related indicators and maps. Landscape ecology is the analysis of relationships among watershed drivers (e.g., climate runoff, water use, restoration); patterns and distributions of habitat, hydrology, and ecological properties (e.g., soils and species); and changes in ecological processes such as plant and animal growth, community succession, and nutrient availability and cycling. With a greater understanding of the Upper Mississippi River landscape ecology, restoration practitioners can better understand the ecological consequences of modifications to landscape patterns and connect improvements to the overall condition of the river system to site-specific habitat and resource limitations. This will become increasingly important as policy makers and habitat managers require a better understanding of how climate and other regional landscape changes affect biodiversity and ecosystem processes. More information on the findings are explained in the science feature on page 23.

Table 3-3 — UMRR Technical Reports Published from FY 2011 to FY 2015

Year	Title
2010	Evaluation of factors influencing metaphyton abundance and distribution on navigation pools 4, 8, and 13 of the Upper Mississippi River
2011	Aerial imagery processing and classification training for the Upper Mississippi River System 2010 Land Cover/Land Use Project
2012	Summary of zooplankton in Lake Pepin Upper Mississippi River, 1993-2006
	Assessment of high-resolution digital imagery for UMRS vegetation mapping and software-based vegetation classification
	Nutrient controls on phytoplankton composition and ecological function among hydrologically distinct habitats in the Upper Mississippi River
	Application of Wind Fetch and Wave Models for Habitat Rehabilitation and Enhancement Projects – 2012 Update
	Growth, Tissue Composition and Stoichiometry of Duckweed Grown in Low Nutrient Backwaters of the Upper Mississippi River
2013	Fisheries Monitoring in Pool 13, Upper Mississippi River, from Long Term Resource Monitoring Program, 1989-2013
	Mortality, movement, and behavior of native mussels during a planned water level drawdown in Pool 6 of the Upper Mississippi River
	Pool 8 State of the Ecosystem Report, 2012
2014	Relationship of weed shiner and young-of-year bluegill and largemouth bass abundance to submersed aquatic vegetation in navigation pools 4, 8, and 13 of the Upper Mississippi River, 1998-2012
	Spatially explicit habitat models for 28 fishes from the Upper Mississippi River System (AHAG 2.0)
	Monitoring rationale, strategy, issues, and methods: UMRR-EMP LTRMP Fish Component
	Trend estimation methods for LTRMP water data
	Long -term Resource Monitoring Program Procedures: Fish Monitoring, 2nd Edition
	Temporal trends in water quality and biota in segments of Pool 4 above and below Lake Pepin, Upper Mississippi River: indications of a recent ecological shift
	Pool 8 state of the ecosystem report, 2013
2015	General classification handbook for floodplain vegetation in large river systems
	Accuracy assessment/validation methodology and results of 2010-11 land cover/land use data for Pools 13, 26, La Grange, and Open River South, Upper Mississippi River System
	Analysis of spatial and temporal dynamics of submersed aquatic vegetation and metaphyton communities of Pool 4
2016	Landscape ecology of the Upper Mississippi River System: lessons learned, challenges and opportunities
	Methods of estimating trends in long term resource monitoring fish catch-per-unit-effort and vegetation percent frequency of occurrence statistics
	Documenting the use of the long term resource monitoring element's fish monitoring methodologies throughout the Midwest

Table 3-4 — Indicators from the 2008 Status and Trends for the Upper Mississippi River



Ecosystem resilience – UMRR is studying the key fundamental relationships between system drivers and the desired ecological services and economic uses that are essential to sustain. Since 2010, UMRR has created overarching conceptual models describing the key relationships occurring in backwater complexes, main channel environments, and floodplain forests. This information will be used to determine locations where it is most critical to implement habitat projects and identify the key ecological processes and functions to address through those projects.

Ecosystem dynamics – Scientific research regarding thresholds affecting key ecological relationships will inform how restoration and management can influence ecosystem health and resilience. For example, the restoration success story on page 26 explains the importance of understanding the threshold at which the timing, depth, and duration of flood events affects the growth and survival of hardwood forests.

Scientific investigations improve knowledge of the river's dynamic ecosystem

UMRR is a multi-disciplinary restoration-science program that interprets long term resource monitoring information through innovative data analysis, research, modeling, and other analytical and mapping approaches in order to effectively:

- Make accurate, scientific statements about the river's ecological health and informed decisions about possible future conditions.
- Understand how in-river and watershed influences affect the ecosystem's structure and function, and the implications for the ecosystem's resilience.
- Answer critical scientific questions about how restoration can best improve the river's ecological health and ability to support its diverse biota and human uses, given various influences that are shaping the river ecosystem.

SUCCESS STORY

The norther portion of the Upper Mississippi River ecosystem has shifted to a cleaner, healthier state with improved fish and wildlife habitat

What we know: The northern portion of the Upper Mississippi River ecosystem has improved from a turbid, less vegetated condition to a clearer, more vegetated condition since 2005. The ecological shift likely resulted from several years of low water discharge into the river (Figures A and B) along with associated reduced sediment loads (Figure C) and improved water clarity, which increases the underwater light available for submersed aquatic vegetation (Figure D). Further, when submersed aquatic vegetation reach a certain abundance threshold, a positive feedback occurs, enhancing growth by reducing current velocity and wave action, root sheer stress, and sediment resuspension. This maintains improved water clarity within and near the vegetation beds, which provide high-quality habitat for fish and wildlife. The ecological shift has stimulated growth in fish species that need high water quality and abundant vegetation, such as weed shiners, yellow perch, largemouth bass, and young-of-year bluegills (Figure E).

UMRR's most substantial research on this shift has focused in Pool 4; however, these changes are also being observed in Pools 8 and 13 and the relationships and ecological processes observed in Pool 4 likely apply to much of the Upper Mississippi River ecosystem. Upper Pool 4 is highly influenced by sediment concentration originating from agricultural drainage in the Minnesota River basin. This sediment is filtered by Lake Pepin in the middle of the pool, allowing for relatively clear conditions with abundant vegetation in lower Pool 4. Because upper Pool 4 has exhibited a relatively rapid shift toward the enhanced ecological condition of lower Pool 4, it suggests that several consecutive years of low discharge can reset the ecological dynamics of the system and that one or two years of high flow interspersed among the low flow years do not necessarily reverse the changes underway. More generally, the rapid response to improved conditions due to natural variation suggests that the ecology might also respond rapidly to management and restoration actions in this portion of the river.

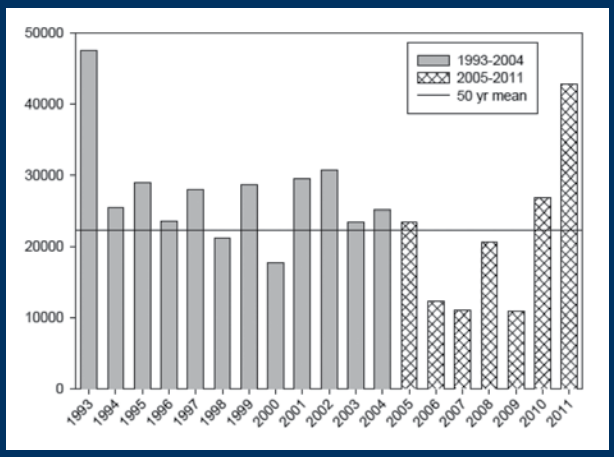
What we want to know: Given that this shift began only 10 years ago, time will tell whether the shift in Pool 4 is simply short-term variation or is a longer term change in the system. The research has mostly focused on Pool 4, but UMRR researchers are analyzing data in other study reaches to assess the extent to which similar changes are occurring elsewhere in the system. Future research will include community analysis of the submersed aquatic vegetation and fish populations, including species' habitat associations and the abiotic variables driving these communities.

How we will learn it: UMRR's long term monitoring of Pool 4's primary ecological features provides important information of the causes and consequences of this ecological shift in its future trajectory. UMRR's long term resource monitoring in other river reaches will allow for comparative and larger spatial analyses to understand the generality of the changes observed in Pool 4.

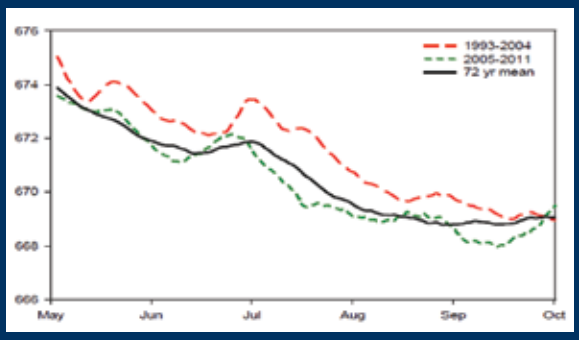
Fun fact! Yellow perch populations have rebounded tremendously on the Upper Mississippi River during this period of increased vegetation, providing unprecedented recreational catches of this popular and delicious pan fish!

Why this knowledge is important: Understanding the underlying dynamics driving changes in the Upper Mississippi River ecosystem is essential to optimizing UMRR's ability to move the river ecosystem to a healthier and more resilient state. The research indicates that water quality improvements drive rapid increases in submersed aquatic vegetation that is necessary to support more abundant, diverse, and resilient vegetation and fish communities throughout the Upper Mississippi River ecosystem. This research provides evidence that supports UMRR's in-river management actions, such as water level management and island restoration, are effective tools to lower water velocity conditions and enhance and restore degraded vegetation beds.

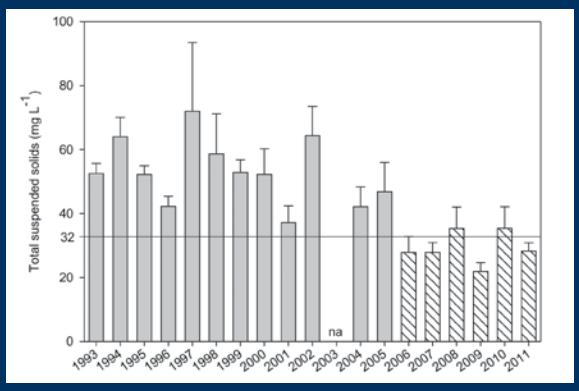
(A) Average summer discharge (cfs) at L&D 3



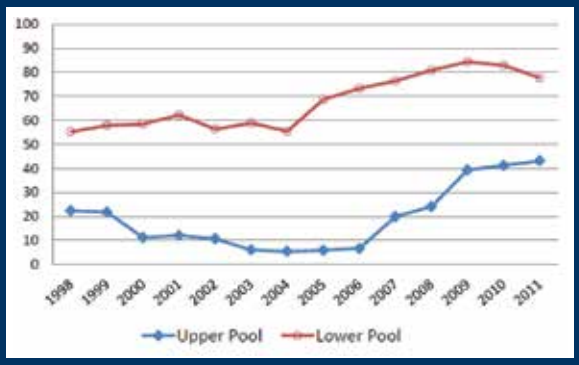
(B) Average water surface elevation (ft) at L&D 3



(C) Total Suspended Solids (mg / L-1) in Pool 4



(D) Submersed Aquatic Vegetation Percent Frequency in Pool 4



(E) Fish Abundance in Pool 4

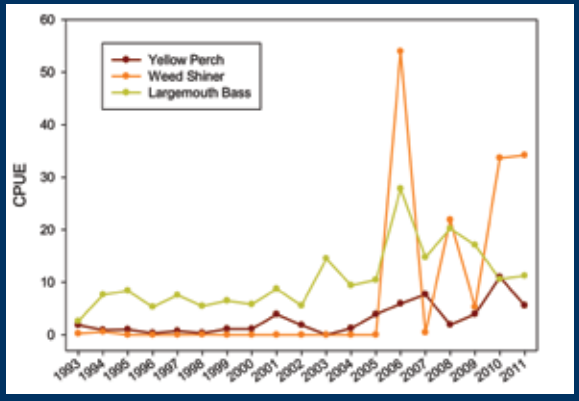
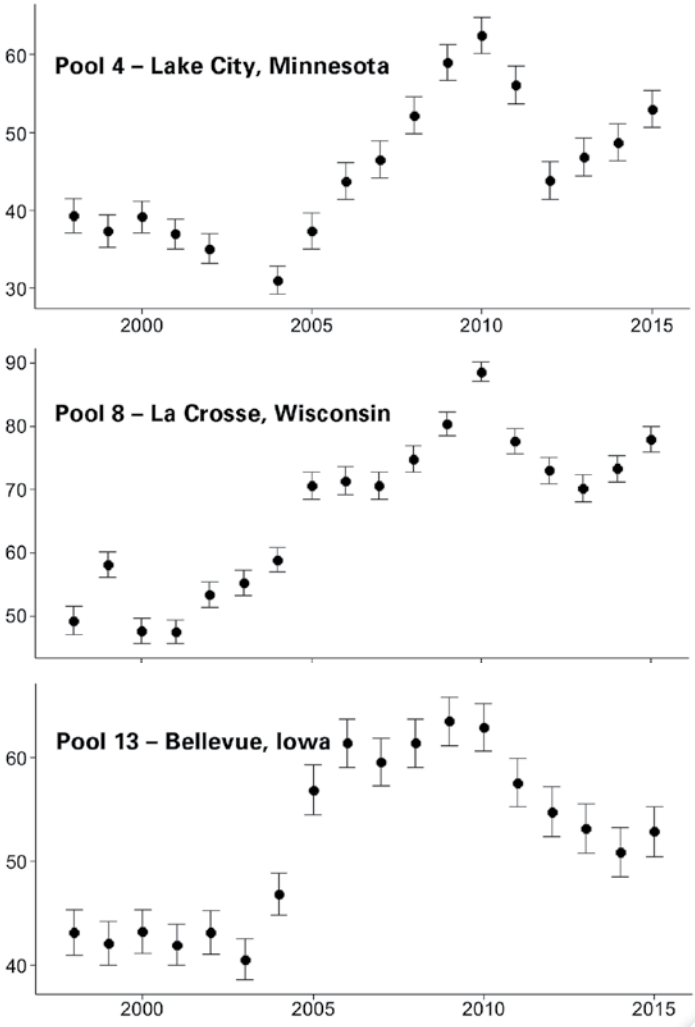


Figure 3-5 — Trends in submersed aquatic vegetation from 1993 to 2015

The Upper Mississippi River ecosystem continues to change seasonally and over time. UMRR's long term data provides us with the information to understand those changes within the context of broader watershed influences. The 2008 UMRR Status and Trends Report Card described the status of submersed aquatic vegetation in the Upper Impounded Floodplain Reach as "mixed-good," but with a declining trend over time. Since the 2008 Report, UMRR's long term monitoring shows that the presence of submersed aquatic vegetation has been highly variable in recent years but remained overall in better condition than in 2004. Abundant vegetation promotes clearer water by anchoring sediments and provides important habitat for many fishes. Increasing numbers of desirable fish species is likely the result of the increased vegetation. [Note: The Upper Impounded Floodplain Reach is evaluated through monitoring of Pools 4, 8, and 13.]



UMRR's long term monitoring tracks the Upper Mississippi River's fundamental ecological characteristics, providing important indicators of its overall health and the effects of various stressors on the ecosystem. Fish tell us a lot about the health of certain stretches of river and where high-quality habitat exists.

Results of UMRR's scientific investigations provide decision-makers with information needed to maintain the Upper Mississippi River as a fully-functioning large-river ecosystem that supports its many economic, ecological, and social values. UMRR's research answers critical scientific questions that improve our understanding of the dynamic relationships among ecosystem characteristics and how restoration can most effectively improve the river's ecological health. The long term data also provide a broader context of large scale changes in river condition that must be understood for proper interpretation of short-term studies and appropriate evaluation of restoration outcomes.

Research and analysis of the Upper Mississippi River ecosystem is challenging. Since the river ecosystem is unique, traditional controlled and replicated experiments are not possible. In addition, the river is highly variable spatially (longitudinally and laterally) and temporally (seasonal cycles, annual variability, and long term changes). However, there are ecological approaches and technical methods that are used in combination to address these challenges. UMRR scientists use theory/modeling, long term observation, comparative study, and ecosystem experiments to better understand the Upper Mississippi River ecosystem. Because of its methodology and breadth of information, long term resource monitoring provides fundamental insights regarding spatial and temporal patterns and processes that influence these patterns.

Strategic management: statistical significance and data integrity

Effective long term resource monitoring requires high-quality data management data management and delivery. Collecting, organizing, analyzing, storing, and reporting these data are fundamental program activities that cannot be compromised without jeopardizing the value of information and the historic database used by decision-makers and the scientific community.

The relational database management system has been consistent over the life of the program and currently houses 305,800 records. The U.S. Geological Survey works with the state field stations to ensure that sampling methods are applied consistently throughout time and across field stations and that new data are served online in a timely manner. Consistency in data collection is critical in order to scientifically detect resource differences and similarities among study reaches and throughout time. The program's scientists and managers participate in programmatic and external quality assurance and other quality control tests of the monitoring protocols and equipment. All manuscripts undergo peer review to be published in peer review journals. In addition, manuscripts and scientific technical reports are evaluated per the U.S. Geological Survey standard scientific review policies and procedures. Essentially, this subjects the program to continuous scientific review.

Maintaining existing data management tools, and investing in new technologies when appropriate, improves efficiency and is critical to the continued integrity of UMRR's conclusions about the river's ecosystem. UMRR's ability to stay current as new technologies emerge has resulted in the program serving as national leader in managing and delivering data.

- In 2012, the U.S. Geological Survey conducted a quality assurance audit of its new long term resource monitoring electrofishing equipment and its Upper Midwest Environmental Services Center water quality lab also participates in the agency's annual Standard Reference Sample Program. The audit found that the new equipment maintains the standardized methods and quality of the data.
- The UMESC and six state-operated UMRR field monitoring stations participate in the U.S. Geological Survey's annual National Field Quality Assurance Project in order to assure the quality of the data collection and analysis.

Scientific Monitoring and Investigations: UMRR's Plan for the Next Six Years

Over the next six years, UMRR will pursue scientific long term resource monitoring and research in a manner consistent with the 2015-2025 UMRR Strategic Plan, which calls for increasing knowledge of the Upper Mississippi River ecosystem for the purposes of understanding its current health and resilience and predicting future conditions in order to inform and enhance river restoration and management:

Quantifying ecosystem health: third status and trends report – The continued accumulation of long term resource monitoring data is necessary to be able to assess, and detect changes in, the fundamental health and resilience of the Upper Mississippi River ecosystem. This includes monitoring and evaluating the river's key ecological components: water quality, aquatic vegetation, fish, bathymetry, and land cover/land use. In particular, UMRR will complete a third comprehensive assessment of the river's ecological condition and compare the results with the first two assessments in order to make inferences about the trends in ecosystem health conditions over time.

Measuring ecological resilience – An ecosystem's resilience is its ability to return to its current state following disturbances. For example, ecosystems can exist in multiple states such as a healthy, clear-water state with high-quality habitat or a turbid state with little to no vegetation and low-quality habitat. Better understanding the factors influencing ecological resilience of the Upper Mississippi River will better equip management and restoration efforts to either augment resilience where the river is in a desired state or overcome resilience in areas where the river is in an undesirable state. UMRR is developing a suite of indicators to answer questions about the river's ecological resilience and to identify specific restoration strategies and opportunities.

A combination of tributary inputs from the watershed, natural and man-made structures in the river floodplain, and water flow management collectively affect the ecological condition of the river. Generations of human activity within the river and watershed has resulted in significant, continuous stressors to the river's ecological condition. These ongoing stressors are likely to remain well into the future, and include point- and non-point source pollution, channel impoundment for commercial navigation, flood control structures, and invasive species.

Accumulation of nutrients and sediments, altered flow regimes and water elevations, changes in flood frequency and floodplain connectivity, and changes in the composition of plant and animal communities are all examples of stressors that have reduced the river's ecological resilience, shifting some areas of the river into undesirable states. As new stressors emerge, understanding how restoration affects the Upper Mississippi River's ecological resilience is increasingly important.

UMRR is undertaking groundbreaking work to apply resilience concepts in a natural resource management context by capitalizing on the diversity of expertise and perspectives of its interagency and interdisciplinary partnership. Specifically, UMRR's scientists and restoration practitioners are working together to:

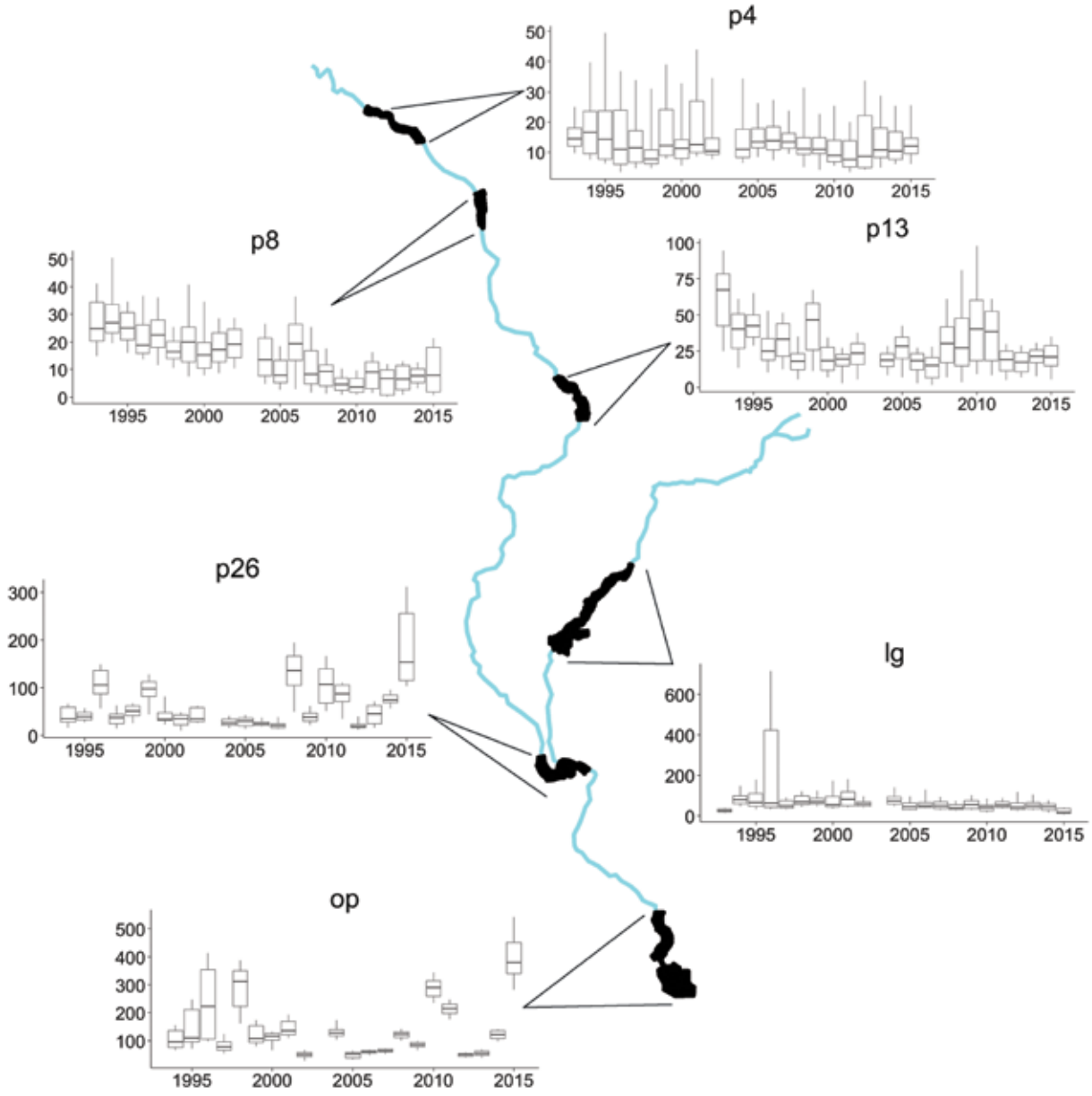
- Develop a clear conceptual understanding and definition of ecological resilience related to the Upper Mississippi River.
- Use conceptual models to develop indicators of resilience, examine the current resilience of the river's various geomorphic reaches, and identify the factors contributing to resilience.
- Evaluate the potential effects of UMRR's habitat projects on resilience.
- Inform and improve UMRR's future restoration activities to better manage resilience.

Asian carp have established populations on the southern three long term resource monitoring study reaches, but not in the northern three study reaches (see Figure 3-1 on page 37, and the story feature on page 52). The impacts to native fish communities from the invasion of Asian carp populations are strongest in the La Grange Reach and less so in Pool 26 and the open river reach. The differences in pools over time allows for scientific comparisons about how the Asian carp affect native fishes and the ecosystem.

Figure 3-6 — Trends in suspended solids concentrations (water clarity) from 1993 to 2015

Water Clarity Improvements: The 2008 UMRR Status and Trends Report Card rated the water clarity conditions (suspended solids concentrations) in the Upper Impounded Floodplain Reach as "mixed-good," with an improving trend (or decreasing suspended solids concentrations). Since 2004, UMRR's long term resource monitoring data show summertime suspended solids concentrations in the Upper Impounded Floodplain Reach have generally declined or remained relatively stable through 2015. [Note: The Upper Impounded Reach is evaluated through monitoring of Pools 4 and 8.] Sustained conditions of clearer water has created larger portions of these reaches suitable for growth of aquatic vegetation, which further stabilizes sediments and reduced suspended solids.

Value of Six Long Term Resource Monitoring Reaches: There are substantial differences among long term resource study reaches, as exemplified by suspended solids concentrations shown in the graphs below. Because study reach span a broad gradient of ecological conditions present in the Upper Mississippi and have large differences in concentrations of suspended solids, these six study reaches allow for a meaningful assessment of the overall condition of the river ecosystem in a way that a single reach could not do.



Complete the habitat needs assessment II – UMRR will finalize the second comprehensive habitat needs assessment as described on page 21, incorporating learned information about the river's fundamental ecological characteristics and the influence of in-river and watershed factors on fish and wildlife habitat. This assessment will serve as a foundational guide to identifying and selecting the third generation of habitat projects.

Scientific research, analysis and modeling – UMRR scientists will continue to conduct research about the factors controlling the dynamics and interactions of important ecological components. Scientific research, analysis, and modeling is focused on gaining critical, management-relevant information about the Upper Mississippi River ecosystem's structure and function and on increasing certainty related to predicting ecological responses to management actions.

UMRR research is answering questions about existing and possible future conditions, ecological patterns and interactions, factors controlling dynamics, fish and wildlife habitat needs, and biological responses to restoration techniques and approaches. The discoveries lead to better habitat projects and maximize ecological benefits. UMRR scientists are prioritizing and focusing research and analyses in response to specific inquiries from the program's restoration practitioners as well as the most pressing questions about ecological trends, such as sedimentation or forest diversity loss. Restoration practitioners and scientists are also working to identify research and analyses needs related to priority ecological questions in the development of the next habitat needs assessment (see Chapter 2 for more information).

Fourth decadal land cover/land use dataset – Collect and analyze the land cover/land use (LCU) of the UMRS, beginning with the collections of digital aerial photos in 2020. LCU products and aerial photo mosaics, accomplished through the collection and interpretation of systemic aerial photography every 10 years, are key components in this monitoring effort. These data are heavily used in restoration project formulation.

UMRS systemic monitoring of key ecological components – Assesses changes in the Upper Mississippi River's ecological conditions and determines how those changes relate to management actions, natural variation, and the overall ecological integrity of the Upper Mississippi River System. Future analyses will expand and build upon these data to also examine long term dynamics and interactions among the various indicators. These data are heavily used in restoration project formulation.

UMRR's continuing role is to provide the data needed to assess changes in the Upper Mississippi River's ecological conditions and to determine how those changes relate to management actions, natural variation, and the overall ecological integrity. Measuring the biological success of restoration techniques is important for learning and improving for the future.

SUCCESS STORY

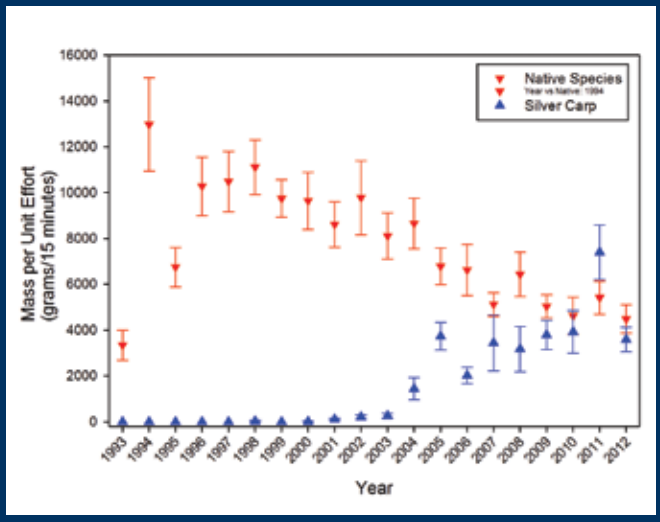
UMRR's long term monitoring show multiple lines of evidence that Asian carp are drastically altering the Upper Mississippi River's native fish communities

What we know: UMRR's long term resource monitoring provides substantial information about the effects of Asian carp (silver and bighead) on the Upper Mississippi River's aquatic food webs. Multiple lines of evidence show that Asian carp have drastically altered native fish community structure and composition in negative ways, including reduced abundance and body condition. Asian carp are more effective at consuming prey, causing significant declines in native fish species that eat the same food like gizzard shad and bigmouth buffalo (see the graph in right column). In the La Grange Reach of the Illinois River, gar and bowfin have increased since the Asian carps' invasion, most likely because they do not compete for the same food resources as Asian carp. Researchers evaluating population dynamics of Asian carp are finding that three- to five-year old fish are dominating the populations in the La Grange Reach. This may indicate a recent lack of successful recruitment to adulthood. That research also indicates that recruitment peaks every four to five years.

What we want to know: Understanding how Asian carp might influence the effectiveness of restoration projects and vice versa is extremely important. Future research efforts will likely include the following:

- Threshold responses of native fish populations in areas invaded by Asian carp, and potential management strategies to effectively minimize effects to native fish.
- Asian carp reproduction, early life history, and desired habitat areas to better understand recruitment and inform management.
- The design and management of restoration features to favor native fish species.

How we will learn it: UMRR takes an ecological community-based approach to monitoring Upper Mississippi River fisheries. With 17 years of fish monitoring pre-Asian carp invasion and more than 10 years of monitoring post-invasion, there exists significant baseline (pre-invasion) and post-invasion data readily available to make scientific conclusions about the influence that Asian carp have on native fish communities. Fish community monitoring is collected in six study reaches that represent the various ecological gradients on the river allowing for comparisons throughout the river



system. The longevity of the data set allows researchers to understand ecological processes and responses over time and how they relate to natural and human-induced changes that the river has experienced. The fact that UMRR has scientifically rigorous monitoring data pre-invasion is extremely valuable for documenting and evaluating the spread of an invasive species on native fish species and ecosystem health. This is very rare in ecology and long term resource monitoring. Continued monitoring will improve understandings of Asian carps' population dynamic, implications for native species, and control and eradication strategies.

Fun Fact! Bighead and silver carp lack a true stomach, requiring them to eat almost continuously.

Why this knowledge is important: The Upper Mississippi River is the most biologically productive and economically important large floodplain river system in the United States, and fish are one of the most important goods and services the river provides to humans. The river is also a nexus of freshwater fish diversity in North America, with approximately one-fourth of the North America freshwater fish native to the basin. Numerous species are listed as endangered, threatened, or of particular conservation concern. The Upper Mississippi River's paddlefish is one of the only two existing species of paddlefishes in the world, and it is home to three species of sturgeons, which is one of the most threatened family of freshwater fishes in the world. At the same time, the Upper Mississippi and Illinois Rivers are crucial links in the spread of invasive species across much of the United States and potentially into Canada.

Science tells us restoration is working, more is needed

UMRR's role, extending from its initial authorization, is to provide knowledge about the factors controlling the dynamics and interactions of important ecological components and how the ecosystem can be shifted to, or sustained in, a healthy and resilient state. Continued monitoring of the Upper Mississippi River ecosystem is required to detect long term changes in the river's ecosystem and to provide early detection of new influences to the system. Long term monitoring is the only method that can provide scientific answers regarding the causes and consequences of annual variability, long term changes in the structure and function of the river, and effects of gradual changes in the river ecosystems, as well as rare events.

Program partners are committed to continuing to acquire and use long term resource monitoring to enhance our understanding of the Upper Mississippi River ecosystem's health and resilience, as well as to predict future conditions in order to inform and enhance river restoration and management. UMRR is achieving this through the following strategies:

- Conducting research and analyses to gain critical, management-relevant information about the Upper Mississippi River ecosystem's process, function, structure, and composition as well as the dynamics and interactions among system components.
- Conducting research projects that improve our understanding of critical ecological conditions and processes by examining the effects of select habitat restoration projects on those conditions and processes.
- Utilizing other information, as needed, to augment UMRR's long term data sets for comprehensive analyses of the river's ecological health and resilience.
- Developing and improving ecological models and other decision support tools to enhance science capabilities and understandings, and improve understanding of the potential effects of future management actions.
- Effectively communicating to habitat project planners and managers how research findings may be applied to habitat projects.

UMRR's long term monitoring clearly indicates that there is a continuing need for habitat restoration on the Upper Mississippi River. Monitoring insights provide valuable information for identifying the most opportune areas to place projects so as to have the greatest benefit to fish and wildlife as well as ecosystem health. For example, since 2010, UMRR has found that:

- While other ecological factors (such as lower tributary discharges and sediment loads) are contributing to the increase in submersed aquatic vegetation occurring in lower Pool 8, UMRR's construction of 22 islands and deep-water habitat extending over 3,000 acres has significantly contributed to increasing the amount and quality of fish and wildlife habitat and the pool's overall ecological health.
- Long term resource monitoring provides the larger-scale, longer term context to assess the effectiveness of management actions. The effects of individual habitat projects are primarily local and difficult to detect at larger spatial scales. However, long term resource monitoring is constructed in a manner to allow for detecting cumulative resource improvements as the changes become evident at the pool scale.
- Habitat projects reduce the impacts of watershed influences while improving important ecological processes and functions. For example, monitoring of the Lake Onalaska habitat project has found that islands constructed at the site create "sheltered zones" immediately down river that increase habitat diversity and efficiently trap sediments. Continued monitoring of this project will allow for more accurately predict the future conditions of these sheltered zones behind constructed islands.

The Upper Mississippi River ecosystem retains some essential elements of its natural structure and function, such as flood pulses, that likely contribute to the resilience of healthier states. The river's longitudinal orientation provides a diversity of climatic and environmental conditions that facilitate the resilience of fish populations in the face of inter-annual variability and long term changes in climate. In addition, some portions of the river system maintain extensive lateral connections and hydrogeomorphic diversity across the floodplain, allowing fish species to persist through substantial seasonal and inter-annual fluctuations by seeking suitable habitat in various locations.

UMRR is Meeting the Challenge: Facilitating Active Involvement, Communicating Results, Collaborating, Exchanging Information

The Upper Mississippi River is a large, complex, and dynamic ecosystem that supports an equally complex set of human uses. It requires that a wide range of interests work collaboratively in order to ensure the sustainability of the river's many economic, ecological, and social values. The Upper Mississippi River Restoration (UMRR) Program is a product of the region's longstanding commitment to the principles of sustainability and multi-purpose management and the program works to preserve integral collaborative working relationships between agencies, organizations, and other stakeholders. UMRR benefits greatly from the information exchange that occurs among organizations and individuals along the river corridor and throughout the watershed.

The continued implementation of successful public engagement strategies regarding programmatic implementation is critical to ensuring that UMRR reflects local, regional, and national priorities. UMRR uses an array of communications and engagement tools to effectively inform and solicit input from river stakeholders. Many Upper Mississippi River stakeholders are extremely interested in UMRR and the program has benefitted from hearing their input and interests. These audiences include the river community residents, recreationists, tourists, local planning organizations, elected officials, nonprofit organizations, businesses, the navigation industry, representatives of economic sectors dependent on the river (e.g., water suppliers), and academic institutions, as well as state and federal agencies engaged in river and watershed issues.

Since the 2010 Report to Congress, UMRR has enhanced brand recognition by developing a new logo and tagline. The new logo serves as an attractive, compelling symbol for UMRR that resonates with many diverse audiences. The logo emphasizes the program's immediate focus on fish and wildlife while also showing that UMRR's restoration of habitat involves restoring an interconnected ecosystem. UMRR's new tagline, "leading – innovating – partnering," describes its long standing reputation as a leader and innovator in large river restoration and science as well as its partnership approach to program implementation and Upper Mississippi River ecosystem and watershed restoration.

UMRR is improving Upper Mississippi River ecosystem management

While UMRR is making significant contributions to improving the Upper Mississippi River ecosystem, it cannot, and should not, attempt to meet all of the river's needs. No one agency or program can solely manage this multi-use ecosystem successfully. Rather, the Upper Mississippi River requires thoughtful and meaningful coordination among numerous agencies and organizations with varying mandates and missions. There are a suite of related federal and state programs and projects aimed at improving the health of the river ecosystem, including for the purposes of threatened and endangered species recovery, managing wildlife, promoting recreational use, and improving water quality. In addition, nonprofit organizations promote conservation and restoration of the Upper Mississippi River ecosystem at various scales and for a variety of constituent interests. Local communities depend on a healthy river for water supply, economic development through tourism and recreation, and overall enhanced quality of life for citizens; and therefore, they advocate for large scale restoration improvements as well as localized habitat restoration projects and water quality initiatives.

UMRR recognizes the mutual benefits of working collaboratively with river and watershed stakeholders, particularly in leveraging resources to achieving a common purpose: a healthier and more resilient Upper Mississippi River ecosystem. UMRR engages the broad array of stakeholders in identifying and selecting restoration opportunities, seeks their input and expertise, and makes data and information readily available for their consumption. These efforts are incredibly useful in improving ecosystem management.

Much of this information exchange occurs through various Upper Mississippi River interagency collaborative forums. In these forums, individuals exchange information about UMRR implementation and other specific regional river management initiatives. On an ongoing basis, many UMRR partners are members of the Upper Mississippi River Conservation Committee, which has been a regional forum for the river states' natural resource/conservation agency professionals to discuss and promote ongoing cooperation in preserving and restoring the Upper Mississippi River since the 1940s. In addition, UMRR has established working relationships with the Mississippi River Cities and Towns Initiative, the Mississippi River Research Consortium, the Midwest Natural Resources Group, and the Upper Mississippi River Basin Association. These groups often promote UMRR's restoration efforts and utilize its scientific findings.

Figure 4-1 — UMRR's Role in The Nature Conservancy's Yangtze–Mississippi River EcoPartnership

UMRR plays a central role in The Nature Conservancy's Yangtze-Mississippi River Great River Partnership, facilitating learning about Asian carp in order to save the species in the Yangtze River while learning how to eradicate them on the Upper Mississippi River. There is limited scientific and baseline data on the status of the Yangtze River's fish species, but the knowledge is critically important as the fisheries populations decline. Upper Mississippi River scientists are providing technical expertise to Yangtze scientists utilizing UMRR's long term resource monitoring sampling protocols and research methods.

Accomplishments since 2010

Since 2010, UMRR's has shared information that has been used to inform the status and trends of the river ecosystem, water quality monitoring and evaluation, threatened and endangered species management, invasive species control, and watershed ecosystem management. A few key highlights include:

- Many key recreational fish species are not able to survive beyond a certain age due to poor habitat conditions in the Illinois Waterway, informing the state management needs.
- Fish monitoring data to make scientific conclusions regarding the effectiveness of Iowa Department of Natural Resources' mandatory catch-and-release regulation on a riverine largemouth bass population, showing that it had only a short-term positive effect. UMRR's long term data was necessary to determine that there was a natural population upswing occurring in accordance with natural variation.
- Long term monitoring protocols and information as a prototype for the Upper Mississippi River Basin Association's water quality monitoring strategies for the five river states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.
- Collaborative restoration planning with the Natural Resource Conservation Service on four habitat projects: Keithsburg, Swan Lake, Batchtown, and Boston Bay.

UMRR provides relevant, timely information to decision-makers

UMRR's non-federal partners have a strong interest in the program's success and therefore may engage in advocacy related to its resource needs and policy discussions. Non-federal program partners also engage state and local elected officials to communicate recent UMRR accomplishments and encourage continued support for the program. The Corps and implementing partners are responsive to elected officials' requests for information as well as for facility and river tours. These communication links have proven effective in ensuring that decision-makers are fully aware of UMRR's contributions to improving the river ecosystem's health and resilience. Boat tours are often the most compelling interactions, allowing elected officials to gain perspective of the river's complexity and an increased understanding of resource and science needs.

Federal and state agency staff that are directly involved in UMRR's implementation interact with leadership within their respective agencies and share relevant information regarding Upper Mississippi River ecosystem monitoring and restoration. This can relate to discussing staffing needs for Mississippi River programs and projects, including UMRR, or sharing information on high priority resource issues (e.g., Asian carp, nutrient loading). In addition, agency staff communicate the program's

importance to their respective state legislatures. For example, in March 2014, UMRR's Regional Program Manager and Iowa's primary UMRR Coordinating Committee representative highlighted the program's history, recent accomplishments, and planned restoration and science work to the Iowa House of Representatives' Natural Resource Committee. Also in 2014, the U.S. Fish and Wildlife Service held its annual meeting of regional refuge chiefs at the Upper Mississippi River National Fish and Wildlife Refuge that included a tour of the Brownsville habitat project site.

UMRR is collaborating for a more integrated watershed management

The Upper Mississippi River is a large, complex, and dynamic ecosystem that is heavily influenced by human activity throughout its watershed. Existing and new watershed stressors will continue to degrade the river's fish and wildlife habitat without continued management and rehabilitation designed to minimize the effects of stressors. While UMRR has substantially improved the river ecosystem's health and resilience, watershed influences and land use changes will continue to affect the system and affect its dynamics. Managing stressors originating within the watershed will require thoughtful and meaningful coordination among numerous agencies, organizations, and individuals to address these challenges at their source. This includes state and federal agencies with responsibilities related to natural resources, water quality, agriculture, transportation, and recreation; non-governmental organizations; academics; and the public.

UMRR is doing this by recognizing the need to consider habitat restoration within the larger watershed context. UMRR can both learn from other organizations and individuals about watershed issues and serve as a resource to watershed programs and projects that influence the Upper Mississippi River's ecological condition. UMRR biologists, scientists, and engineers have been recognized as regional technical experts, sharing their knowledge with many other ecosystem restoration programs and projects. While UMRR's resources remain directly focused on the main stem, those resources will be optimized only by working under the context of integrated watershed management.

A few key accomplishments since 2010 include:

- Technical expertise to inform the America's Watershed Initiative indicators of ecosystem health.
- Nutrient loading monitoring data at tributary confluences provided to federal and state agencies evaluating the efficacy of best management practices implemented in subwatershed agricultural lands.
- UMRR's models were used by the National Oceanic and Atmospheric Administration linking climate, precipitation, and runoff to flood inundation.
- Technical expertise to nonprofit organizations interested in floodplain connectivity restoration for migratory bird populations.

UMRR is improving large river restoration nationally and internationally

UMRR often exchanges information with, and serves as a model for, other large river programs both nationally and internationally. Many benefits result from these interactions, including identifying cost efficiencies in program implementation and gaining insights not available elsewhere. UMRR is often asked to provide expertise in assessing status and trends, share new developments in focused research, and offer recommendations regarding program structure and modeling protocols. UMRR's restoration and science are enhanced through such collaboration. The program's habitat planners integrate lessons learned from restoration efforts on other large river aquatic ecosystems into UMRR restoration, improving the cost efficiency and ecological outcomes of habitat projects. UMRR's scientists incorporate information from other relevant data sources in their restoration efforts. Corps District staff have served as experts in Agency Technical Review processes for other Districts.

UMRR has continued to serve as a leader in restoration, monitoring, and science nationally and internationally since the 2010 UMRR Report to Congress. The use of UMRR's long term resource monitoring protocols by other programs and projects is a prime example of this leadership. These interactions allow UMRR and other regional, national, and international river scientists to compare the status and trends of ecological indicators in different large aquatic ecosystems. To get a better perspective on the actual use of the program's monitoring protocols and processes, the Illinois River Biological Field Station distributed a 2013 survey to the American Fisheries Society and Upper Mississippi River Conservation Committee listserves to seek information about who is using the UMRR's fish monitoring protocols and for what purposes. The results clearly indicate that that UMRR's fish monitoring protocols are well known outside of the program and have been used many times in other monitoring efforts. The Illinois River Biological Field Station plans to do more formal research to better quantify external use of the protocols.

Example national and international exchanges since 2010 include the following:

- 2010 international workshop on river management in India.

- 2011 National Conference in Ecosystem Restoration in Baltimore, Maryland.
- 2013, 2014, and 2015 American Society of Fisheries meetings in Little Rock, Arkansas, Quebec City, Quebec, and Portland, Oregon, respectively.
- 2014 Joint Statistical Meeting in Boston, Massachusetts.
- 2014 U.S. Geological Survey Large River Monitoring Network meeting in Portland, Oregon.
- 2015 International Society for River Science's Biennial Symposium in La Crosse, Wisconsin.
- 2015 American Fisheries Society's Mississippi and Yangtze River Basins Symposium in Wuhan, Hubei, China.

In addition, UMRR collaborates with restoration programs and projects in the Lower Mississippi River for a more holistic view of ecological needs within the larger watershed.

UMRR is engaging the public

Public outreach and interactive dialogue regarding UMRR's implementation have always been a programmatic focus. UMRR uses an array of communications strategies to raise the Program's visibility and facilitate ongoing dialogue with the public in meaningful ways; partners do this collaboratively and individually as part of their respective agency's external engagements. Communications strategies are implemented through a wide range of media and venues to effectively connect with various targeted audiences. This includes traditional print media, site visits and tours, television, radio, internet, museum exhibits, school events, river events, social medial, and public meetings, to name a few.

Since 2010, UMRR has engaged the public in many ways including:

- Engaging local elected officials, media, and public in celebrating several of UMRR's milestones, including its 25th and 30th anniversaries, 100,000-acres of benefited fish and wildlife habitat, groundbreakings and dedications of individual habitat projects, as well as naming contests for newly-constructed islands.
- Providing tours of habitat project sites, hosting public meetings, and soliciting input on program priorities.
- Telling UMRR's story to the public through a variety of means, including radio, local television news, newspaper and magazine articles, and social media sites such as Facebook, Twitter, and Instagram. In particular, UMRR is frequently featured in the Corps's Our Mississippi newsletter.
- Employing a successful media campaign at the Bassmasters's tournaments in the La Crosse area, working with tournament staff and the La Crosse (Wisconsin) Chamber of Commerce. Posters, banners, and the Fish La Crosse magazine publicized UMRR's efforts in the tournament area and included a QR code to helpful maps and relevant fish and vegetation information. In addition, ESPN aired a segment featuring the 2013 Bassmasters's tournament in La Crosse that discussed UMRR's restoration benefits in the area.
- Providing educational resources to local K-12 schools, community colleges, and universities through tours of project sites and government facilities, dissection activities of various riverine species, and materials for teachers to use in the classrooms. In 2011, UMRR's implementing partners hosted a teachers' workshop that featured UMRR.

Implementing partners showcase UMRR in their daily interactions with the public. A more notable example since 2010 includes U.S. Fish and Wildlife Service's "Ranger Dusty" YouTube video illustrating the creation of an UMRR island (Harper's Slough). The video was shared on Facebook and received tremendously positive feedback.

Engagement and Outreach: UMRR's Plan for The Next Six Years

- Over the next six years, UMRR will pursue engagement and outreach in a manner consistent with the 2015-2025 UMRR Strategic Plan, which calls for:
- Ensuring rich collaboration, with key organizations and individuals in the Upper Mississippi River watershed, in advancing complimentary visions, missions, and goals.
- Working with key watershed programs and projects to jointly develop and communicate common messages about the restoration and knowledge needs of the Upper Mississippi River.
- Seeking knowledge from other organizations and individuals for the purposes of being aware of activities that may influence UMRR's work and enhancing programmatic efforts.
- Directly engage relevant organizations or individuals in implementing UMRR's efforts, as appropriate.

In particular, UMRR is developing a communications strategy that targets external outreach on the most pressing challenges to sustaining a healthy Upper Mississippi River ecosystem; this includes a toolbox of communications materials to assist partners in telling the story of UMRR's accomplishments and its planned activities. For example, this might include targeting outreach on issues that will reduce sedimentation from major tributary sources.

Project Partnership Agreements

The UMRR continues to implement habitat projects throughout the Upper Mississippi River System that improve the ecosystem's health and resilience. The nation and the program's non-federal project sponsors gain significant ecological and economic benefits from these habitat projects and are committed to continue advancing future habitat projects. However, some of the requirements of law that stipulate the requirements of local cooperation are sometimes perceived by sponsors as too burdensome. These requirements of local cooperation are also applicable to other Corps' programs and projects. Addressing changes to these statutory requirements is beyond the scope of the UMRR Report.

UMRR's authorizing language requires that a non-federal sponsor of habitat projects provide 35 percent of construction costs, including planning and design, unless a habitat project meets one of the following provisions: 1) is located on lands managed as a national wildlife refuge, 2) is intended to benefit a federally listed threatened or endangered species, or 3) provides a national benefit – e.g., addresses species identified in a treaty. To date, the Corps has only approved full federal funding for projects located on refuge lands. In addition, as modified by Section 107(b) of the Water Resources Development Act of 1992, the authorization provides that operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) is the responsibility of the governmental entity that manages the land on which the project is located.

According to UMRR's non-federal partners, there are two primary areas of concern. One is the statutory requirement that the non-federal sponsor must agree to hold and save the United States free from damages due to the construction or operation and maintenance of the project, except for damages due to the fault or negligence of the United States or its contractors. Some of the UMRR state partners assert that the indemnification requirement conflicts with state constitutions or statutes by committing them to agree to a potential payment of damages that is indefinite as to amount, purpose, and date. The second concern expressed by some partners is the statutory requirement for OMRR&R. Because a project partnership agreement is signed prior to completion of construction, the non-federal sponsors assert that they are assuming long term responsibility for OMRR&R of a project without having a complete understanding of that obligation.

Section 103(j)(1) of the Water Resources Development Act of 1986 requires that prior to initiation of a water resources development project, a non-federal interest must enter into a binding agreement to agree to hold and save the United States free from damages due to the construction or operation and maintenance of the project, except for damages due to the fault or negligence of the project, and to pay 100 percent of the OMRR&R cost of the project. These statutory requirements are reflected in project partnership agreements, which are binding agreements required prior to initiation of water resources development projects. Legislative action is required to change these statutory requirements, which serve important interests. Section 1161 of the recently enacted Water Infrastructure Investment for the Nation Act of 2016 provides additional direction regarding the development of feasibility reports for ecosystem restoration projects and non-federal responsibilities for operation and maintenance of nonstructural and nonmechanical components of such projects.

Many portions of the river in serious need of restoration have no federal lands. Habitat projects in these areas will require a non-federal sponsor to cost-share construction and assume full responsibility for OMRR&R. The inclusion of nonprofit entities with the consent of the affected local government as eligible cost-share sponsors on habitat projects, as provided in the Water Resources Development Act of 2007, could substantially increase the program's restoration opportunities. This is particularly true in the southern river reaches where there is a considerably higher proportion of private land and therefore fewer options for U.S. Fish and Wildlife Service and the states to sponsor projects.

CONCLUSIONS AND RECOMMENDATIONS

The Upper Mississippi River is a nationally treasured, dynamic floodplain-river ecosystem that is rich in biodiversity. The river provides substantial ecological and economic value as a tourist and recreational destination, as a safe and reliable drinking water source, as a commercial and municipal water source, and as an important commercial transportation corridor that directly connects our states to the world market. Recognizing the tremendous importance of the river to the Midwest and Nation, Congress uniquely declared that the river is "a nationally significant ecosystem and a nationally significant commercial navigation system" and committed to balanced management of the river by authorizing the Upper Mississippi River Restoration (UMRR) program. Congress reinforced this need for a balanced management approach into the foreseeable future when in 1999 it reauthorized UMRR as a continuing program.

UMRR was born from a compromise between commercial navigation and ecosystem interests in reaction to a lawsuit against the construction of a second, 1,200-foot chamber at Mel Price lock and dam. The lawsuit pushed for an evaluation of the project's cumulative impacts on the river's other multiple uses. In reaction to this event, Upper Mississippi River interests made a deliberate choice to proceed under a community of collaboration among the river's multiple uses, recognizing that sustaining one use will help sustain the others. The 1981 Master Plan found that the Upper Mississippi River provides a diverse array of opportunities and experiences and recognized the viability of integrated, multi-use management. Congress agreed with the Master Plan's recommendation that the UMRR is needed to ensure the sustainability of the river's ecosystem through habitat rehabilitation and enhancement projects and long term resource monitoring. Congress both authorized UMRR and the construction of the Mel Price lock expansion in the same legislative provision, advancing the federal interest in integrated river management under a collaborative environment. Throughout its implementation, UMRR has remained true to Congress's intention by improving important fish and wildlife habitat and the river's overall ecological condition, employing long term resource monitoring and scientific investigations to better understand the river ecosystem and inform restoration and management of the river, and working collaboratively with other river interests to ensure the river supports the many multiple human and biota uses. This collaboration is unique to the Nation, but is essential to advancing the Corps' many missions for water resource management.

As UMRR recognizes its 30th year of service to the Nation, this Report to Congress provides a timely opportunity to: reflect on the historical evolution of its implementation strategies and capabilities; chronicle its achievements in restoring and better understanding the Upper Mississippi River ecosystem; and set a clear direction of strategic implementation over the next decade, given the ongoing challenges to the ecosystem from land use practices, flood risk reduction measures, climate change, multiple invasive species, and the construction and ongoing operation of the nine-foot navigation channel.

This report reflects UMRR's evaluation of its accomplishments since its last report to Congress in 2010 and within a broader context of its progress since its inception in 1986. The conclusions reflect key lessons learned and observations regarding UMRR's strengths and accomplishments. The recommendations embody the steps necessary to maintain UMRR as a fully-functional program capable of delivering the same efficiency and effectiveness that have been its hallmarks since its inception.

Conclusions

Overall Program

- UMRR substantially improves the ecological health, resilience, and understanding of the Upper Mississippi River ecosystem. Through 55 habitat projects, UMRR has increased and enhanced important fish and wildlife habitat, improved the river's floodplain structure and function, and counteracted factors degrading the river's ecological health. Constructing nearly 50 percent of all ecosystem restoration acres reported by the Corps nationally since 2005, UMRR continuously demonstrates its ability to effectively and efficiently execute planning, design, and construction of habitat projects.
- UMRR effectively utilizes federal appropriations by advancing its authorized purposes and improving the Upper Mississippi River's ecological condition and knowledge. An assessment of future capabilities indicates that UMRR has the capability to effectively utilize appropriations levels at the fully authorized annual amount of $33.17 million. UMRR has routinely executed more than 98 percent of its appropriated funds, including when funding levels are near or at its full annual authorized amount. The relatively consistent flow of funding allows UMRR to manage risk and uncertainty to achieve a high level of planning and construction capability and execute an aggressive schedule. The 2015-2025 UMRR Strategic Plan provides a clear framework for decision-making about resource allocations, as well as ensuring that UMRR remains fully accountable and transparent regarding federal investment.
- UMRR supports high-quality science, technology, engineering, and mathematical (STEM)-related jobs throughout the Upper Mississippi River region. This includes an average of 333 jobs per $10 million spent on habitat project construction and

more than 80 jobs annually for engineering, long term resource monitoring, and scientific investigations.

- UMRR is a pioneer in large river floodplain ecosystem restoration. When UMRR began, large river floodplain ecosystem restoration was essentially non-existent, making its first habitat project designs true experiments. With ongoing emphasis on learning and innovation, UMRR continually refines these techniques with data, modeling, and sophisticated engineering to create cost-effective and sustainable solutions to rehabilitate fish and wildlife habitat and restore complex riverine functions and processes. UMRR's standardized, multi-component and multi-habitat long term resource monitoring offers an innovative approach to assessing the overall river ecosystem under a wide range of conditions that has proven successful.

- UMRR generates critical knowledge about the Upper Mississippi River's ecological health and resilience, providing a solid foundation upon which to base management actions and policy. UMRR's scientific expertise, breadth of information, monitoring protocols, analytical capabilities, and data management and dissemination infrastructure create extensive possibilities to learn about the river's natural functions and processes, human influences, and opportunities to best address critical restoration needs. Continued long term monitoring will be imperative to understanding and managing ecosystem resilience to ongoing and future stressors.

- UMRR is a highly-integrated program, effectively combining ecosystem restoration with scientific monitoring and research to improve the Upper Mississippi River's ecological health and resilience. This involves research and monitoring informing restoration and management efforts and ensuring that restoration efforts are readily available for scientific use as a basis for learning. UMRR informs river management through integrated environmental monitoring, research, and modeling, as well as data management and dissemination.

- UMRR is a dedicated partner in improving the Upper Mississippi River's ecosystem in an integrated, multi-purpose collaborative management context. The Upper Mississippi River is a large, complex, and dynamic ecosystem that supports a uniquely complex set of human uses. A wide range of interests work collaboratively to ensure the sustainability of the river's many economic, ecosystem, and social values. While UMRR's resources remain directly focused on restoring and better understanding the river's main stem ecological health, those resources will be optimized only by working under the context of integrated watershed management.

The Upper Mississippi River provides substantial ecological and economic value as a tourist and recreational destination, as a safe and reliable drinking water source, as a commercial and municipal water source, and as an important commercial transportation corridor that directly connects our states to the world markets.

- UMRR is rooted in a strong, collaborative interagency partnership. The Upper Mississippi River benefits from a deeply-rooted history of interagency and interdisciplinary partnership that transcends traditional geopolitical boundaries and is responsible for UMRR's primary concept, initial authorization and subsequent permanent continuing authority, and maturation into a well-respected, effective restoration and science program. The ongoing commitment from all partners is fundamental to UMRR's longstanding success. This includes the involvement of nonprofits in programmatic implementation and public outreach.

- UMRR is a premier large river restoration and science program. UMRR is recognized nationally and internationally as a proven, highly-successful multi-agency collaborative restoration and science program that serves as a model for other large river programs, both nationally and internationally. Examples of this include the Corps' Rio Grande Environmental Management Program and China's long term resource monitoring of the Yangtze River.

UMRR is a pioneer in large river floodplain ecosystem restoration. When UMRR began, large river floodplain ecosystem restoration was essentially non-existing, making the program's first habitat project designs true experiments. UMRR is now a premier program, recognized nationally and internationally as a proven, highly successful multi-agency collaborative restoration and science program.

Improving the Ecosystem

- UMRR has a proven record of success in building habitat projects that are innovative, durable, and effective in advancing systemic ecological goals and project objectives. UMRR develops feasibility reports for each individual habitat project that ensures accountability to the Corps' overall policy direction and to demonstrate the intended cause-and-effect relationship of providing ecological benefits. Corps Headquarters has recognized the innovative designs and features by awarding the 2014 Chief of Engineers Environmental Award to the St. Louis District for the Batchtown habitat project.
- UMRR strives to utilize the best available knowledge to define and pursue restoration opportunities, evaluating the use of new technology, research findings, and other information as they emerge. Since the 2010 Report to Congress, UMRR has invested strategically in enhancing existing and new analytical tools. Scientific investigations have yielded considerable knowledge about the river's complex and dynamic ecosystem. Individually and collectively, these knowledge gains are invaluable in targeting restoration needs and placement, designing projects to improve site-specific habitat needs and broader ecological processes, and evaluating success in implementing restoration techniques and approaches.
- UMRR continually improves its restoration techniques through adaptive management. UMRR enhances restoration effectiveness and efficiency, learning from its long term systemic monitoring, project-specific monitoring, and focused research. Since the 2010 Report to Congress, UMRR published the 2012 Environmental Design Handbook to communicate insights gained regarding biological responses to project designs, new information about innovative restoration tools, and connections among system, floodplain reach, and site-specific ecological objectives, project criteria, and management objectives. The 2015-2025 UMRR Strategic Plan includes more deliberate and explicit approaches to implementing adaptive management to:
  - Answer broad questions about the Upper Mississippi River ecosystem and its management, beyond the project-level.
  - Identify restoration needs that would be best addressed through "new" restoration techniques.
  - Enhance communication and understanding related to project performance and uncertainties in ecosystem management.
  - Learn from past and current efforts to inform future restoration.
  - Improve the overall effectiveness and efficiency of particular restoration techniques.
  - Inform long term Upper Mississippi River Restoration ecosystem management.
  - Guide and optimize UMRR's investment in habitat restoration – e.g., determine at what point there are diminishing returns from investing in certain areas.

Advancing Knowledge

- UMRR evaluates the fundamental health and resilience of the Upper Mississippi River's ecosystem with scientific certainty and provides early detection and assesses impacts of in-river and watershed influences including invasive species. As the database builds and its diversity of monitored ecological conditions expands, scientific certainty increases regarding the causes and consequences of annual variability, long term changes in the structure and function of the river, and effects of gradual changes in the river ecosystems, as well as rare events, which can only be detected with long term data.
- UMRR's scientific investigations provide critical insights and understanding regarding a range of key ecological questions. Through a combination of monitoring, additional research, and modeling, UMRR informs management and restoration of the Upper Mississippi River ecosystem by answering questions related to existing and future conditions, ecological patterns and interactions, factors controlling dynamics, fish and wildlife habitat needs, and biological responses to restoration techniques and approaches.
- UMRR scientific information is easily useable and publically accessible. The amount of information that UMRR has been able to collect, learn, and capture regarding the Upper Mississippi River ecosystem is copious. To make sure that the information is relevant and utilized to its fullest extent, UMRR has created many models, analytical tools, and interactive web-based browsers to make the datasets useful to a variety of audiences including teachers, nonprofit organizations, and the general public.
- The 2015-2025 UMRR Strategic Plan makes a new commitment to defining and applying the concepts of ecosystem resilience to the program's restoration and science efforts. In the next few years, UMRR's scientists and restoration practitioners will team up together to:
  - Develop a clear conceptual understanding and definition of ecological resilience related to the Upper Mississippi River ecosystem.
  - Use conceptual models to develop indicators of resilience, define the current resilience of the river's various geomorphic reaches, and identify the factors contributing to resilience.
  - Evaluate the potential effects of UMRR's habitat projects on resilience.
  - Inform and improve UMRR's future restoration activities to better manage resilience.

Engaging and Collaborating

- UMRR builds a united effort with other, related in-river and watershed initiatives to more robustly and coherently work towards a healthier and more resilient Upper Mississippi River ecosystem. Enhanced coordination with targeted in-river and watershed efforts leverages resources and talents to improve overall knowledge and ecological conditions of the river system.
- UMRR remains accountable and transparent to Congress, the Administration, and general public by ensuring it continues to communicate relevant information in a timely manner. UMRR supplies key messages regarding plans, progress, and accomplishments of its various programmatic efforts to elected officials, agency leadership, nonprofits, and the interested public in various ways. This builds important relationships with river constituencies who benefit directly and indirectly from UMRR implementation.
- UMRR learns and shares information with other similar large river restoration and monitoring efforts. UMRR continues to serve as a leader in restoration, monitoring, and science, nationally and internationally, since the 2010 Report to Congress, and at the same time, learns from other large river programs in various exchanges. Many benefits result from these interactions, including cost efficiencies in UMRR implementation and insights not otherwise available.

Deeply-Rooted, Interagency Partnership

- UMRR has a strong foundation of interagency partnership that is vital to UMRR's success. As prescribed in its authorization, a suite of federal and state agencies are directly responsible for UMRR's implementation and have worked together to build and refine the program since its inception. UMRR is the only available systemic program for constructing habitat improvements in the river's main stem, creating a common unifying collaboration for which agencies continue to come together and contribute in-kind and cost-share resources and expertise. Since the 2010 Report to Congress, the agencies have worked to continuously improve UMRR's implementation, transparency, accountability, and organizing and maintaining institutional knowledge.

Recommendations

- The Corps, implementing partners, and interested public work collaboratively to implement the goals and objectives of the 2015-2025 UMRR Strategic Plan in an effort to help drive the Upper Mississippi River ecosystem toward a healthier and more resilient state that supports the river's multiple uses.
- The steps necessary should be taken to ensure that UMRR continues to function as an effective and efficient program. UMRR takes a proactive approach to ensure an adequate flow of projects in the planning, design, and construction phase that has been instrumental to UMRR's ability to execute annual appropriations consistently at 98 percent. Focusing implementation on achieving the 2015-2025 Strategic Plan vision for the river in a healthier and more resilient state, UMRR should pursue the following measures:

UMRR's standardized, multi-component and multi-habitat long term resource monitoring offers an innovative approach to assessing the overall river ecosystem under a wide range of conditions that has proven successful at generating critical knowledge about the river's ecological health and resilience. This information provides a solid foundation upon which to base management actions and policy.

- Advance the 2015-2025 UMRR Strategic and Operational Plans's guidance for programmatic implementation regarding the four goals for 1) enhancing restoration, 2) advancing knowledge, 3) engaging and collaborating with other key individuals and organizations, and 4) facilitating a strong, unified interagency partnership.
- Define ecological resilience concepts as they apply to the Upper Mississippi River ecosystem, including developing quantifiable indicators of ecosystem resilience to measure the status and trends of various resilience attributes.
- Renew the UMRR Habitat Needs Assessment that incorporates the best available knowledge and ecological resilience concepts.
- Identify a suite of habitat projects that improve the Upper Mississippi River ecosystem's health and resilience, reflecting insights gained from the renewed Habitat Needs Assessment.
- Formulate and construct the identified suite of habitat projects.
- Evaluate and learn from constructed habitat projects in an effort to inform future restoration and management of the Upper Mississippi River ecosystem.
- Evaluate UMRR's progress in advancing the 2015-2025 UMRR Strategic Plan and continue to learn and improve as a program and in implementing restoration and science techniques.

- UMRR should remain fully functional and continue to serve ecosystem restoration and resource monitoring needs on the Upper Mississippi River, unless and until Congress directs a transition to the Navigation and Ecosystem Sustainability Program. UMRR provides significant benefits to the Upper Mississippi River and nation by delivering high-quality habitat restoration and science projects, products, and services, and is fully capability of executing an effective, efficient program at its full authorized level of funding (i.e., $33.17 million). Specifically, UMRR should continue to:
- Address key ecological needs at various spatial scales through habitat projects that reflect best available knowledge and advance UMRR's vision for a healthier and more resilient Upper Mississippi River ecosystem.
- Apply adaptive management principles to address risk and uncertainty, and continually enhance restoration and knowledge of the Upper Mississippi River ecosystem.
- Assess, and detect changes in, the fundamental health and resilience of the Upper Mississippi River ecosystem by continuing to monitor and evaluate its key ecological components of aquatic vegetation, bathymetry, fish, land use/land cover, and water quality.

- Provide critical insights and understanding regarding a range of key ecological questions through a combination of monitoring, additional research, and modeling in order to inform and improve management and restoration of the Upper Mississippi River ecosystem.
- Work with key organizations and individuals in the Upper Mississippi River watershed; provide information to organizations and individuals whose actions and decisions affect the Upper Mississippi River ecosystem; and exchange knowledge with other organizations and individuals nationally and internationally.
- Promote a common vision and sense of purpose, transparency, and accountability among UMRR's implementing partner agencies.
- Implement UMRR as outlined in the adopted Joint Charter for the UMRR Coordinating Committee, Analysis Team, and Habitat Planning and Sequencing Framework Teams, as well as the FY 2015-2025 UMRR Strategic Plan.

• The Corps and non-federal habitat project sponsors should continue to work together to further inform issues related to execution of project partnership agreements.

Upper
Mississippi River
Basin Association
ILLINOIS, IOWA, MINNESOTA, MISSOURI, WISCONSIN

October 25, 2016

Colonel Craig Baumgartner
District Commander
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Baumgartner:

The Upper Mississippi River Basin Association (UMRBA) is pleased to endorse the Upper Mississippi River Restoration Program's (UMRR's) 2016 Report to Congress and to offer the states' enthusiastic support for UMRR as a whole. The Upper Mississippi River ecosystem supports a highly biodiverse suite of microorganisms, mussels, amphibians, reptiles, mammals, and birds, and provides the largest contiguous area of freshwater wildlife habitat in the central United States. The river is integral to support the many human uses that require a healthy ecosystem. The river serves as the water supply source for municipalities, manufacturing, and agriculture, and it supports the $24.6 billion tourism and recreation industry. Recognizing the river's unique importance, Congress has declared the river to be a "nationally significant ecosystem and a nationally significant navigation system."

The states are especially satisfied with the program's many accomplishments in the past six years and support the partnership's newly developed strategic vision for the Upper Mississippi River ecosystem. The vision is a heathier ecosystem that is resilient in the face of increasing stressors. Since its inception, UMRR has improved the ecosystem by implementing many innovative, sound projects that reestablish important habitat complexes, bringing back the diverse suite of biota important to functioning ecosystems. UMRR's consistent emphasis on learning, science, innovation, and collaboration produce projects that work effectively with the river's natural, high-energy variability. Over its lifetime and in the past six years, UMRR has advanced the science and understanding of the river's fundamental ecological characteristics and the effects that stressors are having on the integrity of the ecosystem. The long term monitoring dataset is one of the most extensive on the world.

The states are confident that UMRR is well-positioned to continue its tremendous contributions to the Upper Mississippi River ecosystem. The states are confident that the Navigation and Ecosystem Sustainability Program (NESP) will maintain UMRR's strategically designed partnership infrastructure. Please be assured that the states will continue to stress the importance of maintaining UMRR as a robust, fully functional program until such time as NESP is funded at a level resulting in a net increase of restoration activities and that a careful transition occur that maintains the strategically-designed partnership infrastructure.

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The states applaud the Corps' ongoing commitment to collaboration in implementing UMRR. The states believe that a significant factor in UMRR's success is due to the input of the many interdisciplinary experts from the federal and state agencies as well as nonprofits and local interest groups.

The states remain committed to serving as active partners in UMRR, including as cost share sponsors of its habitat projects. However, the states and nonprofit organizations face challenges in executing project partnership agreements (PPAs) with the Corps, particularly the provisions related to liability and operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) obligations. The states are seeking the following modifications to the current PPA model in order to allow them to cost share on UMRR habitat projects:

1. Modify the hold and save clause to a more equitable, shared approach to liability that does not conflict with applicable state constitutions and laws.
2. Provide greater specificity regarding OMRR&R costs and requirements in the PPAs so that non-federal sponsors can better estimate long term obligations, including:
    a. A 50-year limit to OMRR&R obligations or a determination that the project shows that it is meeting the desired ecological benefits.
    b. Language providing that unanticipated costs are subject to i) the state's future appropriations for the project or ii) the nonprofit's availability of funds for the project.
    c. Adaptive management processes to address risk and uncertainty regarding project outcomes and the need and ability to perform OMRR&R obligations depending on whether the project features perform as intended.

In closing, I would like to reiterate UMRBA's support for the 2016 UMRR Report to Congress and its recommendations. The states sincerely appreciate the Corps' commitment to collaboration and a shared approach to multi-purpose, integrated management of the Upper Mississippi River System.

Sincerely,

Robert Stout
UMRBA Chair

Illinois Department of
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One Natural Resources Way Springfield, Illinois 62702-1271
www.dnr.illinois.gov

Bruce Rauner, Governor
Wayne A. Rosenthal, Director

October 17, 2016

Colonel Craig Baumgartner
U.S. Army Corps of Engineers District Commander
Rock Island District
P.O. Box 2004
Rock Island, Illinois 61204

Re: Upper Mississippi River Restoration (UMRR)-2016 Report to Congress

Dear Colonel Baumgartner:

The Illinois Department of Natural Resources (ILDNR) supports the Upper Mississippi River Restoration (UMRR)-2016 Report to Congress (RTC). Illinois has within its borders 337 miles of the Illinois River and nearly 600 miles of the Mississippi River, our shared border with Iowa and Missouri. The RTC highlights the strong partnership that exists among the five states of the Upper Mississippi River basin, the U.S. Army Corps of Engineers, the U.S. Geological Survey, the U.S. Fish and Wildlife Service and multiple non-government organizations. The UMRR program has become the model for ecosystem monitoring and restoration worldwide and has restored more than 102,000 acres of habitat for fish and wildlife.

The 2016 RTC features the accomplishments of the UMRR program and specifically highlights the development of the 2015-2025 strategic plan, which includes a commitment to evaluate the Upper Mississippi River's ecological resilience to both ongoing and emerging stressors. The river continues to be stressed by navigation structures, invasive species, and hydrological changes due to climate change and land use within the watershed. Continued long term monitoring will be essential to manage the ecosystem responses to these stressors and guide future restoration planning efforts.

The ILDNR has much the same concerns with the current language of the Project Partnership Agreements (PPA) that challenges the other four upper Mississippi River member states and NGO's. Currently, given that language, Illinois will not be able to participate in future restoration projects. This language is a deterrent to the partnership that is central to the UMRR program's 30 years of success. Progress needs to be made in modifying that language, to the extent possible that will make it acceptable to Illinois and the UMRR member states.

Thank you for the opportunity to comment on the Report to Congress.

Sincerely,

Dan Stephenson
Chief of Fisheries

Fields of Opportunities

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR
KIM REYNOLDS, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
CHUCK GIPP, DIRECTOR

November 1, 2016

Colonel Craig Baumgartner
District Commander
U.S. Army Corps of Engineers
Rock Island District
P.O. Box 2004
Rock Island, Illinois 61204

Dear Colonel Baumgartner:

The Iowa Department of Natural Resources would like to take this opportunity to support the Upper Mississippi River Restoration (UMRR) Program and endorse the 2016 Report to Congress. The partnership aspect and collaborative process truly makes the UMRR a great program. Iowa DNR is enthusiastic to be a part of the process that provides input to the UMRR and the Report to Congress.

Since the 2010 Report to Congress, the UMRR has made great strides for the ecosystem of the Upper Mississippi River and has contributed significantly to ecosystem restoration and the scientific learning on the Upper Mississippi River. Iowans have directly benefited from nearly 40,000 acres of habitat improved through UMRR Habitat Rehabilitation and Enhancement Projects since its inception. Natural resource restorations the UMRR provides not only improve the quality of life for our residents but also benefits the economies of the communities that live long this great river. Through the use of adaptive management and lessons learned, the program has been innovative and incorporated these lessons into the planning of current and future habitat restoration projects.

The UMRR Long Term Resource Monitoring (UMRR LTRM) element provides vital scientific monitoring and analysis needed to improve habitat restoration projects and allows the partners to make informed Mississippi River management and policy decisions. Iowa is very proud of our UMRR LTRM element station and agrees with information sharing among the six UMRR LTRM element stations. The State of Iowa is dedicated to continuing the monitoring and building the scientific information needed to monitor the status, trends and management of the Upper Mississippi River.

The UMRR continues to be the major habitat restoration program and long term scientific learning tool for the Upper Mississippi River. The UMRR has only been fully funded once in its 30 year history, and delays in habitat restoration projects are increasing. Full funding is necessary to decrease these delays and make the necessary improvements to the Upper Mississippi River ecosystem. The State of Iowa staunchly supports the full funding and continuation of this program.

This Report to Congress outlines the vast accomplishments of the UMRR and the Iowa Department of Natural Resources agrees that UMRR provides significant benefits to the Upper Mississippi River System (UMRS) and the nation. UMRR should remain fully functional and continue to provide the ecosystem restoration and monitoring needs on the UMRS.

110 LAKE DARLING ROAD / BRIGHTON, IA 52540
PHONE 319-694-2430 randy.schultz@dnr.iowa.gov www.iowadnr.gov

The Iowa Department of Natural Resources is pleased to support the 2016 Report to Congress and applauds the Corps of Engineers for its leadership and cooperation with program partners on this important program.

Sincerely,

Randall Schultz, Supervisor, Mississippi River Resource Management
Iowa Department of Natural Resources
110 Lake Darling Road
Brighton, IA 52540

110 LAKE DARLING ROAD / BRIGHTON, IA 52540
PHONE 319-694-2430 randy.schultz@dnr.iowa.gov www.iowadnr.gov

Minnesota Department of Natural Resources
500 Lafayette Road · Saint Paul, Minnesota · 55155-4037
Office of the Commissioner
651-259-5555

MNDNR

August 28, 2016

Colonel Craig Baumgartner
U.S. Army Corps of Engineers District Commander
Rock Island District
P.O. Box 2004
Rock Island, Illinois 61204

Re: Upper Mississippi River Restoration (UMRR) – 2016 Report to Congress

Dear Colonel Baumgartner:

The Minnesota Department of Natural Resources (MNDNR) supports the Upper Mississippi River Restoration (UMRR) – 2016 Report to Congress (RTC). As home to the Mississippi River's headwaters and steward of more Mississippi River miles than any other state, Minnesota has a deep and abiding commitment to balanced, sustainable management of the river. The RTC underscores the continued strong partnership that exists among the five states of the Upper Mississippi River basin, the U.S. Army Corps of Engineers, the U.S. Geological Survey, the U.S. Fish and Wildlife Service and multiple non-government organizations. The MNDNR is proud to be a vital partner to the UMRR program. To date, the UMRR program has restored more than 102,000 acres of critical habitat for fish and wildlife and has some of the most comprehensive long term resource monitoring data in the world.

The 2016 RTC features the vast accomplishments of the UMRR program and specifically highlights the development of the 2015-2025 strategic plan, which includes a commitment to evaluate the UMR's ecological resilience to both ongoing and emerging stressors. The river continues to be stressed by navigation structures, invasive species, and hydrological changes due to climate change and land use within the watershed. Continued long term monitoring will be essential to manage the ecosystem responses to these stressors and guide future restoration planning efforts.

I want to emphasize the MNDNR's support for a key recommendation of the RTC that addresses the challenges associated with Project Partnership Agreements (PPA). Resolving the barriers the current PPA language poses to non-federal sponsors would allow states and non-government organizations to participate more fully in restoration projects and further strengthen the vibrant partnership that is central to the UMRR program's 30 years of success.

The MNDNR is pleased to support the 2016 RTC, and would like to thank the U.S. Corps of Engineers for the opportunity to comment on this important program.

Sincerely,

Barb Naramore
Assistant Commissioner

c: Tom Landwehr, Commissioner
Luke Skinner, Director, Ecological and Water Resources Division
Jim Leach, Director, Fish and Wildlife Division

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters

2901 West Truman Boulevard, P.O. Box 180, Jefferson City, Missouri 65102-0180

Telephone: 573-751-4115 ▲ www.MissouriConservation.org

SARA PARKER PAULEY, Director

November 1, 2016

Colonel Craig Baumgartner, District Commander
U.S. Army Corps of Engineers, Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204

Dear Colonel Baumgartner:

The Missouri Department of Conservation (Department) is pleased to endorse the nationally and internationally recognized Upper Mississippi River Restoration (UMRR) program's 2016 Report to Congress and offer our support for the report's recommendations. As Missouri's representative on the UMRR Coordinating Committee, the Department is an active participant in implementing the program and participated in the development of the report. We believe the report effectively describes program accomplishments and it provides recommendations that are important in achieving continued program success.

The Upper Mississippi River Restoration program is very important to the Department. This program is responsible for identifying and completing on-the-ground habitat restoration projects that enhance fish and wildlife resources in the Upper Mississippi River System. One recent example that fits nicely with Department priorities is the Habitat Rehabilitation and Enhancement Project at the Department's Ted Shanks Conservation Area. This project allowed us to work with the U.S. Army Corps of Engineers (USACE) to restore greater amounts of bottomland and emergent wetland floodplain habitats and increase floodplain storage. The UMRR is also responsible for ensuring that scientific information, to enhance understanding of the river ecosystem and to help the USACE manage the river, is gathered and shared.

The report's recommendations are important to achieving continued success of habitat enhancement and restoration and long term resource monitoring within the Upper Mississippi River System. This program has been successfully implemented for over 30 years, and while tens of thousands of acres have been improved and resource knowledge greatly enhanced, it represents only a small amount of habitat improvement and information needs. Much work remains to ensure the river remains a nationally significant ecosystem, as declared in the 1986 Water Resources Development Act.

The Department supports the report's recommendations and stresses the importance of ensuring that non-federal cost-share sponsors are allowed to participate in the program. This is a critical need as project locations require interested and engaged project sponsors. The project partnership agreements must also meet the needs of the cost-share sponsors, in addition to the USACE needs, if this program is to see continued success. Full funding of the program is also critical to meeting the stated goals of the program, implementing the

UMRR's 2015 – 2025 Strategic and Operational Plan, and working towards restoring and maintaining a healthier and more resilient Upper Mississippi River ecosystem.

In closing, the Department supports the 2016 Report to Congress and its recommendations. We appreciate the collaborative efforts of the U.S. Army Corps of Engineers, state and federal agencies, and other partnership members in the development of the report and in the implementation of the Upper Mississippi River Restoration program. We look forward to continued and future program success.

Sincerely,

SARA PARKER PAULEY
DIRECTOR

c: Dru Buntin, Upper Mississippi River Basin Association
Marvin Hubbell, U.S. Army Corps of Engineers, Rock Island District
Robert Stout, Missouri Department of Natural Resources
David Thorne, Missouri Department of Conservation
Matt Vitello, Missouri Department of Conservation
Janet Sternburg, Missouri Department of Conservation

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
101 S. Webster Street
Box 7921
Madison WI 53707-7921

Scott Walker, Governor
Cathy Stepp, Secretary
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Toll Free 1-888-936-7463
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WISCONSIN
DEPT. OF NATURAL RESOURCES

September 12, 2016

Colonel Craig Baumgartner, District Commander
U.S. Army Corps of Engineers, Rock Island District
Clock Tower Building P.O. Box 2004
Rock Island, IL 61204

Dear Colonel Baumgartner:

The Wisconsin Department of Natural Resources is pleased to endorse the Upper Mississippi River Restoration (UMRR) Program's 2016 Report to Congress. As an active partner in implementation of the program, we are proud to have been an integral part of the many partnership accomplishments and collaborations highlighted within the report. The ongoing and future efforts described in the Report and in the 2015-2025 Strategic Plan will ensure that integrated science and restoration will continue to be a cornerstone of success for the UMRR program, and for achieving improved river health and resiliency.

The UMRR program is very important to Wisconsin. The restoration projects, justified solely on their environmental merits, also contribute significant economic benefits to the region and nation. Sustained economic benefits are achieved through increased hunting, fishing and other recreational opportunities, while significant local economic benefits are also realized during project construction.

The substantial knowledge-base of large river ecological dynamics and large river restoration techniques pioneered by the UMRR program are important for the ongoing management of the Mississippi River. The UMRR program has made significant restoration progress, yet both perpetual and new human-induced stressors on the river ecosystem will require continued knowledge development and application of new tools and techniques; we are confident that the UMRR program is poised to meet these ongoing challenges.

The 2016 Report to Congress summarizes various efforts that will ensure continued progress toward the partnership vision of "*A Healthier and More Resilient Upper Mississippi River Ecosystem That Sustains the River's Multiple Uses*." Wisconsin supports the conclusions and recommendations contained in the 2016 Report to Congress. In particular, the following recommendations are important for achieving that vision:

- As a proven effective and efficient program, the UMRR should remain fully functional and continue to serve the continuing restoration and monitoring needs on the Upper Mississippi River.
- The Corps, implementing partners, and interested public should work collaboratively to implement the goals and objectives of the 2015-2025 UMRR Strategic Plan.
- If implemented at the fully authorized funding level (i.e., $33.17 million), the 2016 Report recommendations will help the program realize its full potential, help achieve the partnership vision for a healthier and more resilient system, and help to achieve long-term, balanced management of one of the nation's greatest multiple-use river systems.
- Changes to the cost share agreements that are currently being pursued by the Partnership are needed to improve and continue restoration opportunities.

Over forty years ago, the public and agencies completed the "Comprehensive Master Plan for the Management of the Upper Mississippi River System," with the vision of collaboratively managing the Upper Mississippi River's various environmental and human uses. The 2016 UMRR Report to Congress documents how the partnership continues to implement that vision through the UMRR program. We look forward to continued collaborative success with all of our partners.

Sincerely,

Cathy Stepp
Secretary

c: Dru Buntin, Upper Mississippi River Basin Association
Marvin Hubbell, U.S. Army Corps of Engineers, Rock Island
Sanjay Olson, Wisconsin DNR
Pat Stevens, Wisconsin DNR
Dan Baumann, Wisconsin DNR
Jim Fischer, Wisconsin DNR

United States Department of the Interior

FISH AND WILDLIFE SERVICE

5600 American Boulevard West, Suite 990
Bloomington, Minnesota 55437-1458

IN REPLY REFER TO:
FWS/R3/ NWRS

OCT 20 2016

Major General Michael Wehr
Division Commander
U.S. Army Corps of Engineers
Mississippi Valley Division
Box 80
Vicksburg, Mississippi 39181-0080

Dear Major General ~~Wehr~~ Mike:

The U.S. Fish and Wildlife Service (Service) has been an active partner and supporter of the Upper Mississippi River Restoration (UMRR) program, formerly known as the Environmental Management Program, since it was authorized in 1986. Our staff has been engaged in all facets of this program. As a long standing UMRR partner the Service endorses the 2016 report to Congress and the recommendations therein. The Service appreciates the work that the U.S. Army Corps of Engineers (Corps) has done to ensure the success of the UMRR and the partnership that sustains the program. The Corps and the entire partnership are to be commended for their continued commitment to this important program and for maintaining positive momentum through the years.

The Service is excited to see the Corps initiating the next generation of projects for the UMRR and looks forward to helping design them with the best objectives in mind. The Service is also very excited to see the Corps take new approaches to the design of Habitat Rehabilitation and Enhancement Projects (HREP) which incorporates missing habitats into the ecosystem by facilitating natural processes. We believe that this approach will build resilience and sustainability in the Upper Mississippi River System (UMRS) and we are glad to sponsor projects that help meet these objectives.

With this in mind, we look forward to addressing future challenges through continued collaboration with the partnership. Collaboration will be essential to continue to achieve mutual restoration objectives within the UMRS. We appreciate the opportunity to review the document and are pleased to endorse the 2016 UMRR Report to Congress.

Sincerely,

Charles M. Wooley
Acting Regional Director

cc: Colonel Craig Baumgartner

United States Department of the Interior
U.S. GEOLOGICAL SURVEY
Office of the Midwest Regional Director
1451 Green Road
Ann Arbor, MI 48105

August 25, 2016

Colonel Craig Baumgartner
District Commander
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204

Dear Colonel Baumgartner,

The USGS is pleased to endorse the U.S. Army Corps of Engineers Upper Mississippi River Restoration (UMRR) Program's 2016 Report to Congress. As the Science Advisor for the UMRR partnership, we were an active in the preparation and review of this report. We think the Report presents an assessment of the UMRR that will provide useful information to Congress, resource managers, and the public regarding the capabilities, the successes and effectiveness of this program, and most importantly portrays a continuing vision for its future.

The UMRR, as documented in the Report, is a distinctive program that uses a combination of habitat restoration, long term monitoring, and data analysis to help managers optimize both the ecological and public benefits derived from the Upper Mississippi River System (UMRS). This approach is necessary in complex systems such as the UMRS, a system greatly impacted by local and regional forces such as floods, land use, dams, pollution inputs, and navigation.

The science-based management approach UMRR incorporates is a model for others around the world. USGS thinks this approach, as described in the Report to Congress, is the most effective way to provide the science-based information needed to improve management of the UMRS, which can be transferred to other large rivers within the U.S. and the world. The UMRR Program is more and more serving as a model program both domestically and internationally on how science and management can form an effective partnership.

USGS is pleased to be part of the partnership implementing this cutting-edge Program of ecosystem restoration and sound scientific knowledge. We fully endorse the content and recommendations of the 2016 UMRR Report to Congress.

Sincerely,

Leon M. Carl
Regional Director, Midwest Region

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

AUG 2 2 2016

REPLY TO THE ATTENTION OF:

Colonel Craig Baumgartner
District Commander
Rock Island District
U.S. Army Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204

Dear Colonel Baumgartner:

I am pleased to offer this letter of support for the Upper Mississippi River Restoration (UMRR) program and the 2016 UMRR Report to Congress (RTC). The U.S. Environmental Protection Agency has long been an active member of the UMRR interagency partnership, along with other federal agencies, the five Upper Mississippi River states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, and other stakeholders.

EPA has participated in the UMRR coordinating committee for many years. We were involved in the development of the UMRR 2015-2025 Strategic Plan to guide habitat restoration and the state of the supporting science. We are also engaged in the interagency and stakeholder collaboration that is currently developing the UMRR Habitat Needs Assessment II, which will guide the planning and implementation of the next generation of UMRR habitat restoration projects.

Since its establishment in the 1986 Water Resources Development Act, UMRR has created or restored more than 100,000 acres of habitat along the Upper Mississippi River. UMRR has also engaged in cutting edge monitoring, research, and analysis to further the scientific understanding of the river system and its stressors and to inform current and future restoration projects. In the process, UMRR has become a world leader in large river systems habitat restoration and science. Moreover, the partnership that has guided the UMRR effort is a model for interagency and stakeholder collaboration, so that the ecological, navigational, recreational, and economic aspects of the Upper Mississippi River can be more fully coordinated and enhanced.

Our involvement in the UMRR partnership dovetails with our own mission to achieve the vision of the Clean Water Act. EPA priorities that are assisted by the work of UMRR include:

- Improving water quality.
- Protecting public water supplies.
- Reducing impacts from nutrients, other chemicals, and invasive species.
- Promoting robust aquatic ecosystems.

Much has been accomplished in UMRR's first 30 years. Much remains to be done to achieve a healthier, more resilient river system that will serve the public and sustain the environment. We look forward to our continued involvement in this important work.

Sincerely,

Robert A. Kaplan
Acting Regional Administrator

Cc: Col. Anthony Mitchell, District Commander, St. Louis District, Corps of Engineers
Col. Sam Calkins, District Commander, St. Paul District, Corps of Engineers
Marvin Hubbell, UMRR Program Manager, Rock Island District, Corps of Engineers
Tom Melius, Midwest Regional Director, U.S. Fish and Wildlife Service
Mark Gaikowski, Director, Upper Midwest Environmental Sciences Center, U.S. Geological Survey
Dru Buntin, Executive Director, Upper Mississippi River Basin Association

American Rivers
Rivers Connect Us®

October 24, 2016

Colonel Craig Baumgartner
District Commander
US Army Corps of Engineers
Rock Island District
Clock Tower Building
PO Box 2004
Rock Island, IL 61204

RE: Upper Mississippi River Restoration Program Report to Congress

Colonel Baumgartner:

American Rivers protects wild rivers, restores damaged rivers, and conserves clean water for people and nature. Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and an annual America's Most Endangered Rivers® campaign. Headquartered in Washington, DC, American Rivers has offices across the country and more than 250,000 members, supporters, and volunteers. The Upper Mississippi River is a priority river basin for American Rivers, and we work to ensure a healthy Upper Mississippi River and tributaries supports native fish and wildlife and is sustained by people living in harmony with the land and rivers. American Rivers also currently leads the Nicollet Island Coalition, which works to protect and restore the Upper Mississippi River by advocating for reforms to the navigation system.

We fully support the mission of the Upper Mississippi River Restoration Program to monitor and restore the Upper Mississippi River. The Upper Mississippi River System, including the Illinois River, is a large dynamic floodplain river ecosystem that has been greatly altered by commercial navigation, flood control and land use throughout its watershed. But thanks to efforts to protect and rehabilitate habitat there are areas where the Upper Mississippi and Illinois Rivers still retain many of their natural floodplain ecosystem characteristics including flood pulses, floodplain forests, backwaters and floodplain lakes, despite these stressors. This is in part because of the Upper Mississippi River Restoration Program.

55 unique habitat rehabilitation and enhancement projects have been completed, restoring 102,000 acres of aquatic and floodplain habitat. While this seems like a lot, it only represents about 5 percent of the historic Upper Mississippi River floodplain. Great strides have been made but important work remains to enhance the river system's ecological health and resilience to stressors like sedimentation, nutrient loading, invasive species, altered hydrology and floodplain isolation. Ecological improvements in the Upper Mississippi River System provide substantial public health and economic benefits

1101 14th Street, NW | Suite 1400 | Washington, DC 20005-5637 | phone 202.347.7550 | fax 202.347.9240 | AmericanRivers.org

downstream to the Gulf of Mexico too through enhanced water quality, wildlife habitat and outdoor recreation.

Monitoring and research must also be continued to deepen our understanding of the Upper Mississippi River and big river ecosystems in general. The Upper Mississippi River Restoration Program is internationally recognized for the development of new monitoring and ground breaking research on big rivers. The science and monitoring component of the program is also being adapted to better answer questions about how the habitat enhancement projects are impacting the river's overall health and resiliency, which is critical to the growth and improvement of the program.

We are encouraged that the Upper Mississippi River Restoration Program continues to receive regular funding from Congress and is a priority for the Administration. However, low funding levels continue to constrain the Program's success. We believe that the Upper Mississippi River Restoration Program should not only continue, but be funded at a higher level and expanded in scope to accomplish greater success and ensure a healthy Upper Mississippi River ecosystem.

As the nation's leading advocate for protecting and restoring rivers, American Rivers urges robust funding and support for the Upper Mississippi River Restoration Program. This investment will benefit the surrounding communities and environment today and for generations to come.

Sincerely,

Eileen Shader
Director, River Restoration
American Rivers

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Audubon MINNESOTA

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651.739.9332
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October 24, 2016

Colonel Craig Baumgartner
District Commander
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Col. Baumgartner:

The National Audubon Society would like to express our continued strong support for the Upper Mississippi River Restoration (UMRR) program. Audubon is a national non-profit organization focused on bird conservation and connecting people to birds. We are active in Mississippi River management and restoration, with a Mississippi River flyway team that includes state offices in Minnesota, Louisiana, Illinois, and Missouri. Our staff, along with thousands of citizen members within the flyway network, work with partners to improve and protect habitat for birds and other wildlife. We will continue to be actively involved in the UMRR, and fully support the many opportunities and benefits this program provides to birds and bird conservation along the Upper Mississippi and Illinois Rivers, and associated tributaries.

For over 30 years, UMRR has advanced our collective understanding of the Upper Mississippi River's ecological and water resources, and has directly improved habitat on over 100,000 acres for fish and wildlife. Ecological improvements in the Upper Mississippi River System also provide substantial public health and economic benefits downstream to the Gulf of Mexico through enhanced water quality, wildlife habitat and outdoor recreation.

The long term resource monitoring component of UMRR provides a strong foundation for monitoring the status of fisheries, aquatic vegetation, and water quality; and has greatly improved our understanding of ecological processes and landscape level influences within the Upper Mississippi River System. The habitat rehabilitation and enhancement projects (HREPs) have directly improved habitat and water quality through restoration projects like island rebuilding, dredging to improve depth diversity, and managing flows. HREPs have also greatly improved our understanding of how to most effectively design and construct these types of projects.

Although great strides have been made, important work remains to enhance the river system's ecological health and resilience to stressors like sedimentation, nutrient loading, invasive species, altered hydrology, and floodplain isolation. As UMRR advances into the future,

focusing greater attention on restoring natural low water variability, reconnecting the river to its floodplain, and ensuring the long-term sustainability of critical floodplain forest habitat should be top priorities.

Also critical to Audubon are opportunities for non-profits to engage as cost share partners in habitat restoration projects. Projects on non-federal lands require a non-federal cost share partner to sign a Project Partnership Agreement (PPA) before a project can be implemented. The PPAs currently required by the Corps of Engineers place most of the future liability risk on the non-federal partner, and most partners are unable or unwilling to sign the agreements. Congress can fix this problem, and by doing so would open the door to expanded opportunities for habitat restoration and leveraging federal and non-federal resources.

In summary, UMRR is a proven, effective, and strongly supported program that is improving habitat and water quality within the Upper Mississippi River System to the benefit of birds and people. Audubon places a top priority on the Mississippi flyway and will continue to actively support and participate in this program, and encourages congress to continue improving the program and funding UMRR to its fullest capacity.

Sincerely,

Tim Schlagenhaft
Upper Mississippi River Program Manager

cc: Molly Pederson, Audubon
Rebeccah Sanders, Audubon

MINNESOTA DIVISION IZAAK WALTON LEAGUE OF AMERICA

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Colonel Craig Baumgartner
District Commander
US Army Corps of Engineers
Rock Island District
Clock Tower Building
PO Box 2004
Rock Island, IL 61204

Subject: Upper Mississippi River Restoration Program Report to Congress

Colonel Baumgartner:

The Minnesota Division, Izaak Walton League of America, fully supports the mission of the Upper Mississippi River Restoration Program to monitor and restore the Upper Mississippi River. The Izaak Walton League has a long and respected history of advocating for a healthy Upper Mississippi River ecosystem. We were formed in 1922 by a group of Chicago businessmen dedicated to saving and restoring the Upper Mississippi River. Our first successful National advocacy effort was the creation of the Upper Mississippi River Wildlife and Fish Refuge. We continue our active engagement in advocating for the UMR's protection and restoration that is so important to our members and to our Country.

The Upper Mississippi River System, including the Illinois River, is a large dynamic floodplain river ecosystem that has been greatly altered by commercial navigation, flood control and land use throughout its watershed. But thanks to efforts to protect and rehabilitate habitat there are areas where the Upper Mississippi and Illinois Rivers still retain many of their natural floodplain ecosystem characteristics including flood pulses, floodplain forests, backwaters and floodplain lakes, despite these stressors. This is in part because of the Upper Mississippi River Restoration Program.

55 unique habitat rehabilitation and enhancement projects have been completed, restoring 102,000 acres of aquatic and floodplain habitat. While this seems like a lot, it only represents about 5 percent of the historic Upper Mississippi River floodplain. Great strides have been made but important work remains to enhance the river system's ecological health and resilience to stressors like sedimentation, nutrient loading, invasive species, altered hydrology and floodplain isolation.

Monitoring and research must also be continued to deepen our understanding of the Upper Mississippi River and big river ecosystems in general. The Upper Mississippi River Restoration Program is internationally recognized for the development of new monitoring and ground breaking research on big rivers. The science and monitoring component of the program is also being adapted to better answer questions about how the habitat enhancement projects are impacting the river's overall health and resiliency, which is critical to the growth and improvement of the program.

We are encouraged that the Upper Mississippi River Restoration Program continues to receive regular funding from Congress and is a priority for the Administration. However, low funding levels continue to constrain the Programs success. We believe that the Upper Mississippi River Restoration Program should be funded at a higher level and expanded in scope to accomplish greater success and ensure a healthy Upper Mississippi River ecosystem.

Sincerely,

President
Minnesota Division Izaak Walton League of America

Missouri Coalition for the Environment
EFFECTIVE CITIZEN ACTION SINCE 1969

September 8, 2016

Colonel Craig Baumgartner
District Commander
US Army Corps of Engineers
Rock Island District
Clock Tower Building
PO Box 2004
Rock Island, IL 61204

Subject: Upper Mississippi River Restoration Program Report to Congress

Colonel Baumgartner:

The Missouri Coalition for the Environment (MCE) has been intimately involved with the protection of the Upper Mississippi River (UMR) since our organization was established in 1969. Our first involvement was working with other organizations during the controversial designing and building of the Melvin Price Locks & Dam, which eventually led to the creation of the Environmental Management Program in 1986, the Upper Mississippi River Restoration (UMRR) Program's precursor. Since then MCE has advocated for obtaining the best and most effective solutions to UMR restoration and management.

MCE fully supports the mission of the UMRR Program to monitor and restore the Upper Mississippi River. The Upper Mississippi River System, including the Illinois River, is a large dynamic floodplain river ecosystem that has been greatly altered by commercial navigation, flood control and land use throughout its watershed. But thanks to efforts to protect and rehabilitate habitat there are areas where the Upper Mississippi and Illinois Rivers still retain many of their natural floodplain ecosystem characteristics including flood pulses, floodplain forests, backwaters and floodplain lakes, despite these stressors. This is in part because of the Upper Mississippi River Restoration Program.

Over its existence the UMRR Program has completed 55 unique habitat rehabilitation and enhancement projects, which have restored about 102,000 acres of aquatic and floodplain habitat. While this seems like a lot, it only represents about 5 percent of the historic Upper Mississippi River floodplain. Great strides have been made but important work remains to enhance the river system's ecological health and resilience to stressors like sedimentation, nutrient loading, invasive species, altered hydrology and floodplain isolation. Ecological improvements in the Upper Mississippi River System provide important public health and economic benefits locally and downstream to the Gulf of Mexico too through enhanced water quality, wildlife habitat and outdoor recreation. Much more needs to be accomplished.

Monitoring and research must also be continued to deepen and expand our understanding of the Upper Mississippi River and big river ecosystems in general. The UMRR Program is internationally recognized for the development of new monitoring and ground breaking research on big rivers. The science and monitoring component of the program is also being adapted to better answer questions about how the habitat enhancement projects are impacting the river's overall health and resiliency, which is critical to the growth and improvement of the program.

MCE is encouraged that the UMRR Program continues to receive regular funding from Congress and is a priority for the Administration. However, low funding levels continue to limit the Program's success. We believe that the UMRR Program should not only continue, but be funded at a significantly higher level and expanded in scope to accomplish greater success and ensure a healthy Upper Mississippi River ecosystem. In order to accomplish this, sometime soon the immense public value of healthy and functioning rivers must be fully acknowledged and efforts to restore them must no longer be constrained by questionable economic development priorities.

Sincerely,

Rivers Director
Missouri Coalition for the environment

3115 South Grand Blvd. • Suite 650 • St.Louis, Missouri 63118 • (314) 727-0600 • moenviron@moenviron.org • www.moenviron.org

prairieriversnetwork

PRAIRIE RIVERS NETWORK
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October 20, 2016

Colonel Craig Baumgartner
District Commander
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building
PO Box 2004
Rock Island, IL 61204

Subject: Upper Mississippi River Restoration Program Report to Congress

Colonel Baumgartner:

I am writing to express Prairie River Network's support for the Upper Mississippi River Restoration Program—a vital program that promotes the health and resilience of the Upper Mississippi River. Prairie Rivers Network is a statewide conservation organization that seeks to protect clean water and healthy rivers for the benefit of the people, fish, and wildlife of Illinois. Our organization has been a long-time champion for the ecological restoration of lands and waters throughout the Upper Mississippi River Basin—and programs like the Upper Mississippi River Restoration Program are vital to that cause.

The Upper Mississippi River—a large, dynamic river-floodplain ecosystem—was once among the most diverse and biologically productive systems in the world; however, it has been greatly altered and degraded by commercial navigation, flood control efforts, and land use conversion throughout its watershed. Many agencies and organizations have been able to successfully restore some ecological and hydrologic function at key sites along the river, and these improvements are in part due to the Upper Mississippi River Restoration Program.

Through 55 projects, the program has restored 102,000 acres of aquatic and floodplain habitat, and in doing so addressed major stressors to the river, such as sedimentation, nutrient pollution, and altered hydrology. Yet, these projects only represent approximately 5 percent of the historic Upper Mississippi River floodplain. While strides have been made, we must continue this important work to adequately address the historical and ongoing degradation of river and floodplain habitats.

Further, research and monitoring play a vital role in the Upper Mississippi River Restoration Program. The program is internationally-recognized for the development of innovative monitoring and research practices for assessing large rivers. These efforts must be continued to improve our understanding of the system and track progress toward the goal of a healthier, more resilient river.

We are encouraged by the fact that the Upper Mississippi River Restoration Program continues to be a priority. Moving forward, we hope that the program will be funded at higher levels and expanded in scope to adequately address the many stressors the river continues to face. Thank you for your time, and for your dedication to restoring the health of the Upper Mississippi River.

Sincerely,

Elliot Brinkman
Habitat Conservation Specialist

C: Marvin Hubbell, U.S. Army Corps of Engineers
Kirsten Mickelson, Upper Mississippi River Basin Association

Robert A. Sinkler
Water Infrastructure Director
North America Water
The Nature Conservancy
629 State Avenue (IL Rte 84), Great River Rd.
309-230-8790 (rsinkler@tnc.org)

October 21, 2016

Colonel Craig Baumgartner
District Commander U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

RE: UMRR Report to Congress

Dear Colonel Baumgartner:

As the fourth Report to Congress (RTC) on the Upper Mississippi River Restoration (UMRR) program is assembled, The Nature Conservancy (TNC) would like to strongly support the program accomplishments and future goal for a resilient and healthy Upper Mississippi River ecosystem. Our support of this program includes strategic direction, long term advocacy and a willingness to enter into the program as a full cost share partner should legal constraints be addressed.

This robust program provides resources to counter human induced ecological harm by recreating and rehabilitating river ecosystem elements and monitoring vital river system health and trends to assess the effectiveness of the restoration and current river quality. Reauthorization in 2000 included a continuing authority provision, which demonstrates the understanding that the multiple uses of the Upper Mississippi River require a perpetual commitment to maintain and hopefully exceed impacts from current river ecosystem threats.

The RTC notes direct restoration benefits to 102,000 acres through the construction of 55 projects but these report numbers do not accurately represent the cumulative changes of these projects. For example, the three phases of lower Pool 8 islands collectively create a wind reduction shadow much larger than the projects footprint and the shadow connects to existing valuable and vulnerable habitat. These restoration changes expand the actual project benefits by protecting these external vulnerable areas from further loss. Sophisticated restoration and protection like this only comes from data acquisition and analysis, qualified models and adaptive response from years of experience. Not only is this good for the river but it represents a wise investment of federal funds that produces cumulative benefits as the program reach expands.

TNC confidence in the UMRR program integrity prompted the connection to other large river cooperators around the globe to extend the program knowledge base. Exchanges with the Chinese government have focused on sharing the program fisheries monitoring techniques and restoration options that could provide benefits in the Yangtze as well as Mississippi River. At the same time working with Chinese colleagues has provided opportunities to consider harvest and management opportunities to help combat the Asian carp invasion in the Mississippi River. Exchanges at this magnitude can never be underestimated in terms of global large river health and beneficial international relationships.

TNC will continue to support and partner with other basin stakeholders to perpetuate the innovation, continual progress and long term benefits to people and nature of the UMRR program. Working together we know we can make the UMR a healthy and resilience ecosystem.

Sincerely,

Robert A. Sinkler
The Nature Conservancy

Email copies: Joseph Redican – USACE Headquarters
Mindy Simons – USACE Headquarters.

WATERWAYS
COUNCIL, INC.

October 24, 2016

Colonel Craig Baumgartner
District Commander
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Baumgartner:

I'd like to express the support of Waterways Council, Inc.'s (WCI) for the U.S. Army Corps of Engineers' (Corps') Upper Mississippi River Restoration's (UMRR's) 2016 Report to Congress. Representing inland waterways transportation interests, WCI has played a strong role in the UMRS's deeply-rooted history of collaboration among its multiple uses. WCI believes that investment is imperative for navigation maintenance, rehabilitations, and modernization efforts, along with ecosystem restoration.

The Upper Mississippi River System (UMRS) is an incredible asset, providing an efficient transportation corridor of national importance as well as many ecological services derived from its rich and diverse ecosystem. Recognizing the river's economic and ecological importance, Congress declared it as a "nationally significant ecosystem and a nationally significant commercial navigation system."

UMRR has proven that ecosystem restoration coexists very well with navigation improvements, and we believe this program's interagency model and experience in restoration will continue to achieve many successes as a multiple purpose component of the Navigation and Ecosystem Sustainability Program (NESP). WCI's coalition of navigation interests, along with conservation communities, federal agencies and states participated in extensive deliberations that resulted in an integrated, balanced, adaptive, and collaborative program for modernizing the UMRS' navigation channel and ecosystem. NESP represents a shared commitment to integrated river management that is essential to maintaining the river's reliability and future prosperity.

While we continue to push for sufficient funding for NESP, we do support the Corps' 2012 UMRR/NESP Transition Plan to ensure that UMRR remains a fully functional ecosystem restoration program that can seamlessly transition to NESP without losing its foundational interagency infrastructure and without compromising its long term monitoring.

Sincerely,

Paul C. Rohde
Vice President, Midwest Region

Upper Mississippi River Restoration Program Authorization

Section 1103 of the Water Resources Development Act of 1986 (P.L. 99-662) as amended by

Section 405 of the Water Resources Development Act of 1990 (P.L. 101-640),

Section 107 of the Water Resources Development Act of 1992 (P.L. 102-580),

Section 509 of the Water Resources Development Act of 1999 (P.L. 106-53),

Section 2 of the Water Resources Development Technical Corrections of 1999 (P.L. 106-109), and

Section 3177 of the Water Resources Development Act of 2007 (P.L. 110-114).

Additional Cost-Sharing Provisions

Section 906(e) of the Water Resources Development Act of 1986 (P.L. 99-662) as amended by

Section 221 of the Water Resources Development Act of 1999 (P.L. 106-53).

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 States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, formed for the purposes 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 subsection (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 subsection 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) Program Authority

(1) Authority

(A) In general. The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may undertake, as identified in the master plan

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

(ii) implementation of a long term resource monitoring, computerized data inventory and analysis, and applied research program, including research on water quality issues affecting the Mississippi River (including elevated nutrient levels) and the development of remediation strategies.

(B) Advisory committee. In carrying out subparagraph (A)(i), the Secretary shall establish an independent technical advisory committee to review projects, monitoring plans, and habitat and natural resource needs assessments.

(2) REPORTS. — Not later than December 31, 2004, and not later than December 31 of every sixth year thereafter, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall submit to Congress a report that —

(A) contains an evaluation of the programs described in paragraph (1);

(B) describes the accomplishments of each of the programs;

(C) provides updates of a systemic habitat needs assessment; and

(D) identifies any needed adjustments in the authorization of the programs.

(3) For purposes of carrying out paragraph (1)(A)(i) of this subsection, there is authorized to be appropriated to the Secretary $22,750,000 for fiscal year 1999 and each fiscal year thereafter.

(4) For purposes of carrying out paragraph (1)(A)(ii) of this subsection, there is authorized to be appropriated to the Secretary $10,420,000 for fiscal year 1999 and each fiscal year thereafter.

(5) Authorization of appropriations. — There is authorized to be appropriated to carry out paragraph (1)(B) $350,000 for each of fiscal years 1999 through 2009.

(6) Transfer of amounts. — For fiscal year 1999 and each fiscal year thereafter, 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 amounts appropriated to carry out clause (i) or (ii) of paragraph (1)(A) to the amounts appropriated to carry out the other of those clauses.

(7) (A) Notwithstanding the provisions of subsection (a)(2) of this section, the costs of each project carried out pursuant to paragraph (1)(A)(i) 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 and, in the case of any project requiring non-Federal cost-sharing, the non-Federal share of the cost of the project shall be 35 percent.

(B) Notwithstanding the provisions of subsection (a)(2) of this section, the cost of implementing the activities authorized by paragraph (1)(A)(ii) 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.

(8) 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) 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 15 fiscal years beginning after the effective date of this section.

(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) Determination.

(A) In general. 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.

(B) Requirements. The Secretary shall

(i) complete the ongoing habitat needs assessment conducted under this paragraph not later than September 30, 2000; and

(ii) include in each report under subsection (e)(2) the most recent habitat needs assessment conducted under this paragraph.

(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 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(e). COST-SHARING.

(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 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. Not more than 80 percent of the non-Federal share of such first costs may be satisfied through in-kind contributions, including facilities, supplies, and services that are necessary to carry out the enhancement project. The non-Federal share of operation, maintenance, and rehabilitation of activities to enhance fish and wildlife resources shall be 25 percent.

Upper Mississippi River Restoration

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