UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM

DEFINITE PROJECT REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT
PROJECT #114844

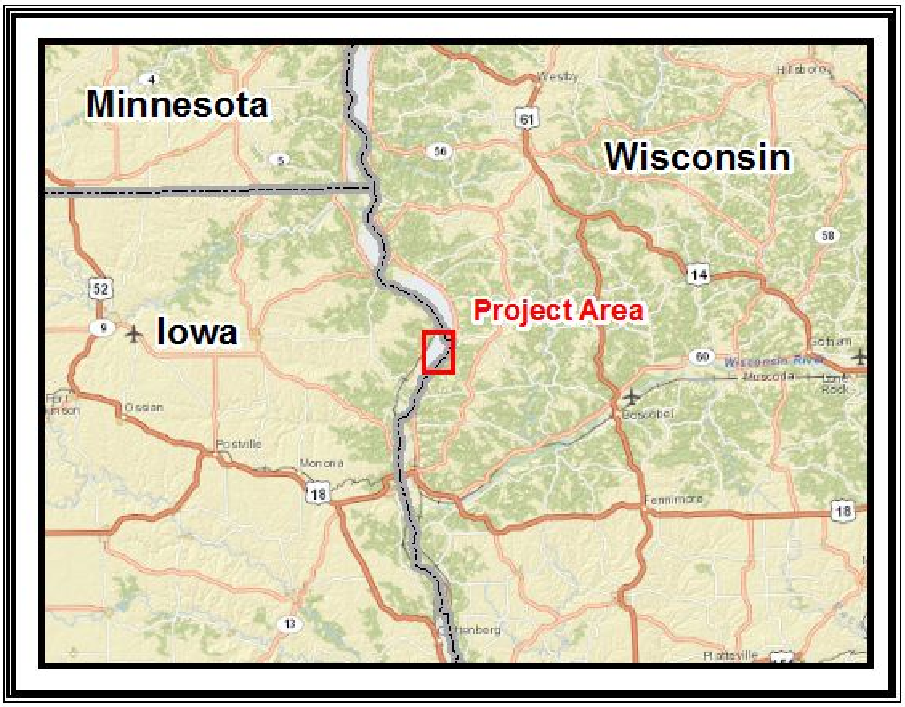
HARPERS SLOUGH HABITAT REHABILITATION and ENHANCEMENT PROJECT

Main Report

POOL9
UPPER MISSISSIPPI RIVER
ALLAMAKEE COUNTY, IOWA and
CRAWFORD COUNTY, WISCONSIN
July 2014

EXECUTIVE SUMMARY

The Harpers Slough Habitat Rehabilitation and Enhancement Project (HREP) is located on the Iowa side of the Upper Mississippi River in lower Pool 9, near Lynxville, Wisconsin (see Executive Figure 1). The proposed project is part of the Upper Mississippi River System Environmental Management Program (UMRS-EMP). The site lies within the Upper Mississippi River National Wildlife and Fish Refuge.



Executive Figure 1. Location of Harpers Slough HREP Study Area.

The overall recommended plan is to protect approximately 46 acres of existing islands and construct 52 acres of new islands at an estimated first cost of $17,427,000 (including sunk general design costs). The average annual equivalent of these costs equals $823,400. In addition to these costs, there will be additional annual O&M costs of $11,100 and annual monitoring costs of $38,200 for a total average annual project cost of $872,700. The project would protect, restore and/or create about 98 acres of islands and produce an estimated 618 average annual habitat units. Annual project cost per annual habitat unit amounts to $1,400.

The habitat concerns within the study area center around the general degradation of habitat quality in lower Pool 9. This degradation is the result of the loss of islands, declining bathymetric diversity, and a decline in aquatic vegetation, mainly emergent vegetation, over the past few decades. However, submersed vegetation has rebounded in the last 20 years. The study area lies within the Upper Mississippi River National Wildlife and Fish Refuge and is considered critical habitat for migrating waterfowl and other water birds. The decline in migration habitat quality is of great concern to the U.S. Fish and Wildlife Service and State resource management agencies.

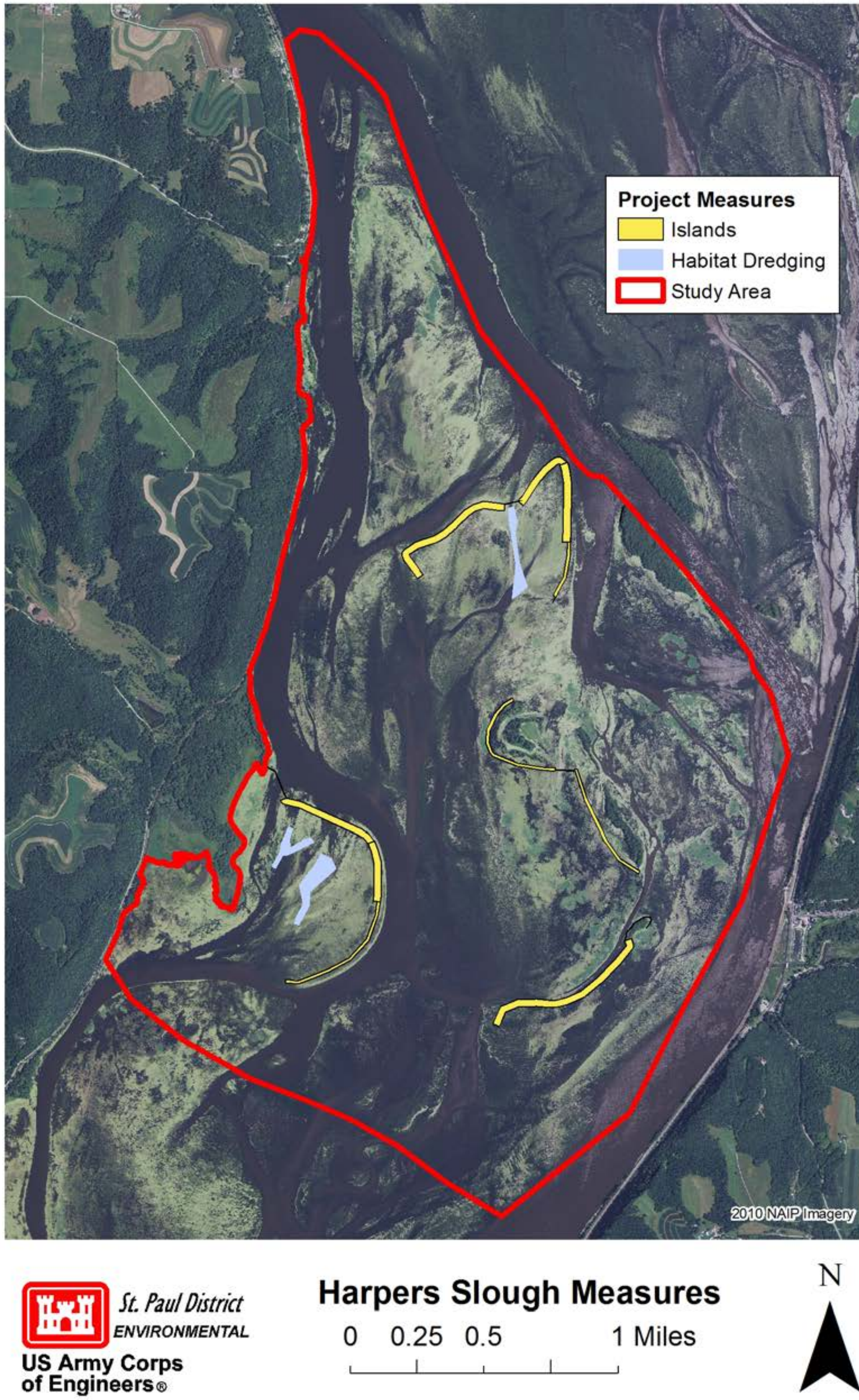
The planning process focused on the protection and restoration of islands and river processes to restore habitat diversity within the approximately 3,500-acre study area. Because it is not possible to restore or create ideal habitat conditions for all forms of fish and wildlife, measures were designed and evaluated primarily to improve conditions for State and Federal natural resource agencies' priority communities: migratory waterfowl and native fish species. However, once the basic island layouts and designs were developed, they were modified to benefit other fish and wildlife wherever possible. Islands were positioned to maintain and/or encourage flowing channels for riverine fish and/or to provide protected deepwater habitat for overwintering centrarchid fish such as bluegills, crappie, and largemouth bass. Measures such as emergent wetlands/mudflats were incorporated into the island designs to provide habitat for shorebirds and wading birds.

To identify alternatives, measures were combined in various logical combinations and constraints were imposed to minimize impacts to native mussels. The resulting six identified alternatives (including the no-action alternative) were evaluated in detail for the Harpers Slough HREP. The U.S. Fish and Wildlife Service's 1980 version of Habitat Evaluation Procedures (HEP) was used to quantify and evaluate the potential project effects and benefits. In addition to the base project of protecting the existing island complex (Alternative 1), two action alternatives were considered "Best Buy" in evaluation of cost effectiveness and incremental cost using the Institute of Water Resources economic analysis program called IWR-Plan. Based on the incremental analysis and other factors, Alternative 2, is recommended for implementation (see Executive Figure 2).

Under Alternative 2, the acreage of emergent and rooted floating aquatic vegetation is expected to increase by over 50 percent and submersed aquatic vegetation is predicted to more than double when compared to the no action alternative, which is synonymous with the future without project conditions. Given the low rates of sediment deposition in this reach of the Upper Mississippi River, the project area will continue to be aquatic habitat throughout the 50-year life of the project, and the project features will continue to enhance this habitat.

Project construction would likely be initiated in 2015 and be completed in 2018.

The entire project lies within the Upper Mississippi River National Wildlife and Fish Refuge. Once completed, the project would be turned over to the U.S. Fish and Wildlife Service for operation and maintenance.



Executive Figure 2. Recommended Project Measures for Harpers Slough HREP.

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DEFINITE PROJECT REPORT

HARPERS SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 9, UPPER MISSISSIPPI RIVER
ALLAMAKEE COUNTY, IOWA and
CRAWFORD COUNTY, WISCONSIN

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DRAFT DEFINITE PROJECT REPORT

HARPERS SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 9, UPPER MISSISSIPPI RIVER
ALLAMAKEE COUNTY, IOWA and
CRAWFORD COUNTY, WISCONSIN

1. INTRODUCTION

1.1 AUTHORITY

Congress authorized the Upper Mississippi River System Environmental Management Program (UMRS-EMP) in Section 1103 of the 1986 Water Resources Development Act (WRDA). Over the course of its first 13 years, EMP proved to be one of this country's premier ecosystem restoration programs, combining close collaboration between Federal and State partners, an effective planning process, and a built-in monitoring process. This success led Congress to reauthorize EMP in WRDA 1999 (Public Law 106-53). Section 509 of the 1999 Act made several adjustments to the program and established the following two elements as continuing authorities:

• Planning, construction, and evaluation of fish and wildlife habitat rehabilitation and enhancement projects (known as Habitat Rehabilitation and Enhancement Projects (HREPs)).

• Long-term resource monitoring, computerized data inventory and analysis, and applied research (known collectively as Long-Term Resource Monitoring Program (LTRMP)).

1.2 PARTICIPANTS AND COORDINATION

Participants in the planning for the Harpers Slough project included the Upper Mississippi River National Wildlife and Fish Refuge and the Region 3 Offices of the U.S. Fish and Wildlife Service (USFWS); the Iowa and Wisconsin Departments of Natural Resources (Iowa DNR and Wisconsin DNR); and the St. Paul District, Corps of Engineers.

The USFWS and the Iowa and Wisconsin DNRs were involved in project planning because the study area is located within the Upper Mississippi River National Wildlife and Fish Refuge and within that portion of Pool 9 bounded by Iowa and Wisconsin.

The following individuals played an active role in the planning and design of the Harpers Slough project. For St. Paul District personnel, the discipline and contribution of the individual planning team members is listed. For resource agency personnel, the individual's position title is listed.

ST. PAUL DISTRICT, CORPS OF ENGINEERS (Project Delivery Team)

Name	Discipline	Contribution
Tom Novak	Project Manager	Project Manager
Katie Opsahl	Planning	Plan Formulation
David Potter	Fishery Biologist	Environmental Lead
Derek Ingvalson	Biologist	Environmental Analysis
Daniel Kelner	Fishery Biologist	Mussels, Environmental Analysis
Brad Perkl	Archaeologist	Cultural Resources Analysis
Keith LeClaire	Cartographer	GIS Analysis
Mike Walker	Cartographer	GIS Analysis
Scott Jutila	Hydraulic Engineer	Hydraulic Analysis
Corby Lewis	Hydraulic Engineer	Hydraulic Analysis
Jon Hendrickson	Hydraulic Engineer	Hydraulic Analysis
Scott Goodfellow	Hydraulic Engineer	Hydraulic Analysis
Kevin Nelson	Geotechnical Engineer	Geotechnical Analysis
Greta Schmalle	Geotechnical Engineer	Geotechnical Analysis
David Tschida	Civil Engineer	Design and Layout
Greg Fischer	Civil Engineer	Design and Layout
Jeff Hansen	Civil Engineer	Cost Estimating
Leon Opatz	Civil Engineer	Cost Engineering

U.S. FISH AND WILDLIFE SERVICE

Richard King	McGregor Refuge Manager
Tim Yager	Deputy Refuge Manager
Clyde Male	Assistant McGregor District Manager
Sharonne Baylor	Environmental Engineer
Phil Delphey	Fish and Wildlife Biologist, Twin Cities Field Office
Lisa Maas	Refuge Biologist
Kyle Mosel	Biological Science Technician

IOWA DEPARTMENT OF NATURAL RESOURCES

Mike Griffin	Habitat Projects Coordinator

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Jeff Janvrin	Mississippi River Habitat Specialist
Patrick Short	Mississippi River Fisheries Biologist
Brenda Kelly	Mississippi River Wildlife Biologist

PRIMARY POINT OF CONTACT FOR THE PROJECT

David Potter
Fishery Biologist
U.S. Army Corps of Engineers, St. Paul District
180 5th Street East, Suite 700
St. Paul, MN 55101-1638
email: david.f.potter@usace.army.mil
Phone: (651) 290-5713
Fax: (651) 290-5258

1.3 PROJECT PUROSE

The purpose of the project is to maintain and improve fish habitat and resting and feeding habitat for migratory birds in approximately 3,500 acres in lower Pool 9.

The purpose of this integrated Definite Project Report (DPR) and Environmental Assessment (EA) is to document the planning process for ecosystem restoration of the Harpers Slough study area on the Upper Mississippi River, provide the opportunity for participation in the planning process for river management partners and the public, meet Corps of Engineers planning guidance and meet National Environmental Protection Act (NEPA) requirements. The DPR and EA will document existing and predict future habitat conditions and deficiencies; identify problems, constraints, and opportunities; define habitat goals and objectives; identify and evaluate alternative measures in accordance with NEPA and other environmental laws and regulations; and recommend a selected plan for habitat restoration and enhancement.

1.4 PROJECT AREA

The Harpers Slough project is a backwater complex located primarily on the Iowa side of the Mississippi River in Pool 9 about 3 miles upstream of Lock and Dam 9 between river miles 665 and 650 (Plate 1). Plate 2 shows the existing islands and the four rock mounds constructed in 1997 in the general area to protect some of the remaining islands under the Environmental Management Program's Bank Stabilization Habitat Rehabilitation and Enhancement Project.

The primary project or study area is adjacent to the navigation channel and lies in the Harpers Slough Closed Area of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge). The closed area is where all migratory bird hunting is prohibited and special motor boat regulations apply from October 15 to the end of the regular state duck-hunting season to allow waterfowl to rest and feed. The project area is approximately 3,500 acres and is a complex of islands, backwaters, and sloughs. The site is located immediately adjacent to the main navigation channel along the right descending bank. The study area includes the footprint of project features and an extended area of potential influence used for assessing habitat benefits associated with project alternatives (see Plate 1). The study area was further subdivided into four evaluation units (EUs) that recognize management priorities for purposes of assessing habitat benefits of proposed features : Upper EU, Middle EU, South West EU, and South East EU (Table 1- 1; Figure 1- 1).

Table 1- 1. Evaluation units identified in the study area.

Evaluation Unit	**Acres**	**Management focus**
Upper EU	631.9	Migrating waterfowl
Middle EU	840.6	Migrating waterfowl, backwater & riverine fish
South East EU	1,330.0	Cultural sites, migrating waterfowl
South West EU	703.3	Migrating waterfowl, backwater fishes, mussels
Total	**3,505.9**	

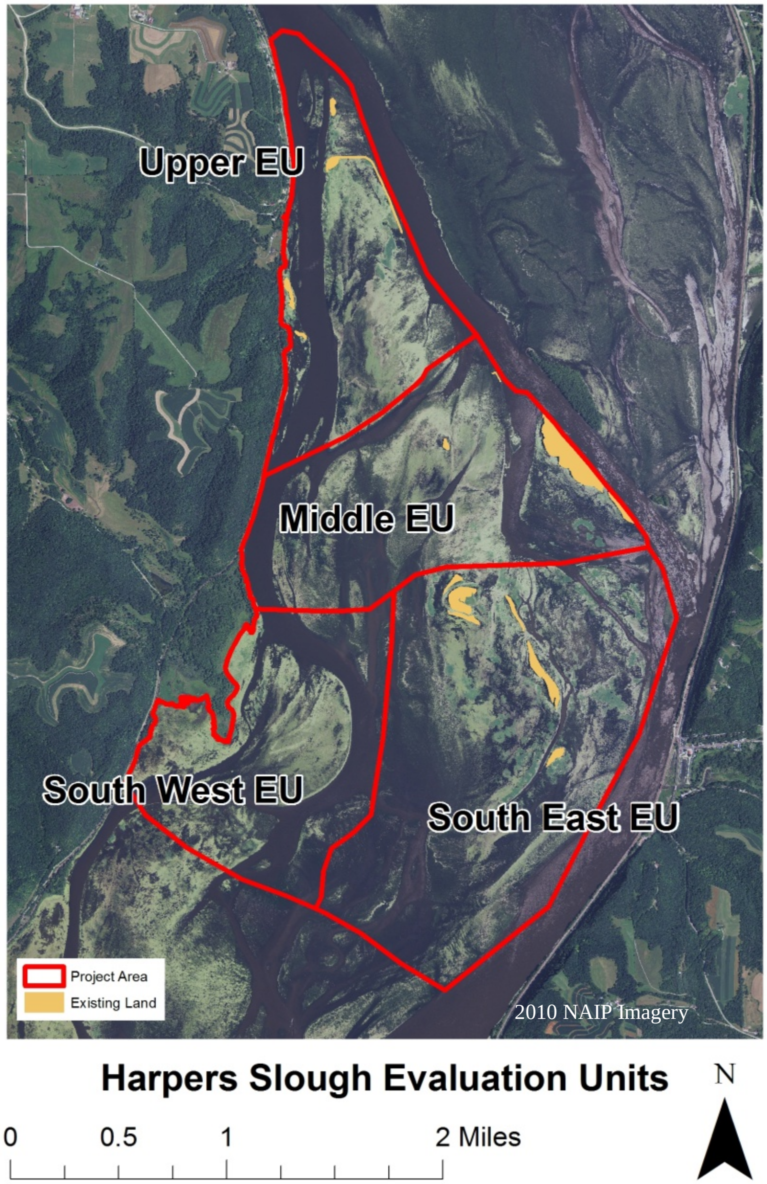

Figure 1- 1. Evaluation units in the study area.

1.5 RESOURCE PROBLEMS/OPPORTUNTIES

The habitat concerns within the project area center around the general degradation of habitat quality in lower Pool 9 for fish and wildlife. This degradation is the result of the loss of islands, declining bathymetric diversity, and a decline in aquatic vegetation over the past few decades. However, submersed aquatic vegetation recovered in the last 10 years. The study area lies within the Harpers Slough Closed Area of the Upper Mississippi River National Wildlife and Fish Refuge and is considered critical habitat for migrating waterfowl and other water birds. The decline in migration habitat quality is of great concern to the U.S. Fish and Wildlife Service and State resource management agencies. The resource problems and opportunities are more fully described in Chapter 4, Problem Identification.

Habitat deficiencies in the Harpers Slough area include the continued loss of the mosaic of habitat, especially the continued disappearance of islands. The area also lacks deep, protected aquatic habitat that would serve as overwintering habitat for centrarchid fish and associated species. This type of over-wintering habitat is rare in lower Pool 9 and has been declining with the loss of islands and bathymetric diversity.

The opportunity exists to protect and restore Harpers Slough wetland complex before it is lost. In many locations within the study area remnants of eroded islands still exist just beneath the water surface. These underwater remnants provide a solid base upon which to reconstruct islands and may be cost effective as less fill is required.

Specific project needs to restore habitat diversity in the area include the following items. These needs will serve as the basis for selecting among the alternatives.

- Maintain and/or enhance habitat in the Harpers Slough backwater area for migratory birds.
- Create habitat for migratory and resident vertebrates with emphasis on marsh and shorebirds, bald eagles, and turtles.
- Improve and maintain habitat conditions for backwater fish species.
- Enhance secondary and main channel border habitat for riverine fish species and mussels.

1.6 DECISIONS THAT NEED TO BE MADE

1.6.1 US ARMY CORPS OF ENGINEERS

Because this potential project is funded by the U.S. Army Corps of Engineers, the District Engineer, U.S. Army Corps of Engineers, St. Paul District, will select one of the alternatives for potential implementation. The District Engineer will also determine, based on the facts and recommendations contained herein, whether this EA is adequate to support a Finding of No Significant Impact (FONSI) or whether an Environmental Impact Statement (EIS) will need to be prepared.

1.6.2 US FISH AND WILDLIFE SERVICE

Because this potential project is located on land managed by the Upper Mississippi River National Wildlife and Fish Refuge (Refuge), the Regional Director, USFWS, Region 3, will determine whether the proposed project is compatible with refuge goals and objectives and the Refuge Comprehensive Conservation Plan. The USFWS Regional Director will also determine if the USFWS approves the selected alternative for potential implementation and if the USFWS will assume operation and maintenance responsibilities of the selected alternative. The Regional Director will also determine, based on the facts and recommendations contained herein, whether the final integrated DPR and EA meets the USFWS's obligations under the National Environmental Policy Act of 1969, the Fish and Wildlife Coordination Act, the Endangered

Species Act of 1973, the Migratory Bird Treaty Act of 1918, and the Bald Eagle Protection Act of 1940.

Before any construction contract begins, the Corps will obtain a Special Use Permit from the Refuge Manager. This permit will be included in the technical specification package and be part of the contract documents.

1.6.3 STATES

Decisions to be made by the states of Iowa and Wisconsin include permits for dredging, disposal and structures, state threatened and endangered species review, archeological review, and endorsement by the River Resources Forum (RRF). The RRF is a state and federal agency partnership for addressing resource issues concerning the Upper Mississippi River system within the Corps' St. Paul District geographic jurisdiction.

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2. GENERAL PROJECT SELECTION PROCESS

2.1 ELIGIBILITY CRITERIA

In January 1986, prior to enactment of Section 1103 of WRDA 1986, the North Central Division, U.S. Army Corps of Engineers, completed a "General Plan" for implementation of the UMRS-EMP. The USFWS, Region 3, and the five affected States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) participated through the Upper Mississippi River Basin Association. Programmatic updates of the General Plan for budget planning and policy development are accomplished through Annual Addenda.

Coordination with the States and the USFWS during the preparation of the General Plan and Annual Addenda led to an examination of the Comprehensive Master Plan for the Management of the UMRS. The Master Plan, completed by the Upper Mississippi River Basin Commission in 1981, was the basis for the recommendations enacted into law in Section 1103. The Master Plan report and the General Plan identified examples of potential habitat rehabilitation and enhancement techniques. Consideration of the Federal interest and Federal policies has resulted in the conclusions below:

a. From the First Annual Addendum.

> The Master Plan report... and the authorizing legislation do not pose explicit constraints on the kinds of projects to be implemented under the UMRS-EMP. “For habitat projects, the main eligibility criterion should be that a direct relationship should exist between the project and the central problem as defined by the Master Plan; i.e., the sedimentation of backwaters and side channels of the UMRS. Other criteria include geographic proximity to the river (for erosion control), other agency missions, and whether the condition is the result of deferred maintenance....”

b. From the Second Annual Addendum.

> “(1) The types of projects that are definitely within the realm of Corps of Engineers implementation authorities include the following:
>
> - backwater dredging
> - dike and levee construction
> - island construction
> - bank stabilization
> - side channel openings/closures
> - wing and closing dam modifications
> - aeration and water control systems
> - waterfowl nesting cover (as a complement to one of the other project types)

- acquisition of wildlife lands"

"(2) A number of innovative structural and nonstructural solutions, which address human-induced impacts, particularly those related to navigation traffic and operation and maintenance of the navigation system could result in significant long-term protection of UMRS habitat. Therefore, proposed projects that include such measures will not be categorically excluded from consideration, but the policy and technical feasibility of each of these measures will be investigated on a case-by-case basis and the measures will be recommended only after consideration of system-wide effects."

2.2 PROJECT SELECTION

Projects are nominated for inclusion in the District's habitat restoration program by a State natural resource agency or the USFWS, based on agency management objectives. To assist the District in the selection process, the States and USFWS have agreed to use the expertise of the Fish and Wildlife Work Group (FWWG) of the River Resources Forum (RRF) to consider critical habitat needs along the Mississippi River and prioritize nominated projects on a biological basis.

The FWWG consists of biologists responsible for managing the river for their respective agencies. Meetings are held on a regular basis to evaluate and rank the nominated projects according to the biological benefits they could provide in relation to the habitat needs of the river system. The ranking is forwarded to the RRF for consideration of the broader policy perspectives of the agencies involved. The RRF submits the coordinated ranking to the District, and each agency officially notifies the District of its views on the ranking. The District then formulates and submits a program that is consistent with the overall program guidance as described in the UMRS-EMP General Plan and Annual Addenda and supplemental guidance provided by the Mississippi Valley Division.

Resource needs and deficiencies have been considered on a pool-by-pool basis to ensure that regional needs are being met and that the best expertise available is being used to optimize the habitat benefits created at the most suitable locations.

The project was evaluated in 1987 by the FWWG and ranked as the 6th priority project for consideration in the St. Paul District's FY 1990 habitat projects program. Harpers Slough was selected for general design (planning) in FY 1995, but was delayed several times because of funding constraints and higher priority projects within the EMP. General design was resumed in FY 2002, but significant delays in the planning process occurred due to budget constraints and mussel concerns. The projects ranked higher than Harpers Slough have been completed or are currently in construction. Harpers Slough is now at the top of the list and is a priority for the FWWG.

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3. ASSESSMENT OF EXISTING RESOURCES

3.1 PHYSICAL SETTING

Pool 9 is part of the 9-foot channel project on the UMRS and was created in 1938 by the construction of Lock and Dam 9. The entire pool extends over 31.3 miles (river mile 647.9 to 679.2). The project pool elevation is 620.0 feet above mean sea level (msl 1912 adjusted), which creates a pool surface area of 29,125 acres. The pool has a meandering outer perimeter shoreline length of approximately 90 miles. Wisconsin is located on the left descending riverbank and Minnesota and Iowa are on the right riverbank. The pool's valley varies in width from about 2 miles at Lynxville, Wisconsin, to over three and a half miles at New Albin, Iowa. The bluffs are steep on both sides and highly dissected, with a maximum relief of 500 to 600 feet (elevation range from about 620 to 640 feet msl 1912 adjusted at river level to over 1,200 feet msl 1912 adjusted on the uplands). Steep-sided tributary valleys may widen abruptly as they enter into the river to form "coves" or elevated delta areas filled with alluvial materials, mostly sand and silt. The lower portion of Pool 9 is open and lake-like, with only scattered islands. The Pool 9 floodplain includes about 51,000 acres, of which about 16,500 acres is wet floodplain forest and meadow, 10,000 acres is submerged and floating leaf vegetated shallow water, 6,000 acres is emergent marsh, and 17,000 acres of open water (Theiling 2000).

The study area is approximately 3,500 acres that extends over 5 miles of the river on the Iowa side of the main channel, from river mile 655 to 650 (Figure 3- 1). The project area includes an intermingled complex of stump fields, sloughs, vegetation beds, and island remnants.

3.2 WATER RESOURCES

All elevations in this section are in feet msl, 1912 adjusted.

3.2.1 UPPER MISSISSIPPI RIVER

Early summer (June) discharges at Lock and Dam 9 generally range from 30,000 to 60,000 cubic feet per second (cfs). By late summer, discharges usually decrease to a range of 20,000 to 40,000 cfs. Winter low flows are usually in the range of 15,000 to 25,000 cfs.

Figure 3- 1. Harpers Slough Project Area.

Table 3- 1 shows the discharges and stages associated with the various events for the Mississippi River at Lock and Dam 9, the Primary Control Point Gauge at Lansing Iowa, and the interpolated elevation at Harpers Slough and Wexford Creek Delta. The monthly average water surface elevation for the project area is provided in Table 3- 2.

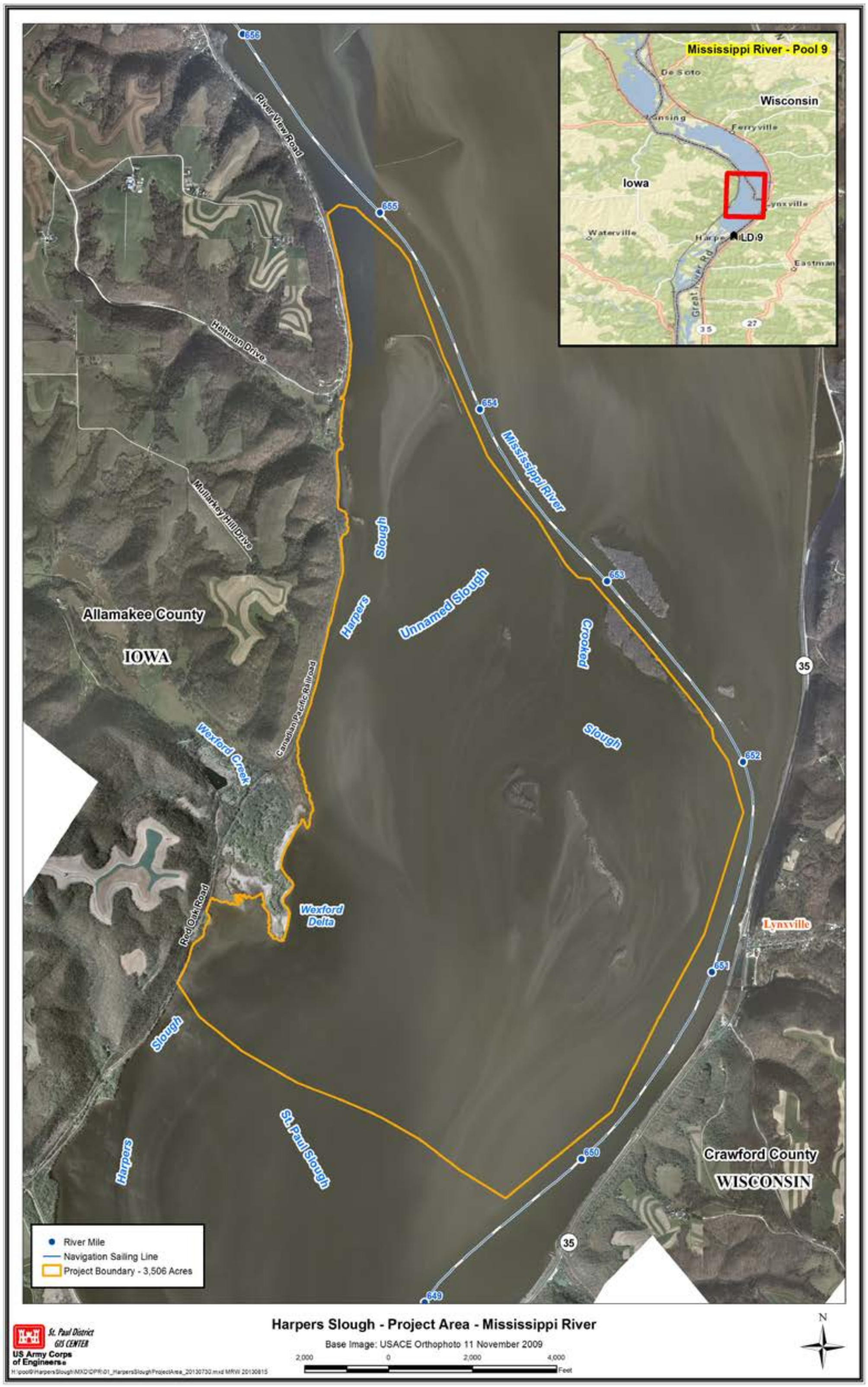

Figure 3- 1. Harpers Slough Project Area.

Table 3- 1.
Mississippi River Discharge Frequencies - Lock and Dam 9.

				Water Surface Elevation (NGVD 1912)			
Discharge (cfs)	Percent of Time Exceeded [1]	Annual Chance Flood [2]	Description of Flow Condition	L/D 9 HW gage, RM 648.0 [4]	Wexford Delta, RM 651.0	Head of Harpers, RM 654.3	Lansing gage, RM 663.1 [4]
21,300	75		Low flow	619.55	619.55 [3]	619.61 [3]	620.0
52,600	25		Moderate flow	619.0	619.31 [3]	619.70 [3]	620.65
97,700	5		Bankfull Events	621.4	621.98 [3]	622.40 [3]	623.8
100,000		50		621.67	622.02 [4]	622.43 [4]	623.49
120,000		33		623.25	623.5 [4]	623.85 [4]	624.7
129,000		25	Small floods	624.0	624.25 [4]	624.52 [4]	625.25
140,500		20		624.82	625.04 [4]	625.3 [4]	625.97
251,000		1	Large flood	632.01	632.21 [3]	632.39 [3]	632.72

[1] Discharge duration information is based on 1970 – 2010 discharge data at Lock and Dam 9.
[2] Discharge – frequency data is based on the 2004 Flow Frequency Study.
[3] Two dimensional model results.
[4] Lock and Dam 9 operating curves.

Table 3- 2.
Seasonal Average Water Surface Elevation for Project Area (50% Duration).

Month	**Stage @ Lansing RM 663** (ft amsl)[a]	**Stage @ Harpers RM 655.25** (ft amsl)[a]	**Stage @ Wexford RM 651.7** (ft amsl)[a]	**Stage @ L/D 9** (ft amsl)[a]
All Year	620.34	620.08	619.62	619.52
January	620.08	619.78	619.36	619.26
February	620.11	619.95	619.65	619.58
March	620.73	620.34	619.72	619.55
April	622.14	621.49	620.47	620.18
May	621.68	621.00	619.91	619.62
June	620.54	620.14	619.49	619.32
July	620.27	619.95	619.39	619.22
August	620.44	620.11	619.58	619.45
September	620.37	620.08	619.62	619.52
October	620.44	620.11	619.58	619.45
November	620.47	620.18	619.68	619.55
December	620.40	620.11	619.58	619.45

[a] Feet above mean sea level 1912 adjusted.

Pool 9 is regulated in a manner typical for navigation pools in the St. Paul District. When river discharges are greater than 64,000 cfs, the gates are removed from the water at Lock and Dam 9 and the pool is unregulated. When discharges are between 32,000 and 64,000 cfs the pool is in "secondary control," i.e., a pool elevation of 619.0 feet is maintained at the dam. The pool upstream of the dam rises and falls with river discharge. Due to the slope on the pool, the range of fluctuation under secondary control is greater the farther upstream from the dam one progresses.

When river discharge declines to 32,000 cfs, regulation of the pool shifts to "primary control", whereby a water surface elevation of 620.0 is maintained at the primary control point at river mile 663.0 at Lansing. As discharges decline below 32,000 cfs, the water surface elevation at Lock and Dam 9 rises from 619.0 feet toward 620.0 feet. If river discharges were to decline to zero, the pool water surface would (in theory) be flat at elevation 620.0.

The current allowable drawdown at Lock and Dam 9 between project pool elevation 620.0 feet and the secondary control elevation of 619.0 ft is 1.0 foot. When the dam first went into operation, the allowable drawdown was 2.5 feet to elevation 617.5 ft. In 1947, the allowable drawdown was reduced to the current 1.0 foot. Additional discussion of the effects of water level regulation at the project site is provided in section 4.3.2.

3.2.2 TRIBUTARIES

The Wexford Creek tributary enters the floodplain in the South West EU, forming the Wexford Delta. Land use/land cover in the watershed of this tributary is dominated by upland forest interspersed with use by agriculture and, to a lesser extent, grazing. Bottomland forest are also prevalent. Although considered a perennial stream, the amount of flow Wexford Creek contributes relative to the Mississippi River is minor.

3.2.3 GROUNDWATER

Large quantities of groundwater are present in the highly permeable, surficial sand deposits. The principle aquifer for shallow wells (less than 150 feet) would be the Franconia formation. Deeper wells in the northern end of the Pool 9 region may penetrate into the Galesville or Eau Claire formation, although water quality would not differ much from that of the Franconia formation. Groundwater is considerably harder than the Mississippi River in Pool 9.

3.2.4 IMPORTANT HYDROLOGIC UNITS IN IMMEDIATE PROJECT AREA

Harpers Slough branches off the main channel at the upper end of the study area. An old closing dam crosses Harpers Slough near the upstream end. St. Paul Slough branches off Harpers Slough on the southern end of the study area below Wexford Delta. Crooked Slough is the historic main channel and formed the border between the States of Iowa and Wisconsin. Near river mile 653 a large bend in Crooked Slough was cut off and a new main channel, the present day main navigation channel, was created to the north east. Material dredged to create the new channel alignment was placed adjacent to the channel, resulting in the formation of two large islands and some smaller islands between river miles 652.0 – 653.2. As a result, while most of the study area is in Iowa, the area between the main channel and Crooked Slough is in Wisconsin. A relatively large un-named slough was formed after inundation by Lock and Dam 9 near river mile 653.4 and connects the main channel and Harpers Slough. Harpers, St. Paul, Crooked Slough, and the unnamed slough are generally deep ranging from 6 to 15 feet at the average pool elevation of 620.1 feet above mean sea level. Outside of these sloughs, depths range from 1 to 5 feet, except in smaller sloughs and lakes that were present prior to impoundment, Plate 4 shows the 2011 bathymetry for the Harpers Slough complex.

3.2.5 HYDRODYNAMIC CONDITIONS IN THE PROJECT AREA

Much of the floodplain was completely submerged when Lock and Dam 9 went into operation, greatly changing the hydrodynamic regime in the project area. The two primary changes that occurred include the continuous flow of water through the floodplain in the project area and the creation of a lake-like lower Pool 9 that is subject to wind-driven wave action. An adaptive hydraulics (ADH) model was used to simulate flows throughout the project area (see Appendix H for more details). The modeling indicates that approximately 45-percent of the total river flows is carried through the Harpers Slough and adjoining backwaters for an average river flow (50-percent exceedance) making this a highly divided reach of the Upper Mississippi River.

Figure 3- 1shows the distribution of flows within lower Pool 9 for the low (75% exceedance) and high (5% exceedance) river flow. Higher velocities are somewhat confined to the existing side channels; Crooked Slough, Harpers Slough, St. Paul Slough and an unnamed slough between the main channel and Harpers Slough (Plate 1). Relatively high diffuse flow (0.2- 0.4 feet per second) occurs in much of the backwater area of the complex because of the lack of land areas to direct flows. Aquatic areas partially protected from velocity occur only in shallow water areas around the remaining islands and in the Wexford delta area. As some of the remaining islands disappear, protected areas will also decrease. For the typical high flow condition of 97,700 cfs, average velocities in the main channel are 2 to 3 feet per second (fps), while average velocities in the sloughs are 1 to 2 fps. The shallow wetlands have velocities from 0.5 to 1 fps, which could cause sediment resuspension and plant breakage.

Wind generated waves are a major factor affecting habitat conditions within the project area. Wind and wave models developed by the U.S. Geological Survey (USGS) were used to evaluate wind fetch and sediment suspension probabilities for the project area. A detailed description of the models can be found in Appendix K. Figure 3- 2 shows the mean weighted fetch for the study area, with much of the study area exceeding 2,000 meters fetch (7,000 feet). The rock mounds constructed in 1997 for the Bank Stabilization HREP and the other remaining islands do offer some level of protection, but fetch values are still high throughout most of the project area. As the islands continue to disappear, except those protected in 1997, wind fetch will increase substantially. Wind generated waves create orbital velocities that in shallow waters can resuspend sediments and uproot vegetation. As a result of the long fetches, the probability of sediment resuspension and erosion from wave action is very high and will increase in the future as islands erode (Figure 3- 3). Wind driven wave action during larger wind events can generate orbital velocities that exceed river flow velocities in the floodplain of the project area.

The overall hydrodynamic conditions in the local area, the upstream land use, and upstream conditions are important factors that affect the flow of sediment carried by the river in the vicinity of Harpers Slough. It is estimated that the total volume of bed material (i.e. sand) that moves through this reach of the Mississippi River is approximately 150,000 tons/year (Hendrickson, 2003). The volume of sand load at Harpers Slough is near the minimum for the entire reach of the Mississippi River in the St. Paul district between Lake Pepin and Lock and Dam 10.

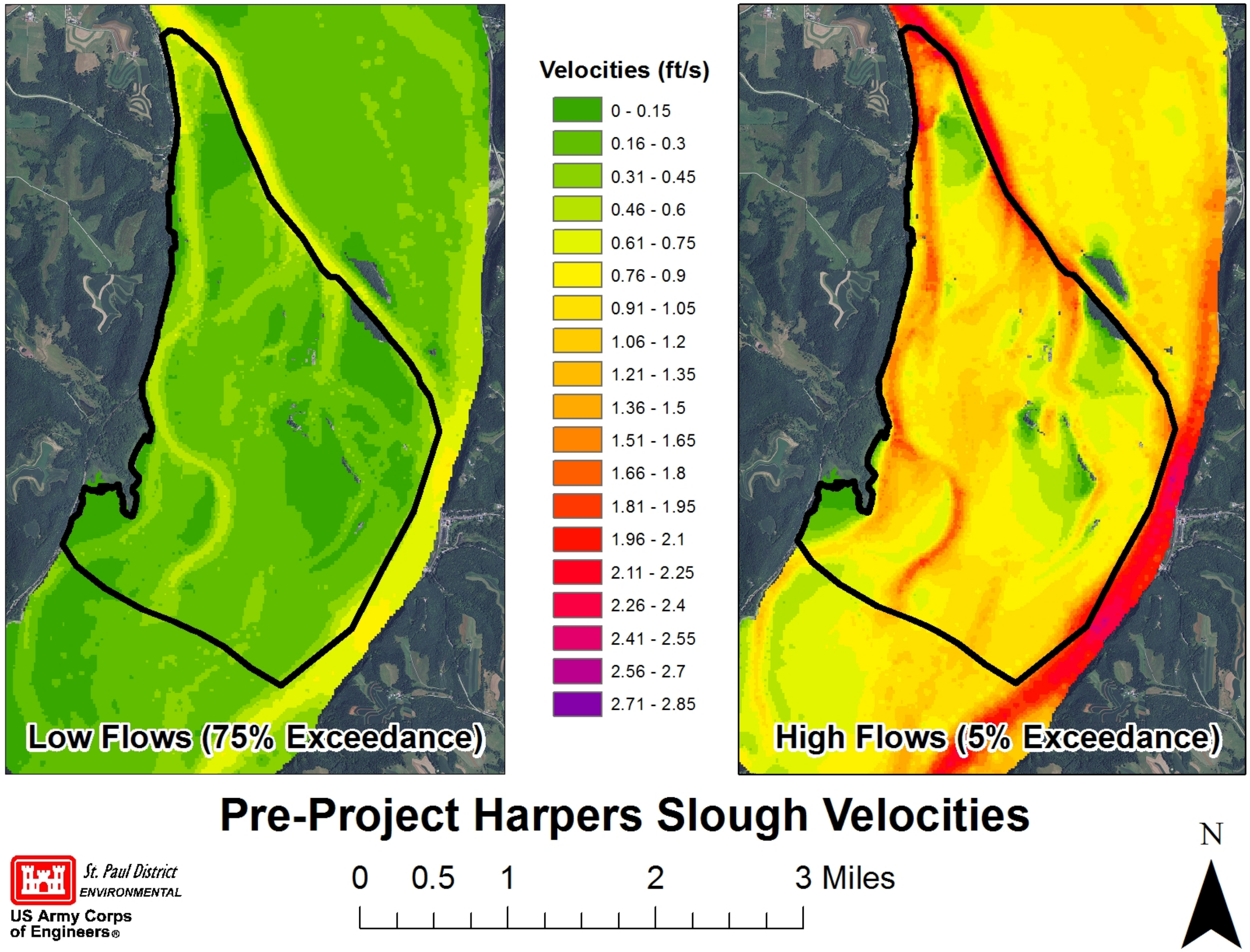

Figure 3- 1. Velocities of low and high flows at Harpers Slough.

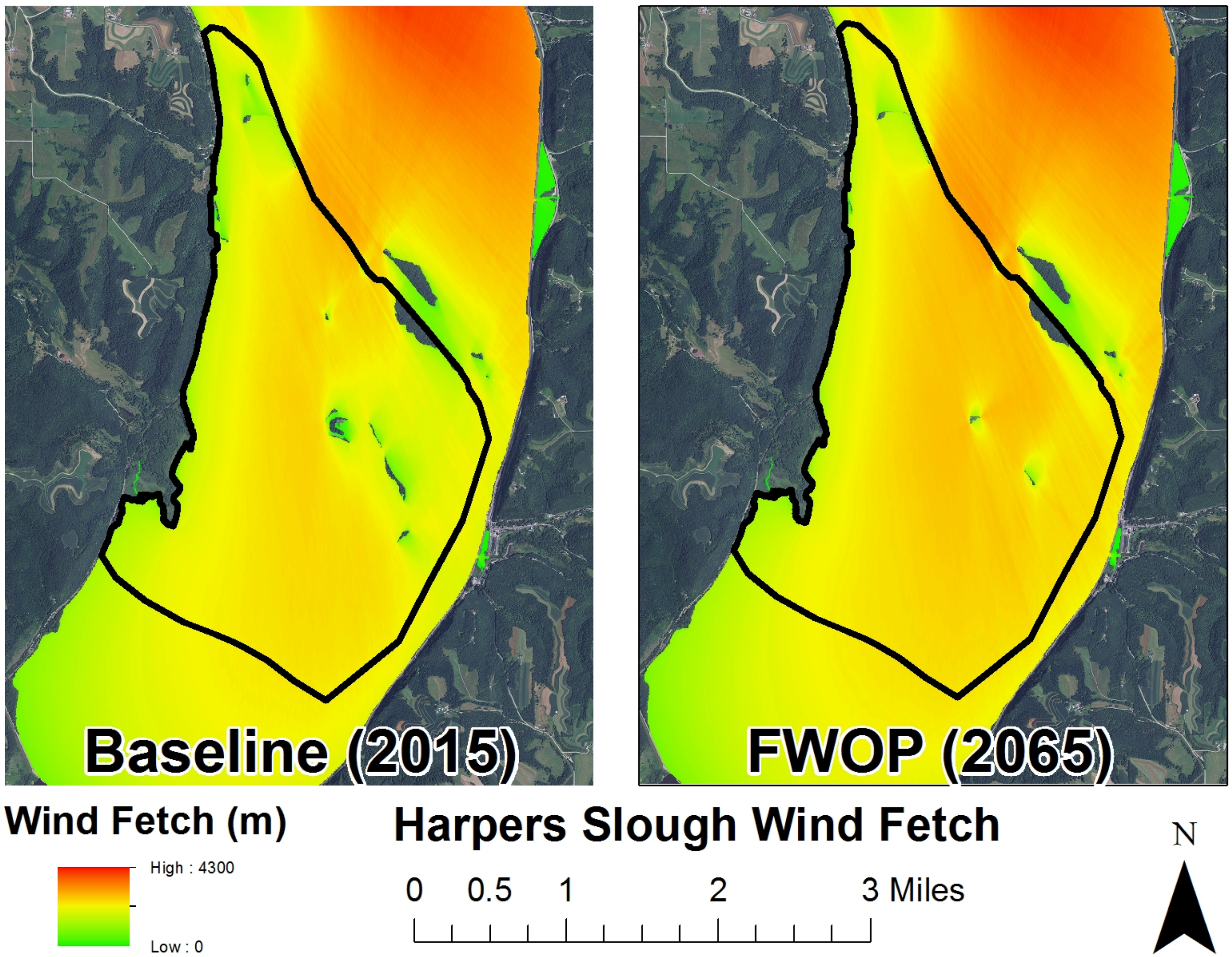

Figure 3- 2. Mean Weighted Fetch for Existing and Future Without Project Conditions.

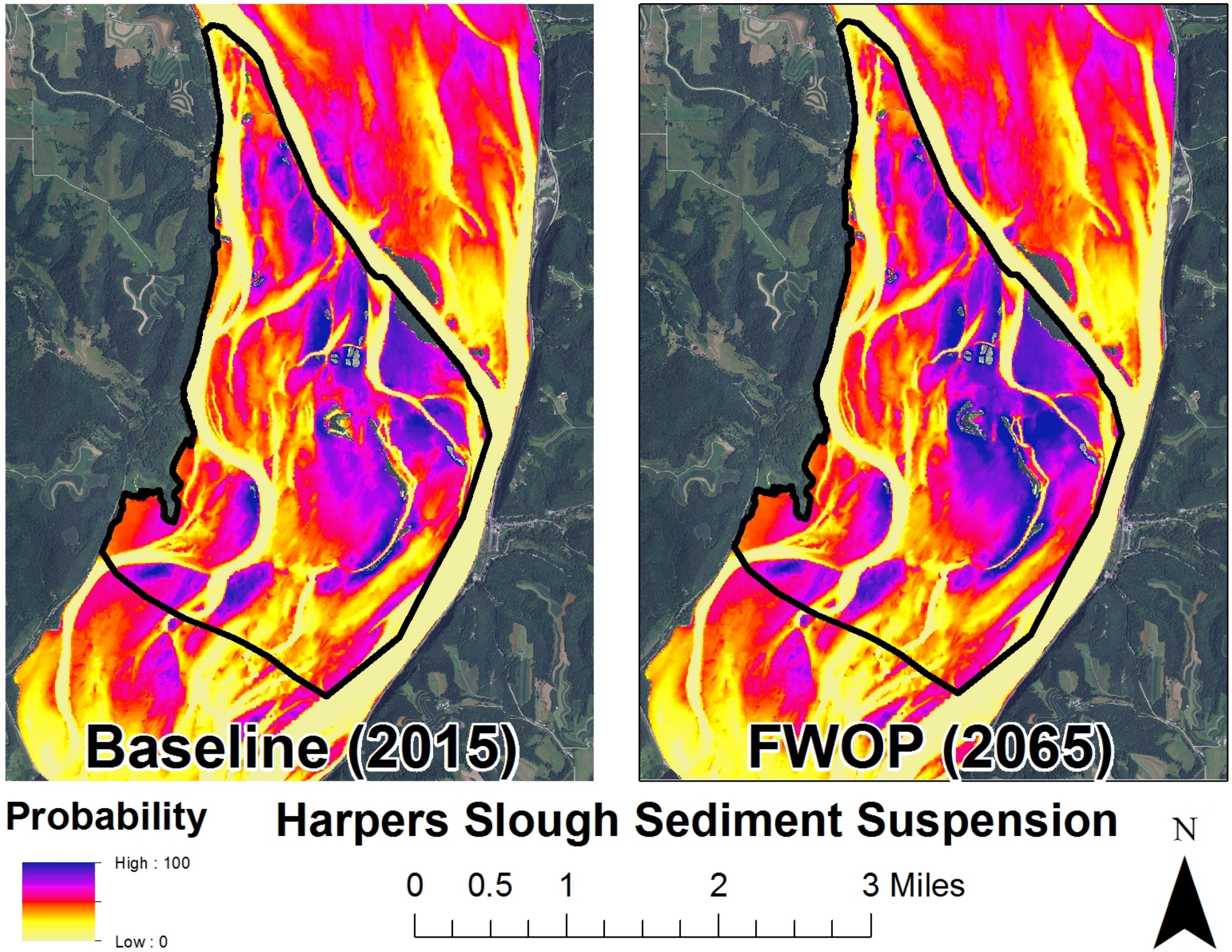

Figure 3- 3. Suspended Sediment Probability for Existing and Future Without Project Conditions (April – July).

3.3 GEOLOGY AND SOIL/SUBSTRATE

The most significant geologic event explaining the nature of the Mississippi River within Pool 9 occurred at the end of the Pleistocene glaciation approximately 10,000 years ago. Tremendous volumes of glacial meltwater, primarily from the Red River Valley's glacial Lake Agassiz, eroded the pre-glacial Minnesota and Mississippi River valleys. As meltwaters diminished, the deeply eroded river valleys aggraded substantially to about the present levels. Prior to impoundment, the broad floodplain of the river was depressions, sloughs, natural levees, islands, and shallow lakes. Since impoundment, a relatively thin veneer of silts, clays, or sands has been deposited over most of the river bottom within the pool. The sedimentation of fines (clay and silt) is generally greater in the slow moving backwater areas than in the major side channels and main channel portions of the impounded area.

In the bluffs of the Upper Mississippi River valley along Pool 9 are exposed Lower Paleozoic sedimentary rocks, dominantly carbonates (limestones and dolomites) and sandstones, overlain by unconsolidated materials of Quaternary (Upper Cenozoic) age loess of the earlier glacial advances. This stretch is part of the Driftless Area that was not covered by advances of the Wisconsin ice sheet. In the stretch from Lynxville north to Reno, Minnesota, the units exposed in the base of the bluffs are Cambrian age sandstones from the Dresbach Formation (Lower Cambrian) in the north to the Jordan Formation (Upper Cambrian) to the south. Overlying the Jordan Sandstone is the Lower Ordovician age Prairie du Chien Formation, a predominantly dolomite sequence generally divided into the Oneota and Shakopee Formations.

The principal parent materials of soils in the drainage basin associated with Pool 9 are loess, alluvium, and glacial drift. Loess over bedrock or over clay loam till is the major historical parent material of Pool 9 and associated uplands. The principal soil associations of the Pool 9 area are the Fayette and Fayette-Dubuque-Stonyland (FDS). The FDS association generally contains a higher percentage of shallow limestone soils on steep, stony land than the Fayette soil association. The sediment load carried into Pool 9 by the Upper Iowa River accumulates in backwater areas and in the navigation channel. The major soil type of upland peninsulas in Pool 9 is silt loam.

Sediment profiles were investigated. A total of 17 borings and 187 probes were completed near island alignments and potential borrow areas. The borings generally show an upper layer of soft to very soft fine-grained sediments (varying in thickness from 0 feet to over 27 feet) followed by a layer of sand mixed with fines and usually the last layer is a clean silty sand.

From a contaminants perspective, sediment quality is generally good in Pool 9. Main channel sediments are primarily medium to coarse sands with only trace amounts (generally less than 3 percent by weight) of silts and clays. Sand, silt, and clay sediments are found within defined sloughs, while finer silt and clay materials are found in marshy backwater areas. Levels of pesticides and other chlorinated hydrocarbons are generally below detection limits in all main channel sediments and detected at low levels in backwaters. Sullivan and Moody (1996) conducted a pre- and post-1993 flood (1991 and 1994) longitudinal (pools 1 through 11) survey of contaminants. This study compared the data to the Ontario Ministry of Environment and

Energy's Sediment Quality Guidelines (Persaud et al. 1993). Nitrogen was found above Ontario's lowest effect level guideline both pre- and post-flood, but was typical of concentrations in adjacent pools. Polychlorinated biphenyls (PCBs) and chlorinated pesticides were found at low levels, below Ontario's lowest effect level guideline. In comparing backwater areas for this reach to other reaches in the Upper Mississippi River, metals concentrations were found at levels within the expected ranges.

The quality of sediments within the project site is also good. Six fine-grained sediment samples were collected with corers in 1999 and 2004. Most sample locations had an upper layer of soft to very soft fine-grained soil of varying thickness. There were no organic hits above Ontario's or Wisconsin DNR's lowest effect level guidelines for sediment (Persaud et al. 1993; Solberg et al. 2003). However, some results were above the lowest effect level guideline for manganese, nickel, ammonia and Total Organic Carbon. Metals were found at levels typical of backwater sediments and comparable to what Sullivan and Moody (1996) recorded for Pool 9 in 1994.

3.4 WATER QUALITY

Mead (1995), in investigations of contaminants in the Mississippi River from 1987 to 1992, found water quality to be generally better in this reach of the Mississippi River than above Lake Pepin and in the reach downstream where tributaries that drain the Corn Belt begin to enter the Mississippi River.

In Pool 9, an assessment of selected parameters of water quality data suggests fair to good water quality. Data collected since 1977 were obtained from the Wisconsin DNR (Appendix P) and are summarized in Table 3- 3 for selected parameters in comparison to recommended guidelines recognized by EMP's LTRMP. Except for isolated sloughs and backwater lakes, the dissolved oxygen (DO) content of the water remains high year round and above levels required to sustain a quality fishery. Only rarely did DO levels drop below the established guideline of 5 milligrams per liter (mg/L). During the winter, high DO levels of over 10 mg/L (along with temperatures close to freezing) have also been shown during recent surveys of the project site. However, winter water velocities exceed criteria for centrarchid overwintering habitat within those portions of the project area with sufficient depth for this type of habitat. Because of its turbulent nature, the river is well aerated, and it can assimilate a considerable biochemical oxygen demand (BOD) loading. However, nutrient levels (nitrogen, phosphorus, potassium, calcium, etc.) were high, indicating ample support for luxuriant growth of rooted aquatics and algae. Concentrations of total phosphorus (TP) and total nitrogen (TN) regularly exceed guidelines, as did chlorophyll a concentrations. Total suspended solids also often exceeded guidelines. High nutrient levels are cause for concern regarding eutrophication.

Table 3- 3.
Water quality data (mean and range) for selected parameters in Pools 8 and 9 in comparison to established guidelines.

	TP (mg/L)	Chl a (μ/L)	TN (mg/L)	Summer TSS (mg/L)	DO (mg/L)
Guidelines	0.01 0.08[a]	10 – 30[b]	0.6 2.18[a]	<25[c]	>5.0[d]
Pool 9[e]					
Mean	0.15	29.2	2.3	41.6	10.7
Range	0.04 –0.35	0.3 –154.0	0.6 – 5.7	7.0 –171.0	3.4 20.0

[a] Source of procedures described for determining this: USEPA 2000; Smith et al. 2003.
[b] Source: Dodds et al. 1998.
[c] Source: summer average; Upper Mississippi River Conservation Committee 2003.
[d] Source: Upper Mississippi River Basin Association 2004.
[e] Source: Wisconsin DNR water quality data; 1977 – 20012.

3.5 VEGETATION

Impoundment resulted in a 58-percent loss of floodplain forest with a corresponding increase in development of aquatic and marsh vegetation in Pool 9. Within the project area, the loss of floodplain forest habitat was greater than 95-percent. This loss comprised a diversity of tree species such as willow (*Salix* sp), maple (*Acer* sp), birch (*Betula* sp), cottonwood (*Populus* sp), and elm (*Ulmus* sp) (in order of dominance). Prior to flooding, a coontail-elodea plant association was most common in ponds and lakes throughout the floodplain. Taxa from this plant group remained dominant in the Upper Mississippi River for some time after flooding. However, with continued stabilization of water levels, pondweeds such as American pondweed, sago, leafy pondweed (*Potamogeton foliosus*), small pondweed (*P. berchtoldii*), flat-stemmed pondweed, bush pondweed and curly muckweed are now much more common throughout much of Pool 9. Despite the overall changes in the plant community since impoundment, coontail (*Ceratophyllum demersum*), elodea, water stargrass (*Heteranthera dubia*), wild celery (Vallisneria Americana) and the pond lilies remain established in certain areas. The lentic (i.e., slack water), open water portions of the pool have a relatively productive plankton community dominated by diatoms and green algae.

The wide variety of floodplain and riverine habitats within Pool 9 has allowed the development of a diverse vegetative assemblage. River birch (*Betula nigra*) and swamp oak are the dominant species at the upland edge of the floodplain. Areas with mature floodplain forest usually consist of an overstory dominated by silver maple (*A. saccharinum*), black willow (*S. nigra*), cottonwood, box elder (*A. negundo*), green ash (*Fraxinus pennsylvanica*) and American elm (*Ulmus americana*). The understory in these areas consists primarily of wood nettle (*Laportea canadensis*), wild grape, aster, and rice cut grass. In transitional zones between aquatic and terrestrial habitat (e.g., sandbars and mudflat areas), dense stands of sandbar willow (*S. exigua*), small black willow and cottonwood trees are common.

The extent of terrestrial vegetation within the project site is limited due to eroding islands, but generally consists of mixed lowland hardwood forest and willows. Within the study area, aquatic vegetation is much more prevalent and consists of hornwort, duckweed, water lily, broad arrowhead, pondweed, and eelgrass.

Invasive plants are also found in the Upper Mississippi River and throughout Pool 9. These include common reed canarygrass (*Phalaris arundinacea*), buckthorn, purple loosestrife (*Lythrum salicaria*), Japanese hops (*Humulus japonicas*), Eurasian water milfoil (*Myriophyllum spicatum*), and curly-leaf pondweed (*P. crispus*). The Corps, USFWS, and State resource agencies are pursuing methods to control the spread of invasive species on lands they manage.

3.6 HABITAT

Pool 9 has a high variety of terrestrial and aquatic habitat conditions that change in diversity, complexity, and quality between the upper and lower sections of the pool. From a poolwide perspective, these habitats continue to support a diverse and productive fishery and provide important waterfowl nesting, feeding, and resting areas. However, the habitat quality for floodplain terrestrial species, terrestrial nesting species (turtles, shorebirds, neotropical migrants, etc), and fish habitat is of a low quality in the lower portions of Pool 9. Aquatic habitat in Pool 9 consists mainly of the main channel, channel border, slough, backwater lakes, impounded area, and tail water. Terrestrial habitat is predominately bottomland forest. The important characteristics of these habitat types, relative to fish and wildlife uses are described below.

3.6.1 AQUATIC HABITAT

Pool 9 contains main channel habitat where the majority of river discharge occurs and includes the navigation channel. This is the deepest part of the channel, which lacks rooted vegetation and varies in velocity with water stages. Sediments are usually dominated by sand and silt, and occasionally, gravel. Between the navigation channel and the riverbank is the channel border, which contains channel training structures (wing dams, closing dams, revetted banks) that create a diversity of depths, substrates, and velocities. However, the quality of habitat in some sections of the channel border has been degraded due to sedimentation, historic dredged material placement and effects of channel training structures. Pool 9 also contains secondary channels that carry less flow than the main channel. Many of the secondary channels have closing dams across the head of the channels where they depart from the main channel. This functions to maintain higher velocities in the main channel to promote scour and reduce maintenance dredging needs while at the same time reducing flow and increasing sedimentation in the side channels. There are numerous river lakes and ponds in the mid to upper sections of the pool that are usually dominated by mud or silt sediments with an abundance of rooted aquatic vegetation. Just below Lock and Dam 8 is a tail water area that is part of Pool 9 where sediments are composed of coarser substrates (sand to cobble) and no rooted aquatic vegetation is present. Immediately above Lock and Dam 9, extending from river mile 648 to approximately 662, is the impounded area. The impounded area has the least year-round diversity of fisheries habitat within the pool due to flooding of terrestrial areas, 70 plus years of sedimentation and island erosion. The vast majority of this area is also subjected to wave action during open water months (typically April – November).

The lower pool has little in terms of quality overwintering habitat for fish. Surveys conducted by resource agencies since 2002 illustrate the lack of quality habitat conditions between river mile 662 and Lock and Dam 9 (Janvrin, pers. comm. 2010). However, backwater areas of lower Pool 9 do provide seasonal use by centrarchids if conditions are appropriate. Evidence of this seasonal use has been observed in the lower pool 8, where largemouth bass and bluegill moved to the backwaters from late September to late October for overwintering (Bartels et al. 2008). Pool 8 backwater areas that were used for overwintering had the right combination of conditions; namely, minimal current velocity, higher winter water temperatures, and greater water depth.

The study area is dominated by submersed vegetation, followed by open water, rooted floating and emergent aquatic vegetation. In most of the area (72-percent) water depths are less than 5 feet, except the remaining sloughs (Table 3- 4, see Plate 4 for bathymetry). Areas with water depths less than 2 feet that might be suitable for establishment of emergent aquatic vegetation covers only around 9 percent of the study area.

Figure 3- 1 shows the distribution of flows within lower Pool 9 for the average river flow. Relatively high diffuse flow (0.2- 0.4 feet/second) occurs in much of the backwater area of the complex because of the lack of land areas to direct flows. Protected velocity shelters occur only around the remaining islands and in the Wexford delta area in areas were water depths average < 2 feet. As some of the remaining islands disappear, protected areas will also decrease. Currently, centrarchid overwintering habitat is non-existent in the Harpers Slough area.

Prior to impoundment, Pool 9 had hundreds of isolated and semi-isolated wetlands that became connected to the river during a variety of different river stages. For example, Galstoff (1924) reported that over 200 small lakes had no connection to flowing water in a 20-square mile area on the Wisconsin side of the main channel between Lynxville and Desoto, the area northeast of the Harper's Slough complex. Currently, there are very few isolated wetlands present in this same stretch of river due to becoming connected by impounding of water or lost due to sedimentation. The only remaining isolated wetlands in the Harper's Slough project area are associated with the Wexford Creek delta.

Table 3- 4. Water depths in the Harpers Slough study area.

	Evaluation Unit[a]				
Water Depth Categories (feet)	Upper (Acres)	Middle (Acres)	South West (Acres)	South East (Acres)	Total (Acres)[b]
<1	19.6	18.4	19.7	24.8	82.6
1-2	97.3	63.2	75.5	118.0	353.9
2-3	159.4	221.4	152.2	271.9	804.9
3-4	105.3	183.7	137.4	280.5	707.0
4-5	54.2	126.0	107.8	312.9	600.9
5-7	48.5	95.8	93.6	216.0	454.0
7-9	41.3	32.3	36.5	38.0	148.2
9-11	33.6	15.7	21.2	22.0	92.7
11-13	34.3	18.2	11.2	13.8	77.6
>13	32.3	34.2	44.0	8.9	119.4

[a] For purposes of habitat evaluation discussed later in this report, the study area was divided into these four geographic evaluation units.

[b]Bathymetry was used to calculated the coverage area of water depths. Some areas in the bathymetry contained "no data" and were most likely extremely shallow or part of an island. Acreages for these areas are not included in the table.

Most of the sloughs are open water, with only submerged banks defining the boundaries. Harpers Slough runs along the floodplain fringe shoreline and has greater water depth diversity than the other sloughs and most other areas where water depths are greater than 9 feet. The sloughs do contain some limited areas of aquatic vegetation along the submerged banks. Sloughs generally provide excellent spawning, nesting, and rearing areas although sedimentation, loss of vegetation, and periodic strong water currents are causing a decline in the fish and wildlife habitat values of these areas. Sloughs with submerged banks have been observed recently with less fish than channels defined by terrestrial features (Jeff Janvrin, pers. comm.).

3.6.2 TERRESTRIAL HABITAT

Terrestrial habitats within the floodplain of Pool 9 include areas of forest, brush and shrub areas, wet and upland meadows, areas disturbed by commercial or residential development and agricultural land. Areas previously disturbed by past dredged material placement are prevalent along the upper reach of the floodplain. Each of these areas can support a diversity of species, and they are important parts of the overall ecosystem. Forested areas in the region are of two types: upland xeric southern forests, and lowland forests of the floodplain (approximately 11,500 acres in Pool 9). Dominant tree species in the floodplain forest type are silver maple, black willow, cottonwood, American elm, and river birch. Species dominant in the better-drained areas are American elm, silver maple, green ash, and basswood. Wet meadows cover approximately 3,000 acres of the floodplain in Pool 9, and willows/shrubs cover approximately 1,500 acres. These habitat types showed significant declines in acres when the pool was inundated, being converted to deep and shallow marshes and large contiguous open water areas above the lock and dam. These habitat types are important to a variety of wildlife. Terrestrial areas dominated by industrial, commercial or residential use are prevalent in the floodplain of the Pool 9 (approximately 400 acres). Agricultural areas (approximately 1,000 acres) include areas devoted to production of annual crops and alfalfa, pastures or landscape nurseries. Within the study area, terrestrial habitat is limited to the remaining islands.

3.7 FISH AND WILDLIFE

3.7.1 FISH

In Pool 9, 93 species of fish have been commonly reported, and 38 species are known from its main tributary, the Upper Iowa River (Steuck et al. 2010). In general, the species assemblages found today in the Upper Mississippi River appear to be similar to what was found before locks and dams were constructed (Janvrin 2005). Common game and panfish species include the walleye (*Sanders vitreus*), sauger (*S. canadensis*), northern pike (*Esox lucius*), channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), white bass (*Morone chrysops*), bluegill (*Lepomis macrochirus*), and white and black crappie (*Pomoxis annularis* and *P. nigromaculatus*). Common nongame fish include the freshwater drum (*Aplodinotus grunniens*), carp (*Cyprinnus* sp.), redhorse (*Moxostoma* sp.), buffalo (*Ictiobus* sp.), and a wide variety of minnows. Catfishes, buffaloes, and carp are the primary fish of commercial interest. Largemouth bass, smallmouth bass (*M. dolomeiu*), bluegill, crappie and walleye use side channels and sloughs for all life functions. Northern pike, white bass, carp and buffalo use side channels and sloughs for rearing, wintering and spawning. Tail waters are particularly important areas for species like paddlefish (*Polyodon spatula*) and sturgeon (*Acipenser* sp.), which were largely displaced by inundation of the natural river.

Recent reports have suggested that invasive Asian carp species may be present in Pool 9, although they are likely in numbers too small to have established sustaining populations. These include silver (*Hypophythalmichthys molitrix*), grass (*Ctenopharyngodon idella*), and bighead (*H. nobilis*) carp. They have not been documented as part of any routine scientific surveys, but have been detected instead by commercial fishermen.

Within the project site, fish surveys were conducted by the Wisconsin DNR from 2007 to 2012. Yearly fixed site species diversity ranged from 8 to 13 species, with 23 total species sampled. Yearly Harper's Slough stratum random site species diversity ranged from 15 to 20 species, with 31 total species sampled. Fish species present included bluegill, common carp (*C. carpio*), emerald shiner (*Notropis atherinoides*), largemouth bass, northern pike, pumpkinseed (*L. gibbosus*), sauger, shorthead redhorse (*M. macrolepidotum*), rock bass (*Ambroplites rupestris*), smallmouth bass, yellow perch (*Perca flavescens*), carpsucker (*C. carpio*), golden shiner (*Notemegonus crysoleucas*), Johnny darter (*Etheostoma nigrum*), brown bullhead (*Ameiurus nebulosus*), and tadpole madtom (*Noturus gyrinus*). The 2007, 2008, 2009 and 2010 average number of species/random run was 5.1, 4.7, 4.1 and 4.1, respectively. Harper's Slough's 2007 – 2010 random run pooled average number of species/run was 4.6 (SE = 2.3). The 2007 – 2010 random runs species diversity within the Harper's Slough stratum was slightly above average for all lower Pool 9 random sites combined. This may due to the presence of some structure and the presence of Harper's Slough and the tributary influence of Wexford Creek within the stratum.

Fixed electrofishing runs in the most likely overwintering sites within Harper's Slough were conducted since 2007. The average catch per unit effort (CPUE) of age 1 plus bluegill and largemouth bass, 1 and 5 fish per hour, respectively, was a fraction of what was observed at fixed runs at known overwintering sites over the same time period (172 and 184 fish per hour, respectively). This CPUE for fixed sites within Harper's Slough was similar to the CPUE of 3 and 2 fish per hour, respectively, determined at the same fixed sites within Harper's Slough during the 2002 – 2006 overwinter inventory.

The 2007-2010 random runs average age 1 plus CPUE within the stratum was 2 bluegill and 4 largemouth fish per hour. This was > 3 times less than the 2007 – 2010 pooled average CPUE of age 1 plus fish from all random runs throughout lower Pool 9. Collectively, the fixed and random runs indicate no overwintering habitat exists within the Harper's Slough complex. This indicates that even the site where Wright (1970) observed ice anglers during 1963 – 1965 aerial surveys no longer provides overwintering habitat.

Length frequencies of bluegill and largemouth bass showed a high proportion of young-of-year fish each year adequate sample sizes were collected. In both cases, these distributions were more similar to the size distribution of random sites than size distribution at fixed runs within known overwintering areas.

3.7.2 WILDLIFE

Pool 9 contains an abundance of wildlife. The area contains a rich mixture of vertebrate animals from the northern and southern United States, as well as an overlapping of eastern and western species.

The great variety of bird species, especially waterfowl, that use Pool 9 can be attributed to its location within the Mississippi flyway. Although Pool 9 is not of great importance as a nesting area for waterfowl (other than wood ducks), it is an important resting area during spring and fall migration. During these seasons, ring-necked ducks, canvasbacks (*Aythya valisineria*), and lesser scaup (*Aythya affinis*) use the deeper areas of the backwater, while mallards (*Anas platyrhynchos*), wigeon, blue-winged teal (*A. discors*) and wood duck (*Aix sponsa*) use the shallower areas. Canvasbacks that use Pool 9 and similar areas in pools 7 and 8 have been estimated to represent up to 90 percent of the continental population of this species east of the Rocky Mountains. Most of the eastern population of tundra swans (*Cygnus columbianus*) (approximately 100,000 birds) also use pools 7, 8, and 9 during migration. High waterfowl use as measured by numbers of birds has been observed in these areas as a part of weekly surveys conducted by the USFWS in the spring and fall (although numbers of birds can be highly variable across sites and seasons). A summary of this data over the last 16 years indicate an average of 5 million waterfowl use days in the project area (Table 3- 5). This represents over 20% of waterfowl use days over the entire refuge.

Table 3- 5. Waterfowl Use Days in the project area and the refuge.

Year	WUDS (Harpers Slough)	WUDS (Refuge Wide)
1997	4,083,124	13,102,433
1998	3,998,671	33,929,949
1999	4,576,556	28,215,021
2000	2,716,378	16,302,653
2001	2,698,522	18,238,278
2002	2,413,857	14,028,271
2003	3,986,121	15,701,769
2004	3,101,890	13,986,426
2005	5,531,435	22,011,378
2006	5,142,520	23,448,863
2007	3,707,963	20,392,914
2008	4,282,708	23,439,889
2009	13,368,290	38,020,998
2010	5,401,975	23,151,275
2011	9,507,475	45,006,437
2012	4,133,605	30,792,536
Average	4,915,693	23,735,568

As with other pools in the Upper Mississippi River Refuge, areas important for waterfowl migrants in Pool 9 are managed in accordance with the USFWS Upper Mississippi River National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006). Closed areas, such as the Harpers Slough Closed Area (5,209 acres), located along the right descending bank from river mile 648 to river mile 655; provide critical resting and foraging opportunities for these migratory waterfowl. Other areas in proximity to the project site but which are open to hunting such as the Lansing Big Lake, Capoli Slough, the large open water area off of Sugar Creek, and Winneshiek Lake, also provide critical resting and foraging opportunities for these migratory waterfowl.

Harpers Slough Closed Area is a critical feeding and resting area for waterfowl during the fall migration, often having more use than any other closed area on the Refuge. It plays a critical role in minimizing disturbance to waterfowl utilizing both the closed area and the open water area upstream in front of Sugar Creek. This area is one of the most important migratory rest stops on the Refuge for canvasback ducks and tundra swans. During peak migration periods up to one quarter of the world’s Canvasback population has been observed resting and feeding in this area. Large concentrations of puddle ducks and additional diving duck species are commonly recorded as well during both fall and spring migration periods. Pool 9 is the most productive (Kcal) pool on the Refuge (Slivinski, 2004). Harpers Slough Closed area protects 14 percent of the pool’s estimated 16,810 million Kcal production for use by migrating waterfowl.

Pool 9 additionally provides nesting and foraging habitat for many passerine bird species. Some of these species spend the entire year in the area, while others migrate into the area at various times of the year. Many varieties of raptors use the river valley as a flyway, and a number of these species, such as eagles, hawks, and owls, over-winter in these floodplain areas. Several bird species occur in Pool 9 that are of special interest because of their status as rare or endangered species.

Foremost among bird species is the bald eagle (*Haliaeetus lecocephalus*), which was recently de-listed from the federal list of threatened species and has increased dramatically in recent years. Eagles use Pool 9 year-round. In addition, the pool is part of an important migration corridor. Although eagle nests in Pool 9 occasionally are located over water, most are found away from the immediate shoreline in large areas of undisturbed mature or old growth timber with an open and discontinuous canopy. Preferred nesting sites are usually tall, prominent trees, with an open structure and stable limbs that allow easy approach from the air. Pool 9 has many active nesting sites, which produce one to two young a year per nest. Also, a large amount of bald eagle use within the pool is during winter. Winter use is highest where the river is ice-free and adequate perch sites are available. Seven active bald eagle nests are in proximity to the study area; on existing islands and flood plain fringe (Figure 3-4). The eagle is protected under the federal Bald and Golden Eagle Protection Act.

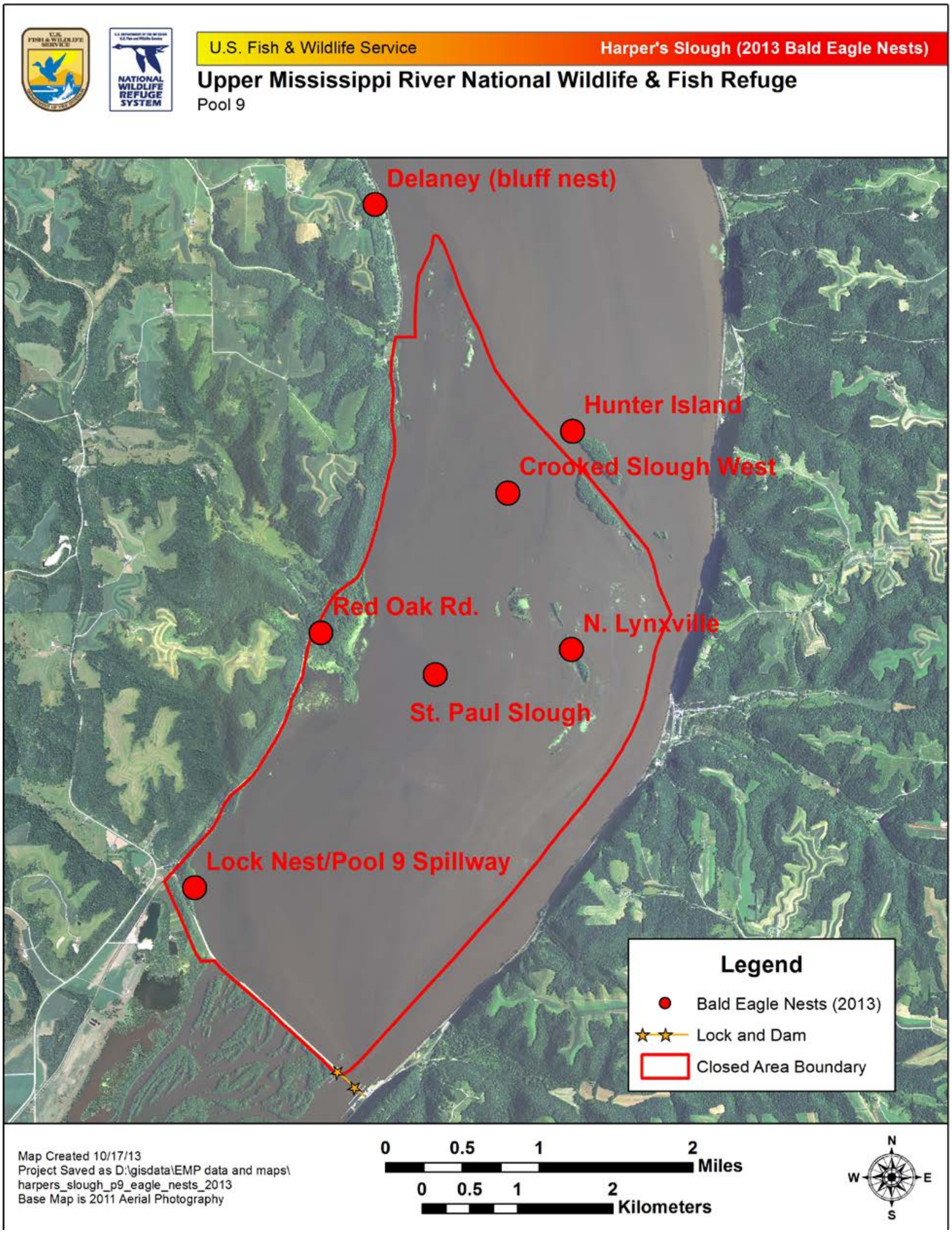

Figure 3-4. Bald eagle nest locations in the study area and immediate surroundings.

Other species known to occur in Pool 9 that are of special interest include the osprey (*Pandion haliaetus*), double-crested cormorant (*Phalacrocorax lucidus*), and pileated woodpecker (*Dryocopus pileatus*).

Pool 9 provides habitat to a wide variety of mammals. White-tailed deer (*Odocoileus virginianus*) use the area throughout the year. Many small carnivores such as fox, raccoon (*Procyon lotor*), and weasel (*Mustela* sp.) use the area. Larger carnivores such as bobcat (*Lynx rufus*) and coyote (*Canis latrans*) use the area infrequently. Many smaller mammals such as beaver (*Castor* sp.), muskrat (*Ondatra zibethicus)*, shrews, moles, bats, rabbits, and squirrels and numerous varieties of mice are relatively common in the area.

The floodplain of Pool 9 provides habitat for a wide variety of amphibians and reptiles. Common species typically found in sloughs of the floodplain may include fox snake (*Pantherophis vulpina*), tiger salamander (*Ambystoma tigrinum*), American Toad (*Bufo americanus*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), snapping turtle (*Chelydridae* sp.), painted turtle (*Chrysemys picta*), common map turtle (*Graptemys geographica*), Eastern hognose snake (*Heterodon platirhinos*), and Northern leopard frog (*Lithobates pipiens*). The scarcity and continued decline of islands in Pool 9 does not provide good nesting and resting habitat for turtles.

Surveys for wildlife other than waterfowl within the study area have not been conducted; however, anecdotal accounts indicate that the small mammals, reptiles, and amphibians identified above use the area. As the islands have decreased in the study area, turtle resting and nesting habitat has become very limited in the study area. Use by large mammals is limited due to the declining size of islands and isolation from the floodplain forest.

3.7.3 AQUATIC INVERTEBRATES

The diverse invertebrate assemblage within Pool 9 can be attributed to a wide variety of habitats available. Suitable lentic, lotic and transitional habitats are available for many different types of organisms. In addition, rocks associated with wing dams and shoreline protection (as well as woody debris accumulated in backwater areas); provide a substantial amount of hard, stable substrate for many highly productive taxa. These taxa can represent a substantial dietary item for many fishes and other vertebrates. Other invertebrate taxa attach to emergent and submerged aquatic vegetation in backwater areas. Many of these taxa serve as an important food source for waterfowl.

The pool supports various species of mussels. Within the project site, species found include common species as well as some of the more rare species. Recent surveys have shown 21 live species and two additional dead species (i.e. empty shell). One live federally endangered Higgins eye (*Lampsilis higginsii*) was collected in 1998, but was relocated away from any future impacts of the project. Overall, approximately 70% of the entire community was dominated by three regionally common species; threeridge (*Amblema plicata*) (30%), giant floater (*Pyganodon grandis*) (29%), and white heelsplitter (*Lasmigona complanata*) (11%) (Appendix M).

A recent exotic introduction, the zebra mussel (*Dreissena polymorpha*) has been observed in very high numbers in the pool. This species has adversely affected the freshwater mussel populations. Fingernail clams (*Musculium transversum*) thrive in areas of Pool 9 that have adequate oxygen and silt bottoms. They are important food items for both waterfowl, especially diving ducks, and several species of fish.

Pool 9 insect fauna is dominated by immature stages of mayflies, midges, and caddisflies, indicative of high dissolved oxygen levels. Being efficient converters of detritus, aquatic insects are an important link in the food web, providing food for fish and waterfowl.

3.7.4 THREATENED AND ENDANGERED SPECIES

The pool has many species of fish, mussels, plants, birds, mammals, and others listed by the states of Iowa, Minnesota, and Wisconsin as endangered, threatened, or of special concern (https://programs.iowadnr.gov/naturalareasinventory/pages/RepDistinctSpeciesByCounty.aspx?CountyID=3; http://dnr.wi.gov/topic/NHI/documents/Crawford_County.pdf). Of these taxa, mussels are of particular interest for the proposed project due to their benthic habitat needs and limited mobility. Wisconsin state-listed mussel species that occur within the study area include the wartyback (*Quadrula nodulata*) and rock pocketbook (*Arcidens confragosus*). Several federally-listed species or candidate species occur in Allamakee County, Iowa and Crawford County, Wisconsin. However, as determined by the USFWS the only federally listed, proposed, or candidate species that is likely to occur within the area that may be affected by the project is the Higgins eye mussel (*Lampsilis higginsii*).

3.8 CULTURAL RESOURCES

Cultural resources are a major component of the Upper Mississippi River Valley and are integral, nonrenewable elements of the physical landscape. Collectively, the archaeological record indicates continual human occupation along the river for approximately 12,000 years. Cultural resources are located throughout the pool and across a wide variety of landforms. Three cultural resource sites are located within the project's Area of Potential Effect (APE). Significant archaeological resources, like those present within the project area of influence, contribute to our knowledge of the past. Preserving and preventing degradation of these important assets is one of the responsibilities of the Corps and other agencies.

Archaeological investigations have been ongoing along the Upper Mississippi River and in the Pool 9 locality for over a century (e.g., Boszhardt 1995, Jalbert and Kolb 2003, Keyes 1928, Lewis 1889, Orr n.d., Thomas 1894). Early research in the area was conducted by antiquarians focused on upland sites around the pool and was centered on the contents of burial mounds and who built them. As professional investigations ensued, a variety of academic and cultural resource management driven projects for road construction and other development activities were conducted (e.g., Penman 1984; Stanley and Stanley 1986, Wedel 1959). However, significant investigations within the floodplain did not commence until 1975 (Benn 1976). Since then, the Corps and the USFWS have sponsored several cultural resource investigations within the pool for various projects, including dredged material placement sites, flood control features, shoreline surveys, erosion monitoring programs as well several literature-based overviews, such as site inventories, geomorphic mapping, shipwreck locations and navigation features (e.g., Benn and Lee 2005; Boszhardt 1992, 1995; Boszhardt and Moffat 1994; Jalbert and Kolb 2003, Jensen 1992; Gnabasik 1993; Madigan and Schirmer 2001; Overstreet et al. 1983; Pearson 2003; Perkl 2002; Vogel et al. 2003, Withrow 1983; Yourd and Anfinson 1982).

Cultural resource sites within the Pool 9 locality exist on a variety of landforms, including uplands, terraces, islands, the river floodplain (e.g., natural levees), and within the river channel. Identified cultural resources include precontact single artifact finds, lithic and artifacts scatters, village sites, rock shelters, caves, petroglyphs, burials and burial mounds. Historic cultural resources include fur trade sites, early American town sites, a Black Hawk War (1832) battlefield, farmsteads, mills, cemeteries, clamming sites, historic standing structures, shipwrecks and river navigation structures (e.g., wing dams). Several cultural resource sites within Pool 9 have been listed on the National Register of Historic Places (NRHP) or are eligible to be listed on the NRHP. As a whole, the assortment of cultural resource sites within and proximal to the Pool 9 locality have contributed to our knowledge base concerning the cultural history of this region of the Upper Mississippi River (e.g., Alex 2000; Benn 1979; Birmingham et al. 1997; Logan 1976; Theler and Boszhardt 2003).

Located in the impounded portion of Pool 9, the Harpers Slough project area has suffered from extreme erosion through the effects of the construction of Lock and Dam 9 in the 1930s and operation/maintenance of the 9-Foot Channel Project. For example, only small, fragmented islands remain from a larger island complex that existed in the area prior to inundation. This widespread environmental degradation has undoubtedly affected cultural resources in the area.

Nonetheless, twenty cultural resources have been identified within one mile of the project. Sixteen of the sites are located along the uplands of the river valley; four sites are situated on islands within the river floodplain. Of these, three sites: 13AM353, 13AM354 and 13AM355 are positioned on the remnant islands of the Harpers Slough complex. Each of these three sites was identified from artifacts exposed along eroding shorelines and each contains a variety of precontact materials (Boszhardt 1995). One site, 13AM354, was subsequently evaluated and determined eligible for listing on the NRHP (Overstreet n.d.). The Corps considers sites 13AM353 and 13AM355 potentially eligible for listing on the NRHP.

3.9 RECREATION/AESTHETIC RESOURCES

The natural character of this portion of the river and the relatively good water quality in Pool 9 contribute to its recreational and aesthetic desirability. The fishery within Pool 9 is one of the most active in the Upper Mississippi River. A relatively high level of sport fishing activity occurs within the pool, and commercial fish harvest in Pool 9 is greater than any other area in the Upper Mississippi River. The commercial fishery is particularly active from the lower reaches of Harpers Slough downstream to the dam.

Recreational activities are most concentrated in the upper two-thirds of the pool, above Lansing. Accordingly, the Lansing Big Lake area is an important recreational resource. This area is heavily used for fishing, boating, and hunting, and a designated canoe route passes through it (and the Upper Iowa River). Other important recreational activities in the pool include picnicking, camping, swimming, canoeing, trapping, and a number of high quality recreational beaches, public day-use and camping recreation facilities, and private marina facilities are available. The Corps of Engineers operates Blackhawk Park, the largest developed recreation facility in Pool 9. It offers boat access facilities, other day-use facilities, and a large campground. Other public recreation facilities in Pool 9 include seven boat landing/parking areas that are scattered throughout the pool. Mt. Hosmer Park, located in Lansing, Iowa, offers picnicking and scenic overlook facilities. In the summer, the public and private access facilities adequately serve the public. These boat access points also facilitate winter hunting, trapping, snowmobiling, and ice fishing. As result of past channel maintenance activities, a number of sand-covered island beach sites currently exist in Pool 9, and most of them receive extensive recreational use.

The nearest recreational facilities to the Harpers Slough project area are an Iowa DNR public boat landing located off of Harpers Slough, Heytmans Landing, a community-owned boat landing at Ferryville, Wisconsin, and the Lynxville Landing, Lynxville, Wisconsin. Recreational use in the project area consists primarily of fishing, waterfowl hunting, and wildlife observation. The Wexford Delta area is particularly popular for bird watching, including resting waterfowl.

3.10 SOCIOECONOMIC SETTING

The setting of the upland areas bordering lower Pool 9 can be characterized as rural-small town. Lansing, Iowa is located approximately 7 miles upstream of the project area and has a population of about 1,300. Ferryville, Wisconsin is located 2 miles upstream from the Harpers Slough project area; it has a population of about 200. Lynxville, Wisconsin is located across the main channel from the study area; it has a population of about 176. The rural areas bordering lower Pool 9 contain a mixture of agriculture and wooded areas. Flat areas on the bluff tops and in the stream valleys are farmed. The areas that are too steep for farming are wooded.

An Interstate Power and Light electric generating station is located on the Iowa side of the river about 5 miles upstream of the project area.

Transportation corridors bound both sides of the floodplain in lower Pool 9. Railroad tracks border both sides of the river in lower Pool 9. On the Wisconsin side, State Highway 35 parallels the river. No paved road is along the river on the Iowa side between river miles 649 and 660. In addition, the river serves as a corridor for commercial navigation of barge traffic via the 9-foot navigation channel as authorized by Congress. Barge traffic transports a wide variety of essential goods on the UMRS. Agricultural commodities, petroleum products, and coal are the leading cargoes, with farm products accounting for approximately half the total tonnage shipped.

Based on the 2010 Census, the population of Allamakee County is 98% white. On the other side of the river, the population of Crawford County is 94% white. African American, Native American, Asian, and Native Hawaiian make up the rest of the population. The median annual income for a household in Allamakee County was $39,000 and in Crawford County was $49,000. About 12.6% and 11.4% of the population was below the poverty line in Allamakee and Crawford counties, respectively.

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4. PROBLEM IDENTIFICATION

4.1 EXISTING HABITAT CONDITIONS

Based on the data discussed above in Sections 3.1-3.10, baseline conditions for habitat in the remaining Harpers Slough complex (project area) would generally be considered poor to marginal for a variety of fish and wildlife species expected to occur in this type of habitat. As more fully detailed above, the area contains a variety of habitats dominated by shallow aquatic areas with emergent and floating-leafed plants. Those areas slightly deeper support beds of submersed aquatic vegetation but also have areas devoid of any vegetation (open water). Running sloughs are within and bound the complex; they provide additional habitat diversity.

Concerns over habitat deficiencies include the continued loss of the mosaic of habitat, especially the continued disappearance of islands and emergent vegetation. Deep, protected aquatic habitat that would serve as overwintering habitat for centrarchid fish and associated species is also lacking and would continue to be lost. This type of over-wintering habitat is extremely rare in lower Pool 9 and has been declining with the loss of islands and bathymetric diversity. Habitat conditions in the project area have degraded, and without the intervention of project measures conditions are anticipated to deteriorate even further. Specifically, the major concerns are as follows:

1. The declining size of quality habitats within the Harpers Slough complex, especially when combined with the disappearance of similar habitat in all of lower Pool 9.

2. The loss of terrestrial habitat (islands) and protected off-channel aquatic habitat.

3. Increases in wind fetch and wave action that contributes to suspended sediments that is detrimental to aquatic vegetation and water quality.

4. Loss of bathymetric diversity caused by sedimentation.

4.2 HISTORICALLY DOCUMENTED CHANGES IN HABITAT CONDITIONS

The following documents the physical and vegetation characteristics of the study area at various points in time for which information exists. No attempt was made to estimate the quality of the fish and wildlife that existed at these points in time.

4.2.1 1929 AERIAL PHOTOGRAPHS

These photographs show the Harpers Slough area to be undeveloped floodplain (Plate 5). Crooked Slough was the main navigation channel. A portion of the main channel was realigned to the east after inundation to cut off a large bend in Crooked Slough as shown on Plate 5.

4.2.2 1970S AERIAL PHOTOGRAPHS

Plate 5 also shows an aerial photograph taken in the 1970s for the 9-Foot Navigation Channel Project. This photograph indicates a marked change in the river from 1929 as a result of inundation. The State boundary follows the old Crooked Slough bend and the eastern portion of the study area is located in Wisconsin. Running slough habitat is much less defined, with greater connectivity with backwaters. Also, much of the diversity associated with terrestrial habitat has been lost. Additional details on the composition of land cover during this period is available from the 1975 Land Class Land Use GIS shapefile (LCLU; Enclosure 1 of Appendix D).

4.2.3 2000 AERIAL PHOTOGRAPHS

The 2000 aerial photographs (Plate 6) show a marked change from the 1970's in the study area. Nearly 30 percent of the land was lost, going from 88 to 63 acres and emergent vegetation declined by almost 80-percent, from 198 to 42 acres. Rooting floating vegetation also declined almost 60-percent, from 465 to 195 acres. However, submersed aquatic vegetation increased from 875 to 1,440 acres (Enclosure 1 of Appendix D). Additional details on the composition of land cover is available from the 2000 LCLU GIS shapefile (Enclosure 1 of Appendix D).

4.2.4 2010 AERIAL PHOTOGRAPHS

The 2010 aerial photograph (Plate 6) shows that there may have been an additional expansion of submersed vegetation compared to 2000. Islands in the study area show a decline since 2000, going from 63 to 52 acres. However, there were notable increases in aquatic vegetation during this period (Enclosure 1 of Appendix D). In the study area, aquatic vegetation is present in nearly all of the areas with water depths less than 5 feet (3,783 acres) and may extend into water depths greater than 5 feet. Additional details on the composition of land cover is available from the 2010 LCLU GIS shapefile (Enclosure 1 of Appendix D).

4.2.5 LAND COVER SURVEYS

Land cover surveys involving formal classification of cover types are available for the project site and its surroundings from 1975, 1989, 2000 and 2010 (Table 4 - 1, Figure 4 - 1). Enclosure 2 of Appendix D shows a comparison of major cover type acreages for the Harpers Slough study area. Throughout this period, there has been a progressive loss of acres and number of islands in the Harpers Slough study area. Emergent aquatic vegetation and rooted floating aquatic vegetation progressively declined from 1975 to 2000, but increased in 2010. However, submersed vegetation has increased substantially throughout this period. This increase is attributed to improved water quality. However, it appears that submersed aquatic vegetation peaked in 2010 and has declined since then evident in the latest aerial photographs.

The mapping of land cover included some generalization based on the resolution of the aerial imagery and the processing of the land cover surveys. The aerial photographs used for the classification of land cover had varying resolution. The resolution of the aerials determined the detail at which land cover mapping took place, resulting in a range of minimum mapping units from less than 1 acre to 2.5 acres. For additional information on the land cover surveys, including the size of minimum mapping units and scale of imagery used for mapping, see Enclosure 2 of Appendix D.

Table 4 - 1. Acreages of major cover types in the study area as obtained from LCLU GIS data. analysis.

	Year			
Cover Type	**1975**	**1989**	**2000**	**2010**
Land	87.7	↓66.8	↓63.0	↓51.8
Open Water	1,880.9	↓1,847.4	↓1,765.9	↓846.3
Submersed Aquatic Vegetation	874.8	↑1,260.1	↑1,441.2	↑2,143.2
Rooted Floating Aquatic Vegetation	465.3	↓284.9	↓194.8	↑360.4
Emergent Vegetation	198.0	↓47.4	↓41.7	↑104.2

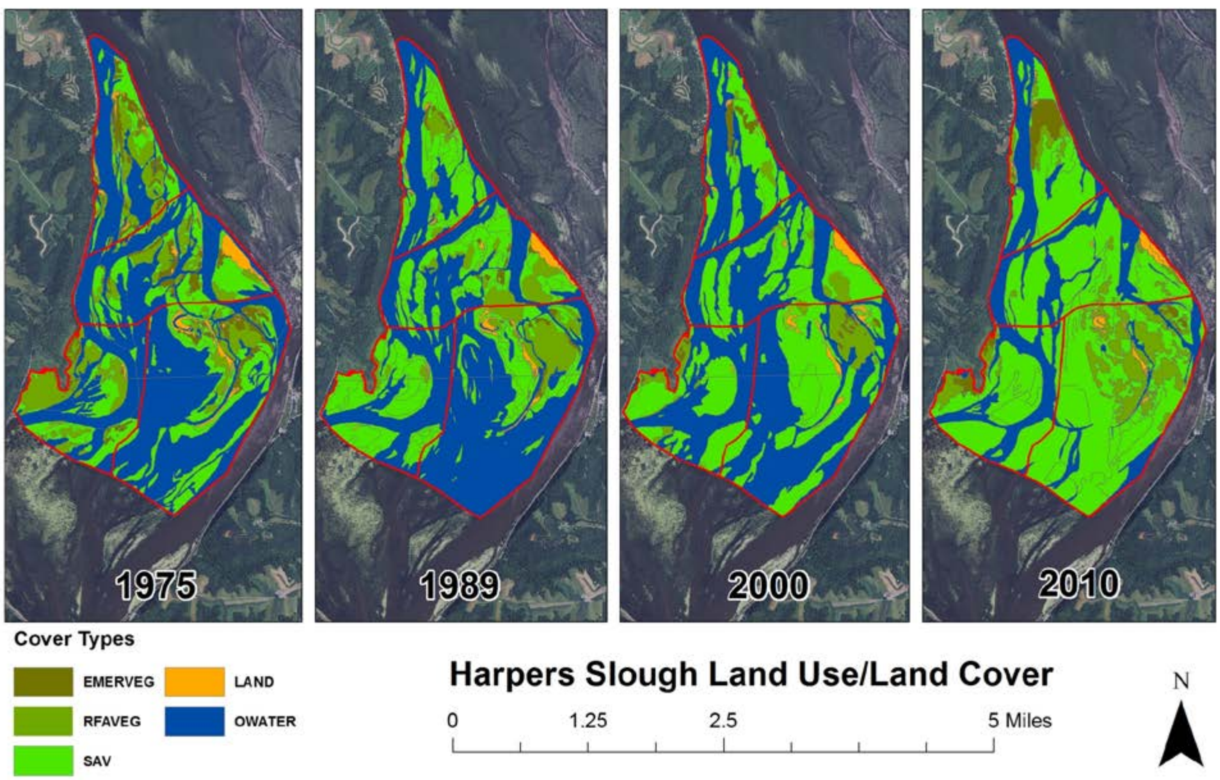

Figure 4 - 1. Cover type distribution of the study area for 1975, 1989, 2000, and 2010.

4.2.6 SUMMARY

Available historic information, consisting primarily of aerial photographs and land cover surveys show the following:

1. Prior to the creation of Pool 9, the Harpers Slough area was an undeveloped portion of the Upper Mississippi River floodplain.

2. Creation of Pool 9 in 1938 resulted in a permanent raise in water levels in the Harpers Slough area of between 6 and 7 feet during non-flood periods.

3. Inundation by the pool left few areas of high ground in the form of islands. Inundation resulted in conditions amenable to the growth of aquatic vegetation.

4. Immediately following inundation, the forces of wave action and currents began reworking the “landscape” of lower Pool 9. The result, with respect to the Harpers Slough area, has been the loss of the riparian islands/aquatic plant beds.

5. Based on the land cover surveys, it is estimated that the area of islands in the Harpers Slough study area has declined from about 88 acres in 1975, to about 67 acres in 1989, to about 63 acres in 2000, and 52 acres in 2010.

6. Emergent aquatic vegetation has shown similar declines, going from 198 acres in 1975 to 104 acres in 2010.

7. Submersed aquatic vegetation has increased since 1975 more than doubling the acres present in 1975.

4.3 FACTORS INFLUENCING HABITAT CHANGE

4.3.1 GENERAL

A number of factors have been identified that are believed to be influencing habitat changes in the lower Pool 9. Many of these factors are synergistic, combining to affect both the physical, chemical and biological environment.

Construction of Lock and Dam 9 submerged the natural levees and floodplain in the lower end of Pool 9 resulting in continuous flow of water and sediment through the floodplain for all conditions. The higher parts of the natural levee became islands. Submergence caused changes in the vegetation communities resulting in decreased floodplain resistance and increased floodplain conveyance with time. For river flows near and well above bank full, the majority of the conveyance is now in the floodplain in the lower pools. This change has decreased the hydraulic slope in the pools and subsequently the fluvial processes of erosion and deposition in channels. In other words, in the floodplain there is not enough hydraulic energy for river currents to erode channel substrates. The result is a less dynamic, depositional river channel.

Wind generated waves are believed to be one of the primary erosive forces that have led to the loss of islands in lower Pool 9. Island loss in lower Pool 9, with some exceptions, has generally progressed from south to north. The islands in the southern portion of the pool were inundated the greatest by the creation of Pool 9 and were likely the most susceptible to erosion by wave action and river currents. As island loss occurred, the remaining islands became exposed to considerable wind fetch from the north and south (southeast to south), which produces some of the most frequent and highest velocity winds during the open water season.

As a consequence of increased wind fetch, wave action is also believed to be one of the factors contributing to the loss of some types of aquatic vegetation in the area. In the Capoli Slough area (just upstream of the study area) and other areas considered for restoration, it has been surmised that wind-generated waves suspend material in the water, thus increasing turbidity and reducing light penetration, and the waves exert a physical force on aquatic vegetation. In addition, the effects of wind-generated waves on aquatic vegetation have probably increased over recent time as the islands and the protection they afforded have decreased. This may not be as clear a driver in the Harpers Slough study area.

The resuspension and subsequent resettlement of sediment particles is believed to be a factor in the decline of bathymetric diversity in the lower portions of Upper Mississippi River navigation pools. This results in the general leveling of the bottom as material is resuspended from shallower areas by wave action and redeposited in deeper areas.

4.3.2 POOL REGULATION

Pool 9 was filled in April 1938. The project pool elevation was and still is 620.0 feet msl 1912 adjusted. During the first 8 years of operation, the allowable drawdown at the dam during the growing season was 2.5 feet to elevation 617.5. In 1947, operation was changed so the maximum drawdown at Lock and Dam 9 is 1.0 foot to elevation 619.0.

The Harpers Slough project area lies between Lock and Dam 9 and the primary control point. Thus, for much of the time during the growing season, water surface elevations in this area fluctuate between 619.5 and 620.0. The following summarizes the approximate amount of time the pool is in primary control, secondary control, and unregulated for the months May through September.

	May	Jun	Jul	Aug	Sep
Unregulated	54%	22%	18%	7%	7%
Secondary control	26%	52%	41%	35%	40%
Primary control	20%	26%	41%	58%	53%

Pool regulation affects habitat conditions in the Harpers Slough project area a number of ways. Obviously, the increased water depths associated with impoundment created aquatic habitat where previously it did not exist. Pool regulation creates a minimum water surface elevation below which inundation is permanent, creating a more lake-like condition as opposed to the prenavigation project riverine condition. In the project area, this minimum water surface elevation is about 619.5.

Pool regulation has little effect on high water or flood events. As noted earlier in Section 3.2, when river flows exceed 64,000 cfs, the dam gates are removed from the water and Pool 9 is unregulated.

4.3.3 FLOW AND CURRENT VELOCITY

Even though impoundment has created lake-like conditions in lower Pool 9, it still is a riverine system with flow passing through the pool. River flows have erosive effects, which reshape islands and other land areas, especially low-lying islands in the lower impounded area. River flows also have velocity, which can affect the suitability of habitat for fish species depending on their tolerance of current velocity. This factor can be especially critical in the winter, for species adapted to quiet water conditions such as bluegill and crappie. These species cannot tolerate high current velocity in the winter, and if over-wintering areas offering refuge from current are insufficient, population levels will be adversely affected.

4.3.4 WIND AND WAVE ACTION

Lower Pool 9 is relatively open and subject to large wind fetches. These large wind fetches result in the generation of large waves, which in turn affect habitat conditions (Attachment 11). Wind generated waves are believed to be one of the primary erosive forces, along with river currents, that has led to the loss of islands in lower Pool 9.

Wind generated waves suspend material in the water, increasing turbidity and reducing light penetration, and the waves exert a physical force on aquatic vegetation. In addition, the effects of wind-generated waves on aquatic vegetation have probably increased over time as the islands and the protection they afforded have decreased.

The suspension and subsequent resettlement of sediment particles contributes to declines in bathymetric diversity. A general leveling of the pool bottom results as material is suspended from shallower areas by wave action and re-deposited in deeper areas. Resuspended sediment can also be conveyed through Lock and Dam 9 and it's spillway where it contributes to increased suspended sediment, reduced light penetration and sedimentation of backwaters in upper Pool 10.

4.3.5 FACTORS AFFECTING AQUATIC VEGETATION

In general, aquatic vegetation in Pool 9 and other Upper Mississippi River navigation pools has declined. Changes were being noted as early as the 1950s and 1960s. During the last three decades, the most noticeable river-wide decline has been the loss of emergent vegetation. Recently, submersed aquatic vegetation has shown substantial recovery in Pool 9 and other pools.

A number of theories pertain to the decline of aquatic vegetation. A number of causative factors have been identified, and it is likely that most or all of them have had some effect, which influences the large fluctuations in coverage observed over the years. The following have been among the factors:

- Disruption of natural hydrology;
- Loss of islands and the shelter they provided;
- Changes in bathymetry;
- Increased turbidity due to wave suspended sediments, and
- Drought of the late 1980s.

The creation of the locks and dams system has altered the natural river hydrology. The largest effect has been the loss of the natural late summer decline in water levels that would be associated with a natural riverine system. The navigation pools maintain a minimum water level that is higher than what would occur in an unimpounded system. This maintenance of artificially high water levels is believed to be an important factor in the decline of emergent aquatic vegetation (due to the loss of the natural process of sediment exposure). This in turn is believed to substantially inhibit the reproductive capabilities of many species of emergent vegetation. However, this altered hydrology is what has provided extensive aquatic areas suitable for the growth of submersed vegetation which has led to the creation of thousands of acres of waterfowl migration habitat present within the project area.

The erosion of islands has resulted in the loss of the physical shelter that islands provide to aquatic vegetation. With the loss of islands, aquatic vegetation becomes more exposed to the physical stresses associated with larger wind fetches and larger wind generated waves. All forms of aquatic vegetation can be affected to some degree, but the direct physical effects on emergent aquatic vegetation are probably greater than the effects on submersed vegetation. This is likely due to greater intensity of wave action in shallow areas (where emergent vegetation is typically found) compared to the deeper areas (where submersed vegetation is typically found).

Changes in bathymetry can have mixed effects on aquatic vegetation. Erosion of shallow areas can make them too deep to support emergent vegetation. Conversely, the filling of deeper areas can bring them within the photic zone capable of supporting submersed vegetation.

The loss of islands and the subsequent increase in wind fetches and the size of wind generated waves increase ambient turbidity due to the resuspension of fine sediments. This in turn can reduce the photic zone and the productivity of submersed vegetation. The effect on emergent vegetation from a reduced photic zone is probably not significant.

A significant decline in aquatic vegetation of all types occurred on the Upper Mississippi River in the early 1990s. This decline followed 3 years of low river discharges in the late 1980s. The causal factors for this decline were never clearly defined. Changes in light-penetration may have been a factor. Nutrient deficiencies in the sediments (the low discharge stimulated plant growth, which consumed sediment nutrients) have also been theorized as a potential cause. Since that time at least one of these cover types, submersed aquatic vegetation, appears to have made a substantial recovery.

4.4 ESTIMATED FUTURE HABITAT CONDITIONS

Estimated future habitat conditions for the Harpers Slough complex without habitat rehabilitation are based on observed changes over time for the complex and adjacent areas. Aerial photographs document the loss of islands and emergent aquatic plant beds in the Harpers Slough complex. These same photographs also show the Harpers Slough complex declining in acres of quality habitat. It is expected that important habitat features in the Harpers Slough complex will decline in size and eventually most of it would disappear, although predicting when that may occur is very difficult. It may occur within the next 20 years or it may take longer to happen.

The most likely scenario is that the complex will continue to be affected by northerly and southerly winds across a relatively large wind fetch. Wave action will suspend sediments at the shallow margins of the complex and these sediments will be transported away from the complex by river currents. The net effect will be continuous erosion of shallow areas capable of supporting emergent and floating-leafed vegetation. As this vegetation disappears, more and more of the complex, including the island remnants, will become subject to wave erosion. Over time, large areas of island and emergent vegetation habitat will become fragmented and disappear.

The complex will also be subjected to erosive forces from the river currents from the main channel side. However, based on the photo record, changes on the main channel side of the complex appear to be occurring at a slower rate and are more likely to change the character of the Harpers Slough complex rather than cause its total loss, within the next 20 years. Breaches in islands and natural levees have occurred, and these will likely enlarge over time, creating new channels and associated habitats.

As the islands and associated cover types decline (i.e., emergent and floating-leafed aquatic vegetation), they likely will be replaced by submersed vegetation such as pondweeds, coontail, and wild celery as some of the area will still be within the photic zone for these species. As leveling continues the quality and/or quantity of submersed vegetation is likely to also decline. Submersed vegetation is also likely to decline in the existing adjacent shadow zone of the Harpers Slough complex. Open water (devoid of vegetation) is likely to replace much of the submersed vegetation over time.

As Harpers complex continues to lose definition, seasonal (summer) habitat conditions for backwater and lotic fish species would decline and use of the area would become very limited. Sedimentation and continued loss of islands makes it highly unlikely that overwintering habitat would ever exist in the area. The mussel fauna in Harpers Slough secondary channels would also decline, especially for riverine mussel species. Mussels would become less dense and the species composition would become dominated by generalists and substrate tolerant species like giant floaters, fragile papershells, and threeridge.

A projection of acreages of land cover types under future without project conditions was estimated as a part of a habitat evaluation of the proposed project (Table 4 - 2; Enclosure 2 of Appendix D –HEP Analysis). This projection was largely based on observed rates of gains/losses of these cover types (derived from available land use/land class GIS data from 1975 to 2010), anticipated loss of bathymetric diversity as seen in adjacent areas, and the modeled increase in wind fetch and corresponding wave action. In general, the study area is anticipated to experience lost acreages of islands and aquatic vegetation and gains in acreages of open water.

Table 4 - 2. Projected acreages of major cover types in the Harpers Slough complex under future without-project conditions.

	Year			
Cover Type	2015	2018	2045	2065
Land	48.0	↓45.3	↓40.9	↓29.0
Open Water	1470.0	↑1603.8	↑2070.5	↑2317.8
Submersed Aquatic Vegetation	1592.5	↓1558.6	↓1101.1	↓762.2
Rooted Floating Aquatic Vegetation	298.4	↓298.0	↓293.3	↓289.7
Emergent Vegetation	97.0	↑97.4	↑103.0	↑107.1

4.5 RESOURCE PROBLEMS AND OPPORTUNITIES

One of the critical steps in the initial planning process is the identification of problems and opportunities associated within the geographic scope of the project area. Problem statements are concise characterizations of the broad issue that will be addressed with the project. Opportunity statements follow each problem and consist of an array of opportunities presented by the virtue of planning and construction activities occurring at the site of the problem. Opportunities can be directly related to solving the problem at hand, but can also be ancillary to the identified problem. From the list of opportunities, objectives for the project are drafted. The success of the project planning is determined by the fulfillment of the objectives through identified alternative measures.

The Harpers Slough complex currently is a relatively large area of poor to moderate quality habitat, but if present stressors continue the Harpers Slough complex is expected to decline in size and quality. The opportunity exists to protect and restore this habitat before it is lost. In many locations within the study area, remnants of eroded islands still exist just beneath the water surface. These underwater remnants provide a solid base upon which to reconstruct islands. The type of habitat provided by the complex is in decline in lower Pool 9 and in the lower reaches of many other Upper Mississippi River navigation pools. The specific resource problems and opportunities are described in sections 4.5.1 – 4.5.7.

4.5.1 RESOURCE PROBLEM: LOSS OF EMERGENT AND FLOATING LEAF AQUATIC VEGETATION

The emergent and floating-leafed aquatic plant communities contribute to habitat diversity in the Harpers Slough complex. If these communities are lost, the Harpers Slough complex will become an area similar to what exists upstream, an area of submersed aquatic plant beds with few surface features and no significant habitat diversity. From 1975 to 2010, there has been a 47 percent loss of emergent vegetation and 23 percent loss of floating leaf aquatic plants in the study area. Subsequent erosion of some of the areas that contained emergent and floating aquatic vegetation in 1975 may preclude the reestablishment of this type of vegetation in these areas. As the islands and shallow areas are eroded from river currents and wind wave action, the emergent and floating leaf aquatic vegetation may further decline. The stressors include large wind fetches, with wave resuspension of sediments and plant breakage, reduced water clarity, elevated river current erosion, and stable growing season water levels.

Opportunities: Harpers Slough still contains relatively large areas of shallow water that if protected from excess current and wind/wave action, with subsequent improved water quality conditions, could provide suitable habitat for emergent and floating-leafed aquatic plant communities. There is also an opportunity to increase elevations from disposal of access and habitat dredging in selected areas to promote the establishment of mud flats and emergent marsh. Water level management during the growing season could also increase the establishment of emergent and floating leaf aquatic vegetation. Islands would also prolong the affects of emergent vegetation response to water level management.

4.5.2 RESOURCE PROBLEM: RESILIENCY AND SUSTAINABILITY OF SUBMERSED AQUATIC VEGETATION

Most of the area in the contiguous impounded area in lower Pool 9 is open water. The area is exposed to long wind fetches from the north to the south and water quality is greatly influenced by wind generated wave action. Submersed vegetation coverage has been highly variable from year to year because of a variety of abiotic and biotic factors, making it difficult to specifically target the number of acres desired. Submersed aquatic vegetation has made a remarkable comeback in recent years, but the resiliency and sustainability are questionable, especially as the islands and shallow water continue to disappear. Stressors include large wind fetches, with wave resuspension of sediments and plant breakage, water clarity, and river current erosion.

Opportunities: The extent and quality of submersed aquatic vegetation could be maintained/increased by modifying current and sedimentation patterns and reducing wave action. As a result, water clarity would be improved during the growing season in areas in and adjacent to the Harpers Slough complex. Aquatic vegetation would contribute to dissolved oxygen levels (DO), thus benefiting fish and other aquatic organisms. However, DO levels could experience wide fluctuations under conditions of extremely dense vegetation and low summer flows. During peak photosynthesis activity (i.e., daytime), DO levels could spike, causing gas supersaturation. During periods of non-photosynthesis (i.e., nighttime), macrophyte respiration could drawdown DO levels substantially. Both conditions are especially harmful to sessile aquatic organisms.

4.5.3 RESOURCE PROBLEM: LOSS OF ISLAND HABITAT AND FLOODPLAIN FOREST

Islands provide habitat diversity and are an important “structural” component of the Harpers Slough complex. Islands help define running sloughs, add habitat complexity, break up wind fetch, provide visual and thermal isolation, and in and of themselves provide habitat for a variety of fish and wildlife species. Along with the emergent and floating-leafed plant communities noted above, the islands in the Harpers Slough complex help define the complex for what it is. From 1975 to 2010, there has been a 41 percent loss of the islands in the study area. An HREP bank stabilization project was completed in the study area in 1997. This has reduced the loss of islands and will provide some level of protection in the future. For the estimated future-without-project, 29 acres of islands are estimated to remain in the 50-year planning horizon, primarily as a result of the 1997 HREP Bank Stabilization Project. Stressors include wind generated wave and river current erosion of islands.

Opportunities: In many locations within the study area, remnants of eroded islands still exist just beneath the water surface. These underwater remnants provide a solid base upon which to reconstruct islands.

4.5.4 RESOURCE PROBLEM: DEGRADATION OF MIGRATORY WATERFOWL HABITAT

Most of the study area is part of the Harpers Slough Closed Area, which is a critical feeding and resting area for waterfowl during the fall migration, often having more use than any other closed area on the Refuge. In developing carrying capacity estimates for the Closed Areas, Slivinski (2004) estimated that the Harpers Slough Closed Area protects 14 percent of the pool's estimated 16,810 million Kcal production for use by migrating waterfowl. The existing islands and emergent wetlands provide somewhat limited visual isolation and thermal barriers for migrating waterfowl, but much of the island and emergent wetland habitat is projected to be lost in the future without action. As the islands and wetlands disappear, the value of the Harpers Slough Closed Area would significantly decline in quality and protection for migrating waterfowl. Stressors include large wind fetches, with wave resuspension of sediments and plant breakage; water clarity; and river current erosion.

Opportunities: There is opportunity to maintain and increase carrying capacity for migrating waterfowl in this very important Closed Area during the fall migration. Potential measures like mudflats/emergent wetlands can increase the available energy production for waterfowl. Restoring islands can serve to maintain or increase the diversity of aquatic plants and associated invertebrates, increasing energy producing food sources for migrating waterfowl. Restoration of islands would increase visual and thermal barriers for migrating waterfowl.

4.5.5 RESOURCE PROBLEM: DEGRADATION/LOSS OF SECONDARY AND TERTIARY CHANNEL FISHERIES AND MUSSEL HABITAT

Running sloughs are an important component of habitat diversity in the Harpers Slough complex. These sloughs are valuable fish habitat and are being lost in lower Pool 9 as the islands and wetlands that defined them are lost. Important components of the habitat value of running sloughs are the slough margins adjacent to bordering islands and wetlands. The margins are generally the more diverse areas of the sloughs containing fallen trees and snags, shallow flats, and aquatic vegetation. In addition to their value as fish habitat, running sloughs can be valuable habitats for mussels. Mussel assemblages are present in the flowing sloughs, including Harpers and Crooked Sloughs. Stressors include river currents and wind-generated wave erosion of channel defining features such as islands, emergent vegetation, and woody debris.

Opportunities: The old island remnants bordering many of the submerged secondary and tertiary channels (Harpers Slough, Crooked Slough, St Paul Slough, and Wexford Delta Slough) in the study area provide an opportunity to re-construct some of these islands and restore wetlands to confine flows and provide self-sustaining running channel habitat. There are also opportunities to create running slough habitat with strategic placement of islands and allow natural processes to form the channel habitat. In the Capoli Slough area in lower Pool 9, which is located around 3 miles upriver from Harpers Slough study area, an old closing structure near the head of the Capoli Slough provides a rock riffle, deep pool, and downstream gravel bar. This unique habitat provides valuable fish and mussel habitat; in mussel surveys the downstream gravel bar had one of the highest densities of native mussels, including the endangered *L. higginsii*. There are opportunities to create a rock riffle and allow natural processes to form the riffle/pool/gravel bar habitat in the Harpers Slough study area.

4.5.6 RESOURCE PROBLEM: LOSS OF HABITAT SUITABLE FOR NEOTROPICAL MIGRANTS, MARSH AND WATER BIRDS (GREBES, WHITE PELICANS, BITTERNS, HERONS, OTHERS); SHOREBIRDS; TURTLES AND OTHER REPITILES; AMPHIBIANS, AND AQUATIC MAMMALS.

With the loss of islands, isolated wetlands, emergent wetlands and associated shallow water and shoreline zones in Harpers Slough area, there has been a very large loss of habitat suitable for neotropical migrants, marsh and water birds (grebes, white pelicans, double-crested cormorants, bitterns, herons, egrets, rails, and terns), and shorebirds. The lack of and continued disappearance of islands and littoral habitat in the study area may be a stressor limiting the use of the study area by these bird species.

In addition, there has been a near total loss of suitable habitat for aquatic or semi-aquatic mammals. The continued loss of emergent aquatic vegetation could be a significant constraint on aquatic mammals, such as muskrats, which depend on emergent vegetation as a food source and to construct lodges.

Turtle nesting habitat within or adjacent to Harpers Slough is very limited. Suitable nesting habitat is generally lacking in the lower Pool 9, except along the floodplain fringe not blocked by riprap used to protect the railroad embankment or the earthen embankment that is a part of Lock and Dam 9. Providing this type of habitat would address this habitat need. Stressors include lack of nesting habitat and shoreline loafing structures in lower Pool 9. Many species of amphibians depend on relatively isolated wetlands, which are virtually non-existent in the study area, for various life stages.

With a loss of islands in the area, there has been a loss of trees for nesting, roosting, and perching habitat for species such as bald eagles and other raptors. Currently, four active bald eagle nests occur in the study area, with at least two of them at risk of being lost due to island erosion in the future. These numbers and the locations of nests may change over time. Bald eagle foraging habitat is abundant in the study area, but the lack of forested islands in the study area may be a stressor limiting the number of eagle nesting pairs.

<u>Opportunities:</u> In restoring some of the islands there are opportunities to incorporate habitat conditions more suitable for migratory and resident vertebrate species.

There is also an opportunity to increase elevations from disposal of access and habitat dredging in selected areas to promote the establishment of mud flats and emergent marsh, an important isolated microhabitat for fish and wildlife. Isolated wetlands could also be incorporated into the layout of islands to provide habitat for a variety of aquatic and semi-aquatic species. On the sheltered side of islands the bank and littoral habitat should also increase habitat availability for shorebirds and marsh and water birds. Increases in emergent vegetation and bank habitat could provide increased foraging opportunities and lodge and bank dens for muskrats, beavers, and mink.

It is possible to create sparsely vegetated, sand habitat that would be suitable for turtle nesting in some of the more protected areas of the islands. Because of the relatively isolated nature of the Harpers Slough complex, egg predation would be low and nesting success might be high. Creating shorelines would also increase future loafing structures for turtles. In the sheltered areas of re-constructed islands there is an opportunity to construct an isolation berm around adjoining shallow wetlands (less than 2 feet) to create isolated wetlands.

Bald eagles have a territorial range of around 1 mile and the addition of strategically placed islands and subsequent forestation could increase the number of nesting pairs in the approximately 5.5-square mile study area.

4.5.7 RESOURCE PROBLEM: LACK OF PROTECTED OFF CHANNEL LACUSTRINE FISHERIES HABITAT.

Protected off-channel lacustrine fisheries habitat is an important component of the Mississippi River ecosystem. This type of habitat has declined in lower Pool 9 with the loss of islands and the leveling effects of sedimentation in off-channel areas. Eight years of late fall electrofishing by the Wisconsin Department of Natural Resources in lower Pool 9 has documented the poor quality of late fall and winter habitat for backwater species in the lower 16 miles of Pool 9 (Janvrin 2011). No appreciable habitat of this type exists below river mile 662 in Pool 9, except for the habitat restored as part of the Cold Spring and Capoli Slough HREPs. Restoration of backwater complexes would improve habitat conditions for a large variety of backwater and channel fish species. The complexes should include a diversity of water velocities, including areas of undetectable velocity during below bank full conditions. Adequate water depths (greater than 4 feet) will need to be provided to improve centrarchid overwintering habitat. Stressors include lack of protected deepwater habitat as fish overwintering habitat because of excessive velocities and lack of deepwater (greater than 4 feet).

Opportunities: The limited existing off channel deepwater habitat receives excess flows, which is likely to increase as islands continue to erode. There is an opportunity to reduce flows by the creation of barrier islands, thereby, creating protected deepwater areas and expanding the deepwater habitat by dredging for use as topsoil/random fill on constructed islands and creation of emergent marsh/mudflats and isolated wetlands.

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5. PROJECT GOALS & OBJECTIVES

Congress authorized EMP to help address ecological needs on the UMRS through the HREP element, consistent with the comprehensive master plan for the management of the UMRS, dated January 1, 1982 (Public Law 95-502). The HREP element utilizes an interdisciplinary and collaborative planning approach for habitat restoration, preservation, and enhancement at the system, reach, pool, and local scales. Each HREP is multi-faceted, enhances many types of habitats and species, and addresses specific ecological goals that are identified through a comprehensive planning process. Thus, various plans addressing fish and wildlife management goals that cross various jurisdictions are recognized herein.

5.1 INSTITUTIONAL FISH AND WILDLIFE MANAGEMENT GOALS

Fish and wildlife management goals are identified in a number of plans that include the project area. Those with the most relevance to the proposed project's goals and objectives are the Upper Mississippi National Wildlife and Fish Refuge's Comprehensive Conservation Plan and the interagency Fish and Wildlife Working Group (FWWG) described in more detail below.

Other notable plans include:

1. Upper Mississippi River Ecosystem Restoration Objectives Report (Corps 2009). http://www.mvr.usace.army.mil/Portals/48/docs/Environmental/EMP/UMRR_Ecosystem_Restoration_Objectives_2009.pdf.
2. Upper Mississippi River Conservation Committee's (UMRCC) Upper Mississippi River Fisheries Plan (Janvrin et al. 2010). http://www.umrcc.org/Reports/Fish%20Section/FishPlanFinalcompressed.pdf
3. The Corps of Engineers Upper Mississippi River Systemic Forestry Stewardship Plan (Guyon et al. 2012). http://www2.mvr.usace.army.mil/UMRS/NESP/Documents/UMR%20Systemic%20Forest%20Stewardship%20Plan-Aug%202012.pdf
4. Wisconsin DNR – Fisheries Strategic Plan (2007) - Program goals and strategies - http://dnr.wi.gov/topic/Lands/FisheriesAreas/documents/FMStrategicPlan.pdf.
5. Wisconsin DNR – Waterfowl Strategic Plan (2007) - http://dnr.wi.gov/topic/WildlifeHabitat/documents/plan2.pdf
6. Upper Mississippi River/Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy (Soulliere et al. 2007).

5.1.1 UPPER MISSISSIPPI RIVER NATIONAL WILDLIFE AND FISH REFUGE GOALS

Fish and wildlife management goals and objectives for the area fall under those defined more broadly for the Upper Mississippi River National Wildlife and Fish Refuge and those designated specifically in the Comprehensive Conservation Plan. The management goals and objectives of the Upper Mississippi River National Wildlife and Fish Refuge which apply most directly to the study area include:

Environmental Health Goal: Improve the environmental health of the Refuge by working with others.

- Working with others and through a more aggressive refuge program, seek a continuous improvement in the quality of water flowing through and into the refuge in terms of parameters measured by the LTRMP (DO, major plant nutrients, suspended material, turbidity, sedimentation, and contaminants).
- Increase efforts to control invasive plants and animals through active partnerships with States and other service programs and Federal agencies, and increase public awareness and prevention.

Wildlife and Habitat Goal: Habitat management will support diverse and abundant native fish, wildlife, and plants.

- If this project is constructed, the Refuge will make management changes to the Harper's Slough Closed Area. This change includes enacting spatial and temporal restrictions during the waterfowl season to reduce human disturbance of wildlife.
- By 2021, in cooperation with various agencies and States, implement at least 30 percent of the refuge-priority Environmental Pool Plan actions and strategies in pools 4 through 14.
- Adopt and use the following guiding principles when designing or providing input to design and construction of habitat enhancement projects:
    - Management practices will restore or mimic natural ecosystem processes or functions to promote a diversity of habitat and minimize operation and maintenance costs. Mimicking natural process in an altered environment often includes active management and/or actions.
    - Maintenance and operation costs of projects will be weighed carefully because annual budgets are not guaranteed.
    - Terrestrial habitat on constructed islands and other areas needs to best fit the natural processes occurring on the river, which in many cases will allow for natural succession to occur.
    - If project features in Refuge Closed Areas serve to attract the public during the waterfowl season, spatial and temporal restrictions of uses may be required to reduce human disturbance of wildlife.
    - The esthetics of projects in context of visual impacts to the landscape should be considered in project design.
- Develop and implement monitoring and management plans for threatened and endangered species, fish, mussels, turtles, furbearers, and forest species.

Wildlife-Dependent Recreation Goal: Manage programs and facilities to ensure abundant and sustainable hunting, fishing, wildlife observation, wildlife photography, interpretation, and environmental education opportunities for a broad cross-section of the public.

- Provide a balanced approach between the needs of the waterfowl and the public.
  - Provide migrating waterfowl a more balanced and effective network of feeding and resting areas.
  - Minimize disturbances to feeding and resting waterfowl in closed areas.
  - Provide waterfowl hunters with more equitable hunting opportunities over the length of the refuge.
- Enhance fishing opportunities on suitable areas of the refuge through habitat, access, and facilities improvements.

5.1.2 FISH AND WILDLIFE WORK GROUP GOALS AND OBECTIVES

The interagency Fish and Wildlife Work Group (FWWG) and River Resources Forum in 2004 developed Environmental Pool Plans (EPP; Fish and Wildlife Work Group River Resources Forum 2004). The EPP identify a desired future habitat condition toward which resource agencies and river interest can strive to attain. The EPPs are considered to be an environmental concept that the River Resources Forum can reference when considering future projects and activities brought forth by member agencies. The overall goal in the EPP for Pool 9 is to maintain and increase aquatic and terrestrial diversity.

The pertinent specific actions identified to address these goals are:

- Increase Depth Diversity in Channels and Backwaters
- Maintain Existing Quality Habitats
- Protect and Restore Islands
- Manage River Flows and Connectivity to Improve Habitat

Quantitative desired cover types from the Pool 9 EPP was used, where possible, as a guide for quantitative objectives in the Harpers Slough study area; i.e. acres of island, secondary channel, fish overwintering habitat, emergent vegetation, etc. (Table 5- 1). These are described in more detail in Section 5.2.2.

Table 5- 1. Environmental Pool Plan- Acres of desired land cover for the project area.

Cover Type	Acres
Existing Islands	45
New Islands	193
Emergent Vegetation	557
Submersed aquatic vegetation	1,721
Open Water	2,712
Total	5,228 [a]

[a] At the time of formulating objectives, the Harpers HREP area was considered larger than its current area of influence (i.e., 5,200 acres versus 3,500 acres).

5.2 PROJECT GOALS AND OBJECTIVES

Because the study area is within the Upper Mississippi River National Wildlife and Fish Refuge, the Refuge management goals and objectives, the FWWG Desired Future Habitat

Conditions, together with input from State and Federal agency natural resource managers, were used to guide the development of goals and specific project objectives. However, this study is only one part of a larger cooperative natural resource management effort on the river.

Earlier sections of this report discussed in detail existing habitat conditions and problems (see Section 4.1 Existing Habitat Conditions, Section 4.4 Estimated Future Habitat Conditions, and 4.5 Resource Problems and Opportunities). The habitat goals and objectives were developed as part of a coordinated effort on the part of all of the resource agencies involved in the study. The following factors were considered important in the development of the project goals and objectives:

1. Management objectives of the Upper Mississippi River National Wildlife and Fish Refuge, Fish and Wildlife Work Group, and of the Wisconsin and Iowa DNRs.

2. Historic and existing fish and wildlife habitat conditions.

3. Resource problems, opportunities, and constraints.

4. Habitat deficiencies, now and in the future for Pool 9.

5. Species groups and individual species habitat requirements.

6. Desirable hydraulic and sediment transport conditions to sustain habitat.

5.2.1 PROJECT GOALS

GOAL A: Maintain and/or enhance habitat in the Harpers Slough backwater area for migratory waterfowl birds.

This is a major goal for the Harpers Slough HREP, because of its designation as a Closed Area. Quantification of habitat will be based on achieving a proportion of the target waterfowl use days for the Harper's Slough closed area as presented in the Upper Mississippi River Wildlife and Fish Refuge's Comprehensive Conservation Plan (USFWS 2006) (Target will be based on proportion of area of direct influence of project vs. total size of closed area).

GOAL B: Create habitat for migratory and resident vertebrates with emphasis on marsh and water birds, shorebirds, bald eagles, aquatic mammals, turtles, and amphibians.

No numerical habitat goal for these particular species groups has been established for the Harpers Slough area. For all of these species groups, there are no specific thresholds identifying the amount of habitat required within the river corridor to meet the needs of these species. Any restoration of habitat for these species would benefit their overall population levels. However, specific micro habitats needed for these species are quantified within objective criteria presented later (i.e. shoreline, forest, floodplain terrestrial nesting habitat, isolated wetlands, etc.)

GOAL C: Enhance channel habitat for riverine fish and mussel species.

The existing secondary and main channel border habitats in the project area are important areas for riverine aquatic species. However, in general, these habitats lack diversity in the form of cover and shelter. Creation of more diverse current velocity, substrate, and cover conditions would enhance the area for riverine species.

GOAL D: Create and maintain protected lacustrine habitat for backwater fish species.

Habitat conditions for backwater fish species in the Harpers Slough area are considered suboptimal during the spawning, and growing seasons and nonexistent in the winter. The emphasis was placed on improving conditions for centrarchids because these species are a major component of the Upper Mississippi River backwater fisheries and habitat used by this group of species is well documented. Additionally, many other species use the same habitat considered good for centrarchids.

5.2.2 PROJECT OBJECTIVES

Based on the project goals, specific objectives were established and are listed below along with the rationale behind them. Many of these objectives are interrelated and will assist in meeting one or more of the four main goals. Specific planning and design criteria for each of the objectives are described in Section 6.3. Planning and Design Considerations.

Objective 1 – Protect wetland areas from river currents and wind and wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native emergent aquatic plant beds (> 500 acres).

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have about 557 acres of emergent wetlands.

Objective 2 - Protect wetland areas from river currents and wind and wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native floating leaf and submerged aquatic vegetation beds (> 1,800 acres).

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have about 1,721 acres of submersed or rooted floating aquatic vegetation.

Objective 3 – Protect existing (40+ acres) and increase forested islands (> 100 acres).

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have about 45 acres of existing island and 193 acres of new island habitat.

Objective 4 – Maintain/increase quality migrating waterfowl habitat, including maintenance of available aquatic plant tubers and seeds for fall migrating waterfowl of yearly minimum of 1,877 million kilocalories gross energy production.

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have a total of about 557 acres of emergent wetland and 1,721 acres of submersed or rooted floating aquatic vegetation. Each of these cover types varies as in the production rate of gross energy (in the form of seeds and tubers) to waterfowl (Slivinski 2004). The sum of energy production across these cover types for the acreages identified in the EPP is at least 1,877 million kilocalories/year.

Objective 5 - Create 10 open to sparsely vegetated sand terrestrial areas (minimum 0.25 to 0.50 acres each) adjacent to sheltered backwaters for turtle nesting at various locations throughout the Harper's Slough backwater complex.

Rationale: Sand pads may be necessary to construct as part of construction of new islands. In addition, the interface between water and land may consist of sand areas that may serve as valuable nesting habitat for turtles. There is interest in creating an interspersion of turtle nesting areas throughout the project area.

Objective 6 – Create interspersion of forested islands to create habitat capable of supporting between 6-8 nesting pairs of bald eagles.

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have a minimum of 238 acres of terrestrial habitat capable of supporting mature floodplain forest. At the time objectives were identified, the study area was believed to be about 8-square miles and bald eagles were believed to have a territorial range of around 1 mile.

Objective 7 – Maintain/increase to a minimum of 80,000 lineal feet of sheltered bank and associated littoral habitat for use by marsh and water birds, shorebirds, aquatic mammals, amphibians and reptiles.

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have a combination of islands that would afford protection from high wind fetch that would promote aquatic vegetation. Within the project area, this target of sheltered bank and associated littoral habitat is believed to provide an appropriate level of protection.

Objective 8 – Create 2 – 4 isolated wetlands (1 to 5 acres each) for use by amphibians and water and shore birds.

Rationale: The project area of the Pool 9 EPP indicates a desired future condition would have 557 acres of emergent wetlands, a portion of which could be isolated, i.e., disconnected from the river. This target was based on the average size and densities of isolated wetlands as viewed from historic Mississippi River Commission maps and current maps of the upper pool. Another factor was the professional judgment and the experiences of resource management agencies that understand optimal habitat conditions in this part of the river.

Objective 9 - Maintain/enhance existing slough habitat in the Harpers Slough complex as well-defined, self-maintaining running slough habitat, with a diversity of substrate and current velocity, and create a minimum of 10 acres of similar habitat where possible.

Rationale: The rationale for this objective is based on the professional judgment and the experiences of resource management agencies that understand optimal habitat conditions in this part of the river. It is also based on potential land forms on both sides of the channel.

Objective 10 – Maintain/increase to a minimum of 40,000 lineal feet of tertiary, secondary and main channel bank and associated littoral habitat for riverine fish and mussels.

Rationale: The project area of the Pool 9 EPP indicated this as an approximate target level.

Objective 11 - Create "riffle/pool/gravel bar" habitat (approximately 5 acres each) in secondary or tertiary channel areas.

Rationale: The rationale for this objective is based on the professional judgment and the experiences of resource management agencies that understand optimal habitat conditions in this part of the river.

Objective 12 – Enhance habitat for lacustrine fish, including creation of at least 4 discrete overwintering habitat areas similar in size to existing overwintering habitat within Upper Pool 9 which ranges from approximately 4 to 21 acres per site (average = 14).

Rationale: The rationale for this objective is based on an understanding of existing overwintering sites in upper Pool 9 and the professional judgment and the experiences of resource management agencies.

Objective 13 - Create 2 – 4 sand/mudflats (1 to 5 acres each) for use by amphibians and water and shore birds.

Rationale: The rationale for this objective is based on an understanding of the similar types of habitat in upper Pool 9 and their value to amphibians and shorebirds.

The relationship between resource problems, opportunities, goals, and the objectives are summarized in Table 5- 2.

Table 5- 2. Resource Problems, Opportunities, Goals, and Objectives.

Resource Problems	Opportunities	Goals	Objectives
Loss of emergent aquatic vegetation.	Protection of existing and creation of additional islands to reduce wind/wave and river current erosion would protect and expand emergent and floating leaf aquatic vegetation.	Goal A: Maintain and/or enhance habitat in the Harpers Slough backwater area for migratory waterfowl birds. Goal B: Create habitat for migratory and resident vertebrates with emphasis on marsh and water birds, shorebirds, bald eagles, aquatic mammals, turtles, and amphibians. Goal D: Create and maintain protected lacustrine habitat for backwater fish species.	Objective 1 – Protect wetland areas from river currents and wind and wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native emergent aquatic plant beds (500 acres).
Submersed aquatic and rooted floating leaf vegetation has been highly variable, but as the islands continue to disappear and the river bottom levels off, SAV are likely to lack resilience and sustainability and show even greater fluctuations in the future.	The extent and quality of submersed aquatic vegetation could be maintained, and large fluctuation in coverage reduced, by modifying current patterns and reducing wave action; thereby improving water clarity in areas in and adjacent to the Harpers Slough complex.	Goals A, B and D.	Objective 2 - Protect wetland areas from river currents and wind and wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native floating leaf and submerged aquatic vegetation beds (1,800 acres).
Loss of Islands. Islands help define running sloughs, add habitat complexity, break up wind fetch, direct current velocities, provide visual isolation, and in and of themselves provide habitat for a variety of wildlife species.	In many locations within the study area, remnants of eroded islands still exist just beneath the water surface. These underwater remnants provide a solid base upon which to reconstruct islands. Protection and creation of islands provide an opportunity to reduce current velocity and wind-generated wave action.	Goal A.	Objective 3 – Protect existing (40+ acres) and increase forested islands (>100 acres).
Degradation and large fluctuation in the quality of Closed Area habitat for migrating waterfowl. The Harpers Slough Closed backwater complex has received an average of 21% of the total waterfowl use days on the Upper Mississippi River Wildlife and Fish Refuge.	There are opportunities with strategic placement of islands to modify current patterns and wind generated wave action to improve water quality and protect and enhance aquatic vegetation, a major energy source for waterfowl during fall migration. The islands will also provide visual and thermal barriers for waterfowl.	Goal A.	Objectives 1, 2, and 3. Objective 4 – Maintain /increase quality migrating waterfowl habitat for migrating waterfowl, including maintenance of available aquatic plant tubers and seeds for fall migrating waterfowl by providing a minimum of 1,877 million kilocalories gross energy production.
Loss of habitat suitable for neotropical migrants, marsh, and water birds (grebes, white pelicans, bitterns, herons, others); shorebirds; turtles and other reptiles; aquatic mammals; and amphibians.	Islands would increase the amount and quality of shoreline and littoral habitat. There is an opportunity while creating new island to incorporate features to enhance the value for a variety of fish and wildlife species. There is also an opportunity to increase elevations in aquatic areas from disposal of access and habitat dredging to promote the establishment of mudflats and emergent marsh, an important isolated habitat for fish and wildlife.	Goal B.	Objectives 1, 2, and 3. Objective 5 - Create open to sparsely vegetated sand terrestrial areas (3 acres) adjacent to sheltered backwaters for turtle nesting at various locations throughout the Harper's Slough backwater complex. Objective 6 – Create interspersion of forested islands to create habitat capable of supporting between 6-8 nesting pairs of bald eagles. Objective 7 – Maintain/increase to a minimum of 80,000 lineal feet of sheltered bank and associated littoral habitat for use by marsh and water birds, shorebirds, aquatic mammals, amphibians and reptiles. Objective 8 – Create 2-4 isolated wetlands (1-5 acres each) for use by amphibians and water and shore birds. Objective 13- Create 2-4 sand/mudflats (1to 5 acres each) for use by amphibians and water shore birds.
Harpers Slough, Crooked Slough, and other secondary and tertiary channels are valuable flowing channel habitat that are expected to degrade as the islands and wetlands that define them disappear and wave and current work to level the river bottoms.	Protection and re-construction of islands bordering Harpers Slough provides an opportunity to confine flows, increase shoreline and littoral diversity and quality, and provide a self-sustaining running channel habitat. There is also an opportunity to increase substrate diversity by creating rock riffle, pool, and downstream gravel bar habitat.	Goal C: Enhance channel habitat for riverine fish and mussel species.	Objective 3. Objective 9 - Maintain/enhance existing slough habitat in the Harpers Slough complex as well-defined, self-maintaining running slough habitat, with a diversity of substrate and current velocity, and create a minimum of 10 acres of similar habitat where possible. Objective 10 – Maintain/increase to a minimum of 40,000 lineal feet of tertiary, secondary and main channel bank and associated littoral habitat for riverine fish and mussels. Objective 11 - Create "riffle/pool/gravel bar" habitat (approximately 5 acres each) in secondary or tertiary channel areas.
Loss of habitat diversity, bathymetric diversity and islands reduces habitat value for lacustrine fish. The limited existing deepwater habitat in Harpers Slough complex receives excess flows, which is likely to increase as islands continue to erode, and provides only very limited overwintering habitat for bluegills and other lacustrine species. Overwintering habitat is lacking throughout the lower 16 miles of Pool 9.	There is an opportunity to reduce flows by the creation of barrier islands, protecting the existing deepwater areas and expanding the deepwater habitat by dredging for use as topsoil/random fill on constructed islands and creation of emergent marsh/mudflats.	Goals C and D.	Objectives 1, 2, and 3. Objective 12 – Enhance habitat for lacustrine fish, including creation of at least 4 discrete overwintering habitat areas similar in size to existing overwintering habitat within lower Pool 9 which ranges from approximately 4-21 acres per site (average=14).

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6. ALTERNATIVE MEASURES

6.1 PLANNING CONSTRAINTS

The following constraints were considered in the plan formulation:

Impacts to Flood Heights – Restoration features should not increase flood heights or adversely affect private property or infrastructure.

Navigation – Restoration features and activities should avoid impacts to the existing navigation project.

Mussels – Restoration features should not adversely impact mussels.

6.2 ALTERNATIVE MEASURES IDENTIFIED FOR FURTHER STUDY

6.2.1 NO ACTION

The no action alternative is defined as no implementation of a project to modify habitat conditions in the study area.

6.2.2 POTENTIAL MEASURES TO MEET OBJECTIVES

Table 6- 1outlines the objectives; the chemical, physical, and biological stressors that need to be addressed to reach the objectives; and the potential management measures to address these stressors. Sections 6.2.3 through 6.2.9 address the potential management measures in more detail.

6.2.3 ISLAND RESTORATION/CREATION

Island restoration/creation could serve a variety of habitat purposes at the Harpers Slough complex. Island creation was the primary habitat restoration feature evaluated for the Harpers Slough backwater area. Restoration of islands protects shallow areas from wind and wave action, which in turn protects existing aquatic vegetation beds and improves conditions for the growth of aquatic vegetation in other shallow areas.

Islands provide terrestrial habitat, and their restoration increases habitat diversity and provides habitat niches that have been lost through the erosion of islands in this area. Islands can also be designed in a manner to channel flows to enhance or restore secondary channel habitat and to maintain bathymetric diversity.

Through brainstorming and coordination with resource management agencies, a number of island locations and configurations were identified for consideration. Hydrodynamic models were used to assist in laying out the islands and for quantifying changes in hydrodynamic conditions for various island layouts.

Table 6- 1. Objectives, Stressors, and Potential Restoration Measures.

Objectives	Stressors	Potential Restoration Measures
Objective 1 – Protect wetland areas from river currents and wind and wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native emergent aquatic plant beds (500 acres).	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills, creation of emergent wetlands
Objective 2 - Protect wetland areas from river currents and wind and wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native floating leaf and submerged aquatic vegetation beds (1,800 acres).	Wind/wave action, river currents, water clarity	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 3 – Protect existing (40+ acres) and increase forested islands (100 acres).	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 4 – Maintain /increase quality migrating waterfowl habitat, including maintenance of available aquatic plant tubers and seeds for fall migrating waterfowl of yearly minimum of 1,877 million kilocalories gross energy production.	Wind/wave action, river currents, water clarity	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 5 - Create 10 open to sparsely vegetated sand terrestrial areas (minimum 0.25 to 0.50 acres each) adjacent to sheltered backwaters for turtle nesting at various locations throughout the Harper's Slough backwater complex.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 6 – Create interspersion of forested islands to create habitat capable of supporting between 6-8 nesting pairs of bald eagles.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 7 – Maintain/increase to a minimum of 80,000 lineal feet of sheltered bank and associated littoral habitat for use by marsh and water birds, shorebirds, aquatic mammals, amphibians and reptiles.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 8 – Create 2-4 isolated wetlands (1-5 acres each) for use by amphibians and water and shore birds.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills
Objective 9 - Maintain/enhance existing slough habitat in the Harpers Slough complex as well-defined, self-maintaining running slough habitat, with a diversity of substrate and current velocity, and create a minimum of 10 acres of similar habitat where possible.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock sills, cobble liners to create riffle/pool/gravel bar habitat
Objective 10 – Maintain/increase to a minimum of 40,000 lineal feet of tertiary, secondary and main channel bank and associated littoral habitat for riverine fish and mussels.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock sills,
Objective 11 - Create "riffle/pool/gravel bar" habitat (approximately 5 acres each) in secondary or tertiary channel areas.	Lack of current velocity and substrate diversity	Cobble liners to create riffle/pool/gravel bar habitat
Objective 12 – Enhance habitat for lacustrine fish, including creation of at least 4 discrete overwintering habitat areas similar in size to existing overwintering habitat within the lower Pool 9 which ranges from approximately 4 to 21 acres per site (average=14).	Lack of protected overwintering fish habitat in lower Pool 9, including areas >4 feet deep meeting water quality criteria	Bank protection, island restoration/creation, rock sills, habitat dredging (>4feet)
Objective 13 - Create 2 – 4 sand/mudflats (1 to 5 acres each) for use by amphibians and water and shore birds.	Wind/wave action, river currents	Bank protection, island restoration/creation, rock mounds, rock sills

6.2.4 BANK PROTECTION

Bank protection is a tool that can be used to control erosion. Generally, with habitat projects on the Upper Mississippi River, bank protection is in the form of vanes, groins, a rock layer on the bank (traditional riprap design), or a rock mound. Bank protection was evaluated for all the remnant natural islands in the study area.

6.2.5 ROCK SILLS

Rock sills are generally structural measures designed to control or reduce flow. Rock sill structures are generally constructed with rock, though new design concepts involving the incorporation of woody material are being developed. Rock sills were identified as measures for consideration between some of the new large islands complexes running perpendicular to river currents. These rock sills are designed to be overtopped first, essentially providing a relief point under higher flows.

6.2.6 DREDGING

Dredging has been proposed as a potential measure to improve bluegill habitat as well as obtain materials for island construction. Dredging when combined with construction of islands would incrementally improve centrarchid habitat in the upstream, middle, and Wexford Delta areas of the study area. Increased availability of deeper water combined with reduced velocities would greatly improve wintertime habitat conditions for bluegills.

6.2.7 CHANNEL STRUCTURE

Harpers Slough offers the opportunity to add structure to its channel for lotic fish and mussel habitat improvement. Structures will be evaluated in the locations shown in the drawings.

6.2.8 EMERGENT WETLANDS/MUDFLATS

Emergent wetlands or mudflats could be created in the shallow flats near the existing or new islands. These would be constructed to an elevation near normal pool. This would restore the amount of emergent vegetation or mudflat habitat in the Harpers Slough area. It would also provide placement sites for unsuitable and/or excess material dredged for access and habitat dredging for use as granular fill or topsoil for the islands.

6.2.9 ISOLATED WETLANDS

Creation of isolated wetlands was considered for the Harpers Slough HREP. Isolated wetlands would be shallow wetlands (less than 2 feet deep under normal pool) that would not be connected to other aquatic areas during bank-full conditions. These areas would generally be fish-free, because they would not provide suitable habitat for fish. These areas could provide excellent habitat for amphibians, reptiles, and other similar wildlife.

6.3 PLANNING AND DESIGN CONSIDERATIONS

River managers and engineers provided a number of ideas for consideration in the planning and design of project measures and alternatives. The Environmental Design Handbook (USACE 2012) also provides recommendations for consideration in planning and design of project measures. A specific Value Engineering (VE) study on the Harpers Slough HREP was completed early in the planning process. These recommendations were considered in planning and design for Harpers Slough (Appendix N). In August 2012 an updated VE study was completed (Appendix N). In addition, the FWWG developed conceptual models for biota, including performance criteria, to assist in the planning and design of future ecosystem restoration efforts.

6.3.1 RIVER PROCESSES

Restoration of natural river processes disrupted by creation of the locks and dams is an overall goal for habitat restoration on the Upper Mississippi River. It is believed that restoration of these processes will generally result in improved habitat conditions for a wide variety of fish and wildlife. While restoration of natural river processes has merit from a systematic perspective, it is difficult to define this goal on a site-specific basis in a quantifiable manner. Also, the primary source of disruption of river processes, the navigation system with regulated pools, will remain in place. Planning for habitat restoration measures must take into account that the navigation project is in place, the operation of which is going to affect what can be accomplished with various restoration measures. As long as the navigation project is in place, there will be limitations on the restoration of natural river processes. Therefore, the approach selected is to view restoration of natural river processes as a long-term systemic goal. Restoration of these processes will be incorporated into the development of the habitat restoration project where possible.

In the large relatively open area of lower Pool 9, barrier islands provide critical physical infrastructure to diversify flow and sediment transport and to reduce wind fetch and wave resuspension of sediments. Water level management in Pool 9, including summer drawdowns, is being evaluated as part of a more systemic evaluation. It is likely that the combination of water level management and restoring critical physical infrastructure in these large contiguous impounded areas will yield the greatest ecosystem services and goods. Currently, the Corps is not authorized to implement regular drawdowns for ecosystem benefits on a regular basis. This is being examined as part of the Navigation and Ecosystem Sustainability Program (NESP), which has been authorized for implementation but does not have appropriations. Past drawdowns have been conducted on an experimental or one-time basis, which has required considerable planning and deviations from the Corps water control plan for maintaining conditions for the 9-foot navigation channel. A long-term periodic drawdown plan would likely trigger significantly more analysis (including impacts to listed mussels). An analysis of the changed hydrology of the system (as compared to a system of regular drawdowns) would not change proposed project features.

6.3.2 EMERGENT AQUATIC VEGETATION

General conditions for emergent aquatic vegetation

a. Less than 2 feet water depths for average river flows.
b. Mean weighted wind fetch less than 3,500 feet for water depths of 2 feet.
c. Secchi transparency greater than 0.8 meter on average during the June 1 - September 1 growing season in backwaters.
d. Current velocities less than 0.5 feet per second for normal high water and less than 0.2 feet for average river flows.

Constructed emergent wetlands/mudflats

a. Emergent wetlands located in proximity to islands are the optimum condition.
b. It is important to maintain and enhance microtopography (very small scale variations in height and roughness of the ground surface) within expanses of emergent wetlands/mudflats.
c. 50 percent of emergent wetlands/mudflats should be above 619.5 to promote diversity of habitat types.
d. Containment berms should be breached at several locations to allow access for fish and other aquatic life.
e. Create mini wetlands by modifying islands.

Constructed isolated wetlands for amphibians and water and marsh birds

a. Less than 2 feet under average pool elevation (619.8) with topographic diversity.
b. Berms containing the isolated wetlands should not be breached and should be constructed so they are not overtopped during normal high water (elevation 621.2 - around the 1.5-year flood event).
c. Placement of topsoil should be considered on the berms to increase stability and increase vegetation diversity.

6.3.3 FLOATING LEAF AND SUBMERSED AQUATIC VEGETATION

a. Less than 5 feet water depths for average river flows.
b. Mean weighted wind fetch less than 6,000 feet for water depths of 3 feet.
c. Suspended sediment probability from wind wave action less than 60 percent.
d. Secchi transparency greater than 0.8 meter on average during the June 1 - September 1 growing season in backwaters.
e. Current velocities less than 0.5 feet per second for normal high water and less than 0.2 feet for average river flows.

6.3.4 ISLANDS

The Engineering and Design Handbook (Corps 2012) provides a variety of recommendations on island layout, elevation, width, side slopes, topsoil and vegetation. Some of the more germane recommendations from the Engineering and Design Handbook and the Harpers Slough VE recommendations are summarized below.

a. Islands should be located in locations and configurations comparable to the natural islands that previously existed in the study area.

b. Islands should be positioned to reduce wind fetch to less than 3,500 feet in 2 feet of water.
c. A mix of high and low elevation islands is preferred.
d. Use of rock should be minimized to allow for more aesthetic and natural looking conditions. Shorelines deemed critical to maintaining the integrity of an island or an overall island complex should be protected using bioengineering techniques, if possible. Noncritical shorelines should be vegetated with grass or left as sand.
e. Slopes of 10:1 extending from the toe of islands outward for 30 feet or more are desirable. This objective could be accomplished either through direct construction or providing sufficient material in an island berm for beach formation.
f. Do not plant willows on every portion of an island. Create dynamic shorelines with a transition zone (i.e., an above water beach) to provide more habitat that is suitable for shorebirds.
g. Locate islands to induce the maintenance and /or formation of channels to maintain/improve bathymetric diversity.
h. Islands should be located in shallow water to reduce costs and increase stability.
i. Existing island remnants should be incorporated into restored islands for aesthetics.
j. Islands should be positioned so that shoreline stabilization is in shallow water.
k. Minimize access dredging to minimize secondary effects and costs.
l. Position islands to have the greatest effect on hydraulic and sediment regimes.
m. Rock sills should be incorporated to provide floodplain flow for more frequent floods.
n. Flood impacts should be minimized with low elevation islands or aligned in upstream/downstream orientation.
o. Use pile dikes to induce sedimentation in areas of active sediment transport (Appendix N).
p. Increase slope of rock mounds from 1V:3H slope (Appendix N).
q. Use geotubes (with vegetation openings) (Appendix N).
r. Replace rock with wood bundles (Appendix N).
s. Adjust thickness of sand, random fill, and fines to reduce higher cost material (Appendix N).
t. Evaluate geosynthetic and bioengineering for erosion protection (Appendix N).
u. Use other materials for rock sill (log rock structure) (Appendix N).

6.3.5 MIGRATORY WATERFOWL

Source: Chapter 9B in the Environmental Design Handbook (Corps 2012):

a. < 0.5 feet per second velocity.
b. Visual barriers
c. Diverse assemblage of preferred food plants; maintain at least 1,877 million kilocalories of gross energy production from aquatic plant seeds and tubers.
d. Secchi transparency greater than 0.8 meter on average during the June 1 - September 1 growing season in backwaters.
e. Minimize disturbances to feeding and resting waterfowl in Harpers Slough Closed Area. Voluntary avoidance area from October 15 to the end of the state duck hunting season.
f. More restrictive use if major human disturbance which displaces 1,000 waterfowl or

50 percent of the waterfowl present, whichever is less, exceeds one per day based on season long average.

Dabbling Ducks

a. 50/50 mix of open water to emergent/floating leaf vegetation.
b. Depths less than 1/3rd ft across 15 – 25% of area; between 1/3rd ft and 2 ft across 40-50% of the area.
c. Mean weighted wind fetch < 0.5 miles.
d. Sand bars, mud flats, loafing structures, and thermal protection.
e. Suspended sediment probability from wind wave action less than 60 percent.
f. Provide thermal and visual barriers to waterfowl.

Diving Ducks

a. Extensive beds of submersed aquatic vegetation and limited emergent vegetation in large waterbodies (> 200 acres).
b. Mean weighted wind fetch < 1 mile.
c. Depths between 1.5 ft and 5 ft across 40 - 70% of the area.

6.3.6 TURTLES

a. Nesting habitat: sparsely vegetated sand habitat with sufficient moisture to sustain successful nesting habitat.
b. Turtle nesting occurs in late spring/early summer, typically post high water. To minimize nest flooding, nesting habitat should be created to an elevation of 623.5 (approximately 4 feet above average pool and 3-year flood event).
c. Gently sloping beaches with limited vegetation to provide access to nesting habitat.
d. Bank habitat with associated littoral habitat containing fallen trees, snags and other woody debris to serve as turtle basking/resting areas.

6.3.7 BALD EAGLES AND OTHER RAPTORS

a. Foraging areas and perching habit for bald eagle and other raptors in Pool 9 generally consists of forested areas adjacent to water. Island remnants within the project site with some large trees could serve as foraging/perching habitat and should be protected. Overall foraging opportunities are abundant in the project area.
b. Bald eagles normally have a territorial range from 1 to 2 miles around a nesting site, but have been observed at much higher nesting densities if there is good forage and adequate screening between nests. New islands should be dispersed in the project area to maximize potential bald eagle nesting opportunities.
c. Accelerate succession for mature trees on new islands to increase bald eagle nesting and perching opportunities.
d. There is concern with potential effects during project construction on bald eagle nesting activity, which is prevalent in Pool 9 as evidenced through recent surveys by the USFWS that estimated nearly 100 nests in Pool 9 (S. Baylor, pers. comm. 2010). Four active bald eagle nests presently occur within the study area. No project activities will be allowed during the nesting season within 660 feet of one or more

bald eagle nests, this buffer would be extended to one-half mile if the project will cause loud noises (e.g., pile driving, etc.). In Iowa and Wisconsin, nesting season is generally mid-February to mid-July, although these dates may be adjusted by monitoring the behavior at individual nest sites.

6.3.8 MARSH AND WATER BIRDS AND SHOREBIRDS

a. Provide gradual sloping beaches on the sheltered side of the new islands.
b. Create irregular shorelines to increase edge habitat.
c. Create mudflats/emergent wetlands.
d. Create isolated wetlands.
e. Increase shoreline and littoral habitat, with a diversity of native emergent, rooted floating leaf, and submersed aquatic vegetation.

6.3.9 NEOTROPICAL MIGRANT BIRDS

a. Create new islands and plant grasses and or trees.
b. Design islands with a diversity of elevations to provide a more complex and diverse terrestrial vegetation community.

6.3.10 RIVERINE FISH

Riffle/pool/gravel bar habitat in secondary or tertiary channel areas:

a. Dominant substrate type within riffle complex of cobble/boulder with intermixed gravel.
b. At least 35 percent cover in the form of boulders, stumps, dead trees and crevices.
c. Approximately 1:2:2 riffle/pool/gravel bar ratio.
d. Riffle water velocities of 1 to 2 ft/sec.
e. Pool depths greater than 6 ft.

Secondary channel:

f. Confine flows under average and normal high river flows to promote substrate and current velocity diversity and to maintain them as self-sustaining channel habitat.
g. Restore channel habitat where possible.
h. Restore river bank and associated diverse littoral habitat, important structural components of flowing main, secondary, and tertiary channels.

6.3.11 MUSSELS

a. See criteria for riverine fish.
b. Minimize construction related impacts on mussels, especially state-listed species for protection in Iowa and Wisconsin. During the planning process for the Harpers Slough HREP, several modifications have been made to reduce impacts to mussels.
    (1) Island measures should be confined to water depths less than 3 feet to avoid habitat more favorable to mussels along Harpers Slough, Crooked Slough and the main channel border.

(2) Potential borrow areas in the main channel or other locations should have low density mussel populations to minimize impacts to mussels.
(3) Access dredging should be minimized and confined to designated areas and closely monitored to minimize impacts to mussels. The actual footprints of access dredging will be mapped and reported to the USFWS.
(4) Access for project construction should be limited to shallow draft vessels to minimize access dredging and/or access areas should be identified through additional mussel surveys as containing few to no mussels.

6.3.12 LACUSTRINE FISH

The conceptual models developed as part of Upper Mississippi River System Ecosystem Restoration Objectives report (Corps 2009) provides a variety of recommendations on performance criteria for evaluating and planning lentic fish habitat restoration. The specific criteria were developed based on the experiences of State and Federal fishery biologists as to what would be desirable to provide suitable habitat for backwater fish species. Pertinent ones are summarized below.

a. Restore/maintain lentic fish habitat to yield desired fixed site electro-fishing catch per unit effort of age 1 plus fish in overwintering sites.
    - Fair - Good:
        - 100 to 200 bluegills/hour
        - 50 to 100 largemouth bass/hour
    - Good - Excellent:
        - 200 to 300 bluegills/hour
        - 100 to 150 largemouth bass/hour
    - Excellent:
        - More than 300 bluegills/hour
        - More than 150 largemouth bass/hour
b. Aquatic vegetation cover in the range of 40 to 60 percent (summer) and 25 to 50 percent (winter) in off channel areas.
c. Water depth greater than 4 feet in 30 to 60 percent of the lake.
d. 1 to 6 backwater lakes (greater than 10 acres) per square mile of floodplain (more than 10 percent of aquatic area).
e. 80 percent of lakes "connected" to adjacent channels within backwater complex at base flow.
f. High quality overwintering areas less than 2 to 4 miles apart.
g. Substrates of sand and/or gravel available for spawning.
h. DO levels as measured at mid-depth:
    - Spring/summer: greater than 5mg/l
    - Winter: greater than 3 mg/l
i. Water temperature (winter):
    - 4 C^0 over 35 percent of the area,
    - 2 to 4 C^0 over 30 percent of the area,
    - 0 to 2 C^0 over 35 percent of the area.
j. Winter current velocity less than 0.3 cm/sec over 80 percent of the backwater lake area.

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7. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

Alternatives were developed as groups of features or measures to protect, restore, and enhance habitat quality in the study area. The development of island restoration alternatives began as a brainstorming exercise to identify possible locations for island protection and restoration features. Plate 7 shows some of the various conceptual measures that have been considered during the planning process since the 1990s. Preliminary runs of the wind fetch and wave models and hydraulic models were used to design measures such as island configuration and size.

Preliminary measures outlined in the final Performance Appraisal Report (PAR; Plate 7) were carried forward as the preliminary measures for the draft DPR. These were further refined by the Project Delivery Team (PDT) and during coordination with agency partners. Appendix O details the most recent decision process used to identify or modify features for each Evaluation Unit (EU) with emphasis on changes made from the 2011 conceptual plan. Summarizing this by subarea:

- In the Upper EU, five large islands were combined into two large islands, three seed islands and one large island were replaced with chevron islands, some of the large islands were tapered on the downstream sides, and the location of emergent wetlands were moved.
- In the Middle EU, two large islands were combined, one large island was shortened, large islands were tapered on the downstream side, a dogleg island and emergent wetland were added, a rock sill and narrow island were eliminated.
- In the Southeast EU, one narrow island was shortened, a rock sill was added between two islands, two narrow islands were combined, one island was moved, and an emergent wetland was eliminated.
- In the Southwest EU, several islands were eliminated, a rock sill was added between the mainland and one island, two narrow islands and two large islands were combined, and an emergent wetland was added.

Finalized features considered as part of formulating alternatives are presented in detail in Section 7.1 to 7.5.

After a lengthy process involving preliminary analysis and input from resource agencies, a total of 32 features were identified encompassing wide and narrow islands, Chevron islands, rock mounds, rock sills, rock berms, emergent wetlands, habitat dredging, and a cobble liner (Table 7- 1). Additional details for some of the feature types are described below.

<u>Emergent wetland</u> (mudflats) - These measures are dependent on the construction of their respective island measures. The number and size of the mud flats will be based on the need for disposal sites (i.e., there is no target for emergent wetland acreage through mudflat construction), except as identified for placement of habitat dredging material. However, construction of the emergent wetlands will help meet the project objective 13 of creating 2 – 4 sand/mudflats (1 to 5 acres each) for use by amphibians and water and shore birds. These measures are not required as part of any alternative under consideration, but are included as potential storage of additional access channel dredging material.

Habitat dredging – These features are dependent on the construction of their respective island measures as fine material from dredging would be used to top sand islands for vegetation. The number and size of the habitat dredging will be based on the need for fine material.

The preliminary construction costs of features are based on unit prices from the bid abstracts from our current EMP Projects (Table 7- 1). The total annualized costs for each alternative are listed in Table 7- 2Table 7- 1. While these estimates help illustrate the cost of each alternative relative to each other; their primary application is for the cost effectiveness/ incremental cost analysis used to select a recommended plan. Typically, these cost estimates include operations and maintenance (O&M) and monitoring costs. However, the PDT believes these additional costs are a minor component and proportionate with each alternative, thus would not affect plan selection (see Appendix E for a more detailed discussion). After the recommended plan was identified, a more detailed cost estimate was performed for only this plan and included in the DPR. Because the detailed cost estimate was prepared after a recommended plan was identified, minor discrepancies may be found between the preliminary and final costs for select items. These minor differences are within the accuracy of the cost estimate.

After all potential features were identified the IWR-Planning Suite software (http://www.pmcl.com/iwrplan/) was used to consider all possible combinations of features, resulting in over 700 possible alternatives. Continuing the analysis with so many alternatives was not feasible, so the PDT, in coordination with resource agencies with management responsibilities for this area, pared this down through an iterative process. First, a base plan was identified as a stand-alone project with the combination of measures needed to achieve a minimum level of protection for existing features (Alternative 1). Much of this was based on the professional judgment, experiences, and expertise of the group. The combination of features in the base plan is duplicated in all action alternatives. Next, the PDT identified the alternative with the maximum number of restoration measures (Alternative 5). Last, the combination of measures for the remaining action alternatives (Alternatives 2 through 4) was determined based on factors such as ease of construction and management objectives (Table 7- 2; Plates 8 and 9). Consideration was also given to measures that depended on or were exclusive of each other. This iterative approach resulted in a total of six alternatives (including the no action).

Table 7- 1. Description of potential features, preliminary estimated costs, and alternatives for the proposed project.

Feature Name[a]	Type of Feature	Construction Cost ($1,000)[b]	Alternatives[c]					
			NA	1	2	3	4	5
U1	Chevron island	300						X
U4	Type A wide island, tapered	6,500					X	X
EWU4	Emergent wetland	-					o	o
U6	Chevron island	500				X	X	X
U7	Type A wide island, tapered	5,500				X	X	X
EWU7	Emergent wetland	-				o	o	o
M1	Type A wide island	1,500				X		X
CLM	Cobble liner	50				X		X
M2	Type A wide island	3,000		X	X	X	X	X
EWM2	Emergent wetland	-		o	o	o	o	o
M3	Narrow Island w/ rock berm	1,500						X
EWM3	Emergent wetland	-						o
M4	Rock sill	250			X		X	X
M5	Type A wide island, tapered	3,500			X		X	X
EWM5	Emergent wetland	-			o		o	o
HDM	Habitat dredging	550			X		X	X
M8	Rock mound	50		X	X	X	X	X
M9	Narrow island w/ rock berm	1,100						X
L1	Narrow island w/ rock berm	1,400		X	X	X	X	X
L2	Rock sill	190		X	X	X	X	X
L3	Narrow island w/ rock berm	1,500		X	X	X	X	X
L5	Rock mound	150		X	X	X	X	X
L6	Type A wide island	3,000			X			X
EWL6	Emergent wetland	-			o			o
W1	Rock sill	700		X	X	X	X	X
W2	Type A wide island	3,300		X	X	X	X	X
HDW1	Habitat dredging	600		X	X	X	X	X
W3	Narrow island w/ rock berm	2,000		X	X	X	X	X
EWW3	Emergent wetland	-		o	o	o	o	o
HDW2	Habitat dredging	1,000		X	X	X	X	X
W6	Type A wide island	2,000				X		X
EWW6	Emergent wetland	-				o		o

[a] The following conventions were used for labeling potential features in accordance to location relative to the entire study area: U - upper; M - middle; L - southeast; W - southwest. These sub-areas are also defined as evaluation units as described in Appendix D – HEP Analysis.
[b] Price level is based on Quarter 4 of FY13; interest rate of 3.75%.
[c] X – mandatory feature; o = optional feature.

In addition to construction, preliminary costs for Planning, Engineering and Design (PED), and Interest During Construction (IDC) were estimated for project features, summed for each alternative, and annualized across a 50-year period (Figure 7- 1).

Table 7- 2. Preliminary costs associated with each alternative.

		Cost				
Alternative	**Features** [b]	**Construction**	**PED**	**IDC***	**Total**	**Average Annual** [a]
No Action	None					
1	M2, M8, L1, L2, L3, L5, W1, W2, W3, HDW1, & HDW2	$11,735,000	$2,041,000	$1,335,000	$15,111,000	$674,000
2	Alternative 1, plus M4, M5, HDM, & L6	$17,966,000	$3,125,000	$2,044,000	$23,135,000	$1,031,000
3	Alternative 1 plus U6, U7, M1, CLM, L6 & W6	$22,373,000	$3,891,000	$2,545,000	$28,809,000	$1,284,000
4	Alternative 1 plus U4, U6, U7, M4, M5, & HDM	$26,008,000	$4,523,000	$2,958,000	$33,489,000	$1,493,000
5	All features	$34,005,000	$5,914,000	$3,868,000	$43,787,000	$1,952,000

[a] Price level is based on Quarter 4 of FY13; interest rate of 3.75%.
[b] Emergent wetlands or mudflats are optional features and were not considered in defining potential alternatives.
* IDC: Interest During Construction – based on 5-year construction schedule and mid-year funding expenditures

To quantify habitat benefits of the proposed alternatives for the Harpers Slough Complex, the USFWS Habitat Evaluation Procedure (HEP) was used (U.S. Fish and Wildlife Service 1980). The HEP methodology uses a Habitat Suitability Index (HSI) to rate quality of habitat on a scale of 0 to 1 (1 being optimum). The HSI is multiplied by the number of acres of available habitat to obtain Habitat Units (HU), and, in this case, considers the acreages of cover types projected to occur in the future, i.e., HUs were calculated for each cover type, then composited across the study area. One HU is equivalent to 1 acre of optimum habitat. HUs are then averaged for each year of the project's lifespan (assumed to be 50 years) to estimate the Average Annualized Habitat Units (AAHUs). By comparing the AAHUs of the no-action alternative to each of the action alternatives, the benefits can be quantified (net gain in AAHUs).

Based on the management objectives of the resource agencies in this portion of the river, waterfowl and fish models were used to quantify habitat benefits and evaluate the effectiveness of the proposed measures. The waterfowl and fish models that were used include dabbling ducks (Devendorf 2001), diving ducks (Devendorf 1995), bluegill (Stuber et al. 1982; Palesh and Anderson 1990), and bald eagle (Peterson 1986). These models were selected based on their ability to capture the benefits of the project to backwaters and terrestrial habitats. The models have had proven success in evaluating benefits of other HREPs in the upper Mississippi River and are certified or approved by the COE Ecosystem Planning Center of Expertise (ECO-PCX) except for the dabbling duck model. A detailed discussion of the HEP conducted for the project is presented in Attachment 4.

Inherent in the use of these models is a level of risk and uncertainty that is not quantified due to the complexity in projecting future conditions associated with a wide range of alternatives (i.e., there is a high degree of variability across alternatives over time). In addition, models used to assess habitat benefits may lack the sensitivity for determining the direct effects of project measures for certain taxa. In light of these uncertainties, numerous other fish and wildlife benefits are acknowledged that would occur with project construction but may not be captured in the HEP analysis (i.e., incidental and unquantifiable benefits).

Island construction would create conditions allowing for the re-establishment of extensive and diverse aquatic vegetation beds and restoration of bathymetric and flow diversity to the area. This would primarily be accomplished by reducing wind fetch and associated wave action. This effect was modeled using the Wind Fetch/Wave Toolbox for ArcGIS (Rohweder et al. 2013) and results are described in detail in Appendix K and are summarized in Table 7- 3. This analysis indicated that the % of the study area that exceeded the 50th percentile for sediments to become suspended in the water column during the growing season ranged from 7 (Alternative 5) to 46% (No Action).

Table 7- 3. Effects of project alternatives on sediment suspension probabilities (percent of days from April- July where orbital velocities exceed 0.1 meters/second).

	% of Study Area	
Alternative	**0 – 50% Exceedence**	**50 - 100% Exceedance**
Baseline	59	41
No Action	54	46
1	76	24
2	85	15
3	87	13
4	83	17
5	93	7

Source: Figure 3 of Appendix K.

A summary of the habitat benefits and preliminary costs for each alternative across the study area is provided in Table 7- 4.

Table 7- 4. Summary of cover type acreages at TY50, habitat benefits and preliminary costs by alternative.

	Alternatives					
	No Action	**1**	**2**	**3**	**4**	**5**
Cover Type Acreages @ TY 50:						
Land	29.0	76.9	99.4	113.9	122.4	150.2
Emergent Vegetation	107.1	149.2	167.7	185.4	159.2	206.7
RFA Vegetation	289.7	539.3	516.8	493.2	487.4	439.5
Sub Aq. Vegetation	762.2	1608.1	1593.0	1587.7	1642.3	1630.3
Open Water	2317.8	1132.2	1128.8	1125.6	1094.4	1079.0
Habitat Benefits (Net gain AAHUs)	0	501.0	618.0	647.0	655.0	768.0
Average Annual Cost [a]	0	$674,000	$1,031,000	$1,284,000	$1,493,000	$1,952,000
Average Cost per AAHU	0	$1,300	$1,700	$2,000	$2,200	$2,500

[a] Price level based on Quarter 4 of FY13; interest rate of 3.75%.

7.1 NO ACTION ALTERNATIVE

7.1.1 MEASURES

The No Action Alternative is the plan in which none of the measures or combinations thereof would be constructed.

7.1.2 PRELIMINARY COSTS

There would be no cost to the No Action Alternative.

7.1.3 HABITAT BENEFITS

Under future without-project conditions, habitat conditions would continue to erode. Based on historic loss rates and inspection of aerial photographs in the study area, it is predicted that, under the no action alternative, the 52 acres of islands as detected in the 2010 LCLU GIS shapefile, would be reduced to 48 acres in 2015 (baseline) and 29 acres by 2065 (Enclosure 1 of Appendix D).

Currently, no fish overwintering habitat exists in the study area and none would be projected to exist in the future.

Losses in aquatic vegetation are also projected to occur in the study area without restoration. In 2010, rooted floating aquatic vegetation and submersed aquatic vegetation were estimated to be 360 and 2,143 acres, respectively. Based on observations and an analysis of trends, it is believed that each of these cover types will be reduced by 2015 to 298 and 1,592 acres, respectively. Under the no action alternative, by 2065 these cover types will experience further losses, resulting in about 290 and 760 acres, respectively. Associated with the losses of these cover types, open water that is devoid of vegetation is projected to grow in size. Open water is projected to be around 1,470 acres by 2015, and 2,318 acres by 2065 under the no action alternative.

7.2 ALTERNATIVE 1

Alternative 1 is the base plan that would achieve some measure of the habitat objectives such that it would warrant consideration as a stand-alone project.

7.2.1 MEASURES

This alternative consists of the following measures:

- Island M2
- Island M8
- Island L1
- Rock Sill L2
- Island L3
- Rock Mound L5
- Island W2
- Rock Sill W1
- Habitat Dredging W1
- Island W3
- Habitat Dredging W2
- Emergent Wetland EWM2 (optional)
- Emergent Wetland EWW3 (optional)

This alternative is considered the minimum plan to protect the existing island complex in the southeast portion of the study area from further loss. It also creates overwintering fish and duck habitat in the Wexford Delta area. Dredging to increase in winter fish habitat would be completed as part of the island project as a source of fine fill for the islands (Habitat Dredging W1 and W2). The size of habitat dredging may depend on which of the islands are recommended for implementation.

7.2.2 PRELIMINARY COSTS

The estimated preliminary cost of Alternative 1 is $15,111,000 as shown in Table 7- 2. At the current discount rate of 3.75%, the preliminary average annual cost for a 50-year project life would be $674,000.

7.2.3 HABITAT BENEFITS

The primary function of Alternative 1 is to protect the remaining natural islands in the southeast area from erosion by flowing water and to create overwintering fish and duck habitat in the Wexford Delta area. The new and existing islands would provide habitat diversity and protect an area with archaeological significance. The islands would add habitat complexity, provide visual isolation, and in and of themselves, provide habitat for a variety of wildlife species.

By building these features, Alternative 1 would result in a total of around 76 acres of land that would be created or protected.

Alternative 1 would result in about 48 acres of fish overwintering habitat created in the Wexford Delta area. Potentially up to 2 emergent wetlands would be constructed.

With Alternative 1 (as with all action alternatives), islands that are created or protected would reduce wind fetch and wave action, resulting in increases in the quality and quantity of aquatic vegetation when compared to the No Action Alternative. For this alternative, a net increase of 44 acres of emergent wetlands, 250 acres of rooted floating leave vegetation, and 820 acres of submersed aquatic vegetation are projected (see Enclosure 1 of Appendix D). In comparison to the no action alternative, the percent of the study area exceeding the 50th percentile for sediment suspension would be reduced from 46% to 24% (Table 7- 5).

The estimated habitat benefit of Alternative 1 as estimated through HEP is a net gain of about 500 AAHUs.

7.3 ALTERNATIVE 2

7.3.1 MEASURES

Alternative 2 consist of all of the measures described for Alternative 1 and the following:

Rock Sill M4
Island M5
Habitat Dredging Middle HDM
Island L6
Emergent Wetland EWM5 (optional)
Emergent Wetland EWL6 (optional)

The purposes of these additional features would be to create additional fish overwintering habitat and create a seasonal running slough in the middle portion of the study area. These features would also reduce wind fetch, add habitat complexity, and create additional visual barriers for migrating waterfowl. Flows would be constricted upstream of the M island complex in support of running slough habitat.

7.3.2 PRELIMINARY COSTS

The estimated preliminary cost of Alternative 2 is $23,135,000 as shown in Table 7- 2. At the current discount rate of 3.75%, the preliminary average annual cost for a 50-year project life would be $1,031,000.

7.3.3 HABITAT BENEFITS

This alternative would bring about many of the same benefits as described for Alternative 1. Also, the additional islands would reduce wind fetch and wave action in the middle and south portion of the study area. This would promote better quality and greater quantity of aquatic vegetation and create visual barriers promoting duck use.

Compared to No Action, Alternative 2 and the projected reduction to wind/wave action would result in a net increase in emergent vegetation, rooted floating aquatic vegetation, and submersed aquatic vegetation of about 63, 224, 800 acres, respectively. In comparison to the no action alternative, the percent of the study area exceeding the 50th percentile for sediment suspension would be reduced from 46% to 15% (Table 7- 5).

This alternative would also result in an additional 20 acres of fish overwintering habitat and the creation of a seasonal running slough in the middle portion of the study area. The seasonal running slough would create favorable habitat conditions for use by riverine fishes and mussels. Potentially up to 4 emergent wetlands would be constructed.

The habitat benefit of Alternative 2 as estimated through HEP is a net gain of 618 AAHUs.

7.4 ALTERNATIVE 3

7.4.1 MEASURES

Alternative 3 consist of all of the measures described for Alternative 1 and the following:

Island U6 Chevron
Island U7
Island M1
Cobble Liner Middle CLM
Island W6
Emergent Wetland EWU7 (optional)
Emergent Wetland EWW6 (optional)

The main purposes of these additional features would be to further constrict flows to create running sloughs and create visual barriers in the upstream portion of the study area. Also, wind fetch would be lessened from southerly winds in the Wexford Delta area. The addition of a cobble liner would create a riffle complex between the M1 and M2 islands. This feature would have a top elevation of 616.0 feet, a top width of 20 feet, and side slopes of 1V:2H.

7.4.2 PRELIMINARY COSTS

The estimated preliminary cost of Alternative 3 is $28,809,000 as shown in Table 7- 2. At the current discount rate of 3.75%, the average annual cost for a 50-year project life would be $1,284,000.

7.4.3 HABITAT BENEFITS

This alternative would result in many of the same benefits as described for Alternative 1. Also, the additional islands would reduce wind fetch and wave action from the east in the upper portion of the study area, and from the south in the Wexford Delta area. This would promote better quality and greater quantity of aquatic vegetation and create visual barriers promoting duck use. These islands would also constrict flows creating running slough habitat for use by riverine fishes and mussels. The addition of the riffle feature (i.e., cobble liner) would create a scour hole that, among other things, creates hydraulic and depth diversity and increase substrate complexity and cover. The riverbed associated with these types of structures would be expected to transition from that dominated by fines/sands to one dominated by gravels/cobble. Potentially up to 4 emergent wetlands would be constructed. These changes would provide benefits to benthic macroinvertebrates, mussels, and fish.

Compared to No Action, Alternative 3 and the projected reduction to wind/wave action would result in a net increase in emergent vegetation, rooted floating aquatic vegetation, and submersed aquatic vegetation of about 80, 200, 897 acres, respectively. In comparison to the no action alternative, the percent of the study area exceeding the 50th percentile for sediment suspension would be reduced from 46% to 13% (Table 7- 5).

The habitat benefit of Alternative 3 as estimated through HEP is a net gain of 647 AAHUs.

7.5 ALTERNATIVE 4

7.5.1 MEASURES

Alternative 4 consists of all of the measures described for Alternative 1 and the following:

Island U4
Island U6 Chevron
Island U7
Rock Sill M4
Island M5
Habitat Dredging Middle HDM
Emergent Wetland EWU4 (optional)
Emergent Wetland EWU7 (optional)
Emergent Wetland EWM5 (optional)

The main purposes of these additional features would be to constrict flows, create a deep backwater area, provide habitat diversity, and create visual barriers in the upstream portion of the study area.

7.5.2 PRELIMINARY COSTS

The estimated preliminary cost of Alternative 4 is $33,489,000 as shown in Table 7- 2. At the current discount rate of 3.75%, the average annual cost for a 50-year project life would be $1,493,000.

7.5.3 HABITAT BENEFITS

This alternative would bring about many of the same benefits as described for Alternative 2. Also, the additional islands would reduce wind fetch and wave action from the east in the upper portion of the study area. This would promote better quality and greater quantity of aquatic vegetation and create visual barriers promoting duck use. These islands would also constrict flows creating running slough habitat for use by riverine fishes and mussels. Habitat dredging, in combination with the U islands would create favorable backwater conditions in support of bluegill overwintering use in the upstream portion of the study area. Potentially up to 5 emergent wetlands would be constructed.

Compared to No Action, Alternative 4 and the projected reduction to wind/wave action would result in a net increase in emergent vegetation, rooted floating aquatic vegetation, and submersed aquatic vegetation of about 54, 200, 827 acres, respectively. In comparison to the no action alternative, the percent of the study area exceeding the 50th percentile for sediment suspension would be reduced from 46% to 17% (Table 7- 5).

The habitat benefit of Alternative 4 as estimated through HEP is a net gain of 655 AAHUs.

7.6 ALTERNATIVE 5

7.6.1 MEASURES

Alternative 5 consists of all potential measures under consideration.

The main purpose of these additional features would be to constrict flows, create additional backwater and riffle areas, provide habitat diversity, and create visual barriers throughout the study area.

7.6.2 PRELIMINARY COSTS

The estimated preliminary cost of Alternative 5 is $43,787,000 as shown in Table 7- 2. At the current discount rate of 3.75%, the average annual cost for a 50-year project life would be $1,952,000.

7.6.3 HABITAT BENEFITS

This alternative would bring about many of the same benefits as described for Alternative 4. Also, the additional islands would reduce wind fetch and wave action throughout the study area. This would promote better quality and greater quantity of aquatic vegetation and create visual barriers promoting duck use. These islands would also constrict flows creating running slough habitat for use by riverine fishes and mussels. Habitat dredging in combination with the U and M islands would create favorable backwater conditions in support of bluegill overwintering use. Potentially up to 8 emergent wetlands would be constructed.

Compared to No Action, Alternative 5 and the projected reduction to wind/wave action would result in a net increase in emergent vegetation, rooted floating aquatic vegetation, and submersed aquatic vegetation of about 100, 150, and 809 acres, respectively. In comparison to the no action alternative, the percent of the study area exceeding the 50th percentile for sediment suspension would be reduced from 46% to 7% (Table 7- 5).

The habitat benefit of Alternative 5 as estimated through HEP is a net gain of 768 AAHUs.

7.7 PLAN SELECTION

7.7.1 INCREMENTAL ANALYSIS

An analysis of cost effectiveness and the incremental costs of each alternative was completed using the Institute of Water Resources economic analysis program, IWR-Planning Suite (IWR-Plan). This analysis identifies the subset of cost-effective plans that are superior financial investments, called “best buys,” through analysis of the preliminary incremental costs. Best buys are the plans that are the most efficient at producing the output variable. In this case, best buys provide the greatest increase in AAHUs for the least increase in preliminary cost. The first best buy is the most efficient plan, producing output at the lowest incremental cost per unit. If a higher level of output is desired than that provided by the best buy, the second best buy is the most efficient plan for producing additional output, and so on.

The estimated preliminary total average annual cost and net AAHUs were entered into IWR-PLAN for the six identified alternatives, including the No Action Alternative. A plot of preliminary cost versus outputs is shown in Figure 7- 1. Of the identified alternatives, IWP-PLAN identified all as cost effective and four as “best buy” plans. The best buy plans and associated preliminary cost/AAHU are as follows: (1) No Action Alternative, \$0; (2) Alternative 1, \$ 1,300; (3) Alternative 2; \$1,700; and (4) Alternative 5; \$2,500. All the incremental cost/AAHU for the best buy alternatives are shown in Table 7- 5. Figure 7- 2 shows a plot of the incremental cost per AAHU for the No Action and Best Buy Alternatives.

Table 7- 5. Preliminary Incremental Cost of Best Buy Plans.

Alternative	Output (AAHUs)	Average Annual Cost	Average Cost/AAHU	Incremental Cost	Incremental Output (AAHUs)	Incremental Cost per Output
No Action	0	0	NA	NA	NA	NA
1	501.0	$674,000	$1,300	$674,000	501.0	$1,350
2	618.0	$1,031,000	$1,700	$358,000	118.0	$3,030
5	768.0	$1,952,000	$2,500	$921,000	150.0	$6,140

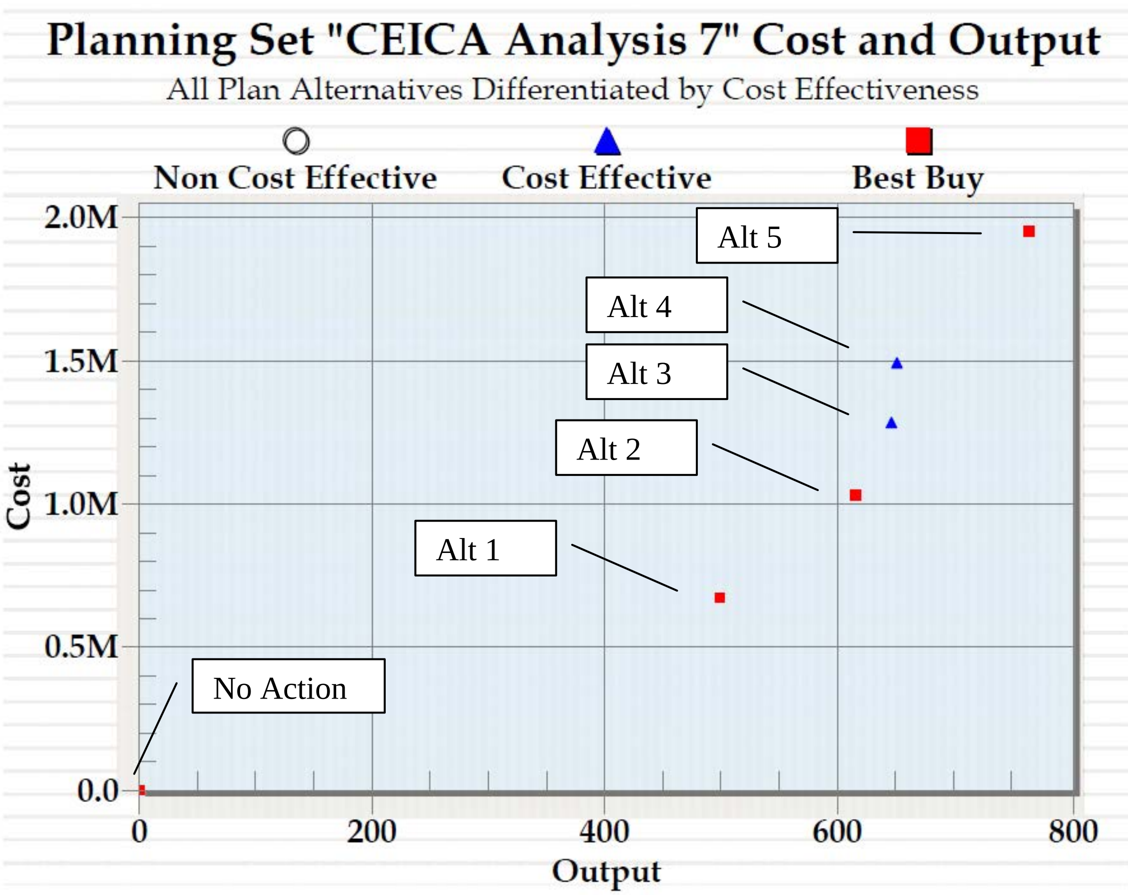

Figure 7- 1. Preliminary Cost Versus Outputs for All Alternatives.

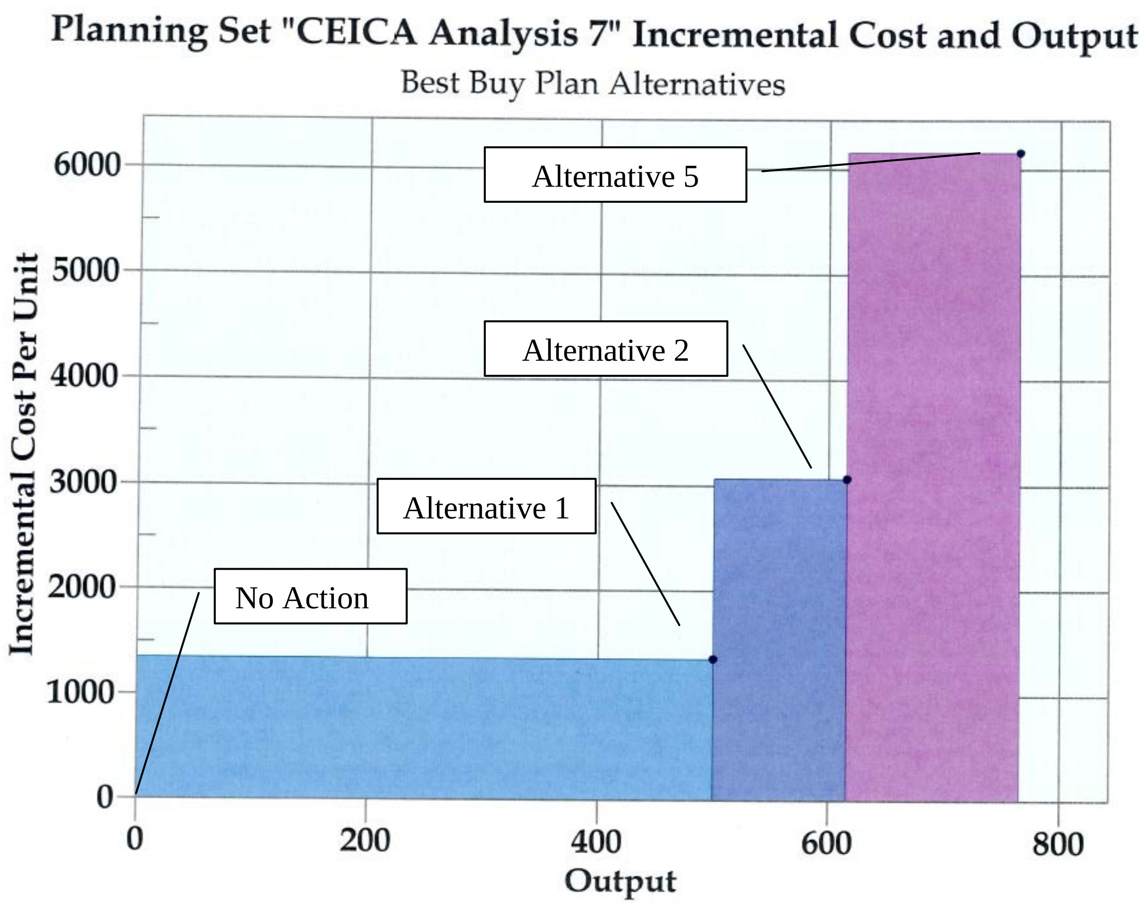

Figure 7- 2. Preliminary Incremental Cost per AAHU for Best Buy Alternatives.

7.7.2 UNQUANTIFIABLE HABITAT BENEFITS

Numerous other fish and wildlife benefits, not quantified by the habitat models, would accrue with project construction. Island construction would create conditions allowing for the re-establishment of extensive and diverse aquatic vegetation beds and restore bathymetric and flow diversity to the area (e.g., see Wind Fetch/Wave model output). These conditions would result in the creation of microhabitats conducive to increases in the diversity and population levels of aquatic invertebrates including: aquatic insects, amphipods, gastropods, and mussels. Likewise, habitat conditions for a wide variety of fish species would be expected to improve as food and cover resources become more widespread and diverse. The islands and associated vegetation would provide habitat for a wide variety of wildlife species including roosting, nesting, and migration habitat for many species of birds, including neotropical migrants, and nesting habitat for turtles. The islands and associated shoreline and shallow water zones would provide marsh habitat for marsh and water birds such as grebes, bitterns, herons, egrets, terns and shorebirds and improved habitat conditions for many species of reptiles and amphibians.

Construction of these features would also have additional waterfowl habitat benefits not quantified in the HEP analysis. Construction of features would result in the restoration of an integrated island complex in approximately a 3,500-acre portion of lower Pool 9, offering an area diverse in vegetation types and microhabitats. The synergistic effects of these features when evaluated as a single project were not quantified. The restoration of this major migration staging area in lower Pool 9 would result in an area that provides the diversity in vegetation, preferred organisms and protection from severe weather and disturbance to ensure that waterfowl depart for wintering grounds in good condition. This would be a substantial contribution to meeting the goals of the North American Waterfowl Management Plan.

7.7.3 INCIDENTAL BENEFITS

HEP results for the dabbling duck model are provided as a measure of incidental benefits of the alternatives under consideration (see Attachment 4). As a measure of habitat quality, existing conditions had HSIs in different parts of the study area ranging from 0.41 to 0.45. Under the no action alternative, the HSIs ranged from 0.34 to 0.41, indicating a decline in habitat quality. However, with proposed project features, HSIs increased to around 0.50. The result was a net gain in AAHUs of between 343 (Alternative 5) and 372 (Alternative 1) (Table 7- 6).

Table 7- 6. HEP Results for Dabbling Duck Across Alternatives.

Alternatives	**Net Gain in AAHUs**
ALT 1	371.9
ALT 2	364.1
ALT 3	357.7
ALT 4	346.8
ALT 5	343.6

It is surmised that the reduction in net gain of AAHUs as more features are built is due to the displacement of aquatic habitat by islands, the latter of which is not considered part of dabbling duck model.

7.7.4 NATIONAL ECOSYSTEM RESTORATION PLAN

The alternative plan that reasonably maximizes the benefits in relation to cost and meets the overall planning objectives is Alternative 2, tentatively selected as the National Ecosystem Restoration Plan (NER Plan). At this stage of planning EMP, habitat project and individual measures yielding an incremental average cost per AAHU of $2,000 have generally been accepted as justified, although $3,000 has been accepted in some circumstances. These numbers have not been adjusted for inflation since they were developed in the early 1990s. These criteria have been used to justify construction of over $59 million in habitat projects within the St. Paul District since the program began.

When viewed relative to the preliminary costs of similar ecosystem restoration projects, the $1,700 per AAHU created by Alternative 2 is efficient in achieving the stated ecosystem objectives and has been considered reasonable for past HREPS in the St. Paul District. Moreover, the $3,034 incremental cost per AAHU relative to Alternative 1 is also within the limits of reason. A similar argument could be made for Alternatives 1 ($1,300/AAHU) and 5 ($2,500/AAHU and $6,140/incremental AAHU). However at this time, the NER Plan has strongest support from the USFWS, as mangers of the resource, and is consistent with regional and State planning for the area.

The Federal objective for water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Achievement of the Federal objective is measured in terms of contribution to Federal accounts intended to track the overall benefits of a given project. The two accounts most applicable to the Harpers Slough HREP are the National Economic Development (NED) account and the Environmental Quality (EQ) account. Regional Economic Development (RED) and Other Social Effects (OSE) are discretionary accounts for display in Ecosystem Restoration Projects in accordance with ER 1105-2-100 Ch. 2.2-3.d(4). Other Social Effects, if any, would be similar amongst the alternatives and would not contribute to a decision amongst the alternatives.

Regional Economic Development (RED) Account

The RED account is intended to illustrate the effects the alternatives would have on regional economic activity, specifically, regional income and employment. While a detailed regional economic development analysis was not performed for the tentatively selected plan (or other alternatives), it is generally accepted that the ecosystem restoration projects that are part of the EMP have contributed RED benefits in small ways as each project is constructed. Over a longer term, ecosystem restoration projects contribute RED benefits on a larger scale by creating added eco-tourism opportunities and increasing economic opportunities in local communities along the entire Upper Mississippi River system. EMP, throughout its 28-year history, has created thousands of employment opportunities related to HREP planning, construction, and evaluation; LTRM monitoring; and research. Once completed, habitat projects create new opportunities for outdoor recreation, further stimulating local and regional expenditures.

Other Social Effects (OSE)

The OSE account is intended to illustrate the effects the alternatives would have on lives of residents and the social fabric of communities in the study area. The OSE account assists in plan formulation and in choosing an alternative that maximizes social benefits. Ecosystem restoration projects such as this one typically have positive net effects on the OSE account. Quality of life variables such as health and safety, material well being, and social connectedness are improved as a result of EMP projects. While the increment may be slight or difficult to measure for any individual EMP project, taken as a whole, the numerous completed restoration projects in the 28 years of the EMP program have greatly enhanced social factors in the Upper Mississippi River system.

National Economic Development (NED) Account

Contributions to NED are increases in the net value of the national output of goods and services expressed in monetary units. NED benefits from recreation opportunities by a project are measured in terms of willingness to pay. Benefits for projects that increase the supply of recreational facilities are measured as the willingness to pay for the increment of added supply. To the extent that the selected NER Plan, Alternative 2, provides additional recreational opportunities or improves upon existing ones that users would be willing to pay for, it contributes to the NED account. However, like monetization of ecosystem restoration benefits, valuation of recreation benefits has inherent uncertainty and is beyond the scope of this study.

Environmental Quality (EQ) Account

The EQ account measures effects on ecological, cultural, and aesthetic resources. For ecosystem restoration projects such as this one, contributions to the EQ account are detailed both through NEPA compliance and through calculation of net ecosystem benefits. Here, NEPA compliance is achieved by integrating an EA into this DPR, with a qualitative summary of environmental effects detailed in Table 9- 1 as well as in Section 9 of this report. A calculation of net ecosystem benefits was completed through use of Habitat Evaluation Procedures/Habitat Suitability Index. The quantitative results of the evaluation are contained in Appendix D. The credit to the EQ account is the quantified benefits resulting from the project, which in the case of the tentatively selected plan, provides a net gain of 618 AAHUs over the 50-year period of analysis. In the cases of the other best buy plans, a net gain of 501 and 768 AAHUs for alternatives 1 and 5, respectively.

7.7.5 COMPLETENESS, EFFECTIVENESS, EFFICIENCY, ACCEPTABILITY

ER 1105-2-100 states that the selected plan should meet the "planning objectives and constraints and reasonably maximize environmental benefits while passing tests of cost effectiveness and incremental cost analysis, significance of outputs, acceptability, completeness, efficiency and effectiveness." The definition of these terms and an evaluation of the alternatives are as follows:

> Completeness – the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of all planned effects. All the best buy alternatives would be considered complete, in that no other action or investments would be required to achieve their respective output.
>
> Effectiveness - the extent to which an alternative plan alleviated the specified problems and achieves the specified opportunities, as established in the planning objectives. All the best buy alternatives would at least partially meet the planning objectives, with Alternative 5 being the most effective and Alternative 1 being the least effective.
>
> Efficiency – the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities as established in the planning objectives, consistent with protecting the nation's environment. All best buy alternatives are recognized as within the acceptable range of costs per outputs for HREPs, adjusted for inflation. Alternative 1 is the most cost efficient and Alternative 5 is the least cost efficient.

Acceptability – The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations and public policies. All the best buy alternatives would be compatible with existing laws, regulations and public policies. In general, the USFWS and the States of Iowa and Wisconsin support the best buy alternatives. However, there was some variation across alternatives. Wisconsin indicated a preference for Alternative 5 to create additional overwintering fish habitat. USFWS indicated a preference for Alternative 2 with the addition of the U7 island for creating running slough habitat. However, they also expressed concerns over migrating waterfowl by closing off the Upper Evaluation Unit with the combination of U7 and U4. USFWS has indicated the existing conditions in this area function well in this regard.

It is important to recognize that the Harpers Slough area is a dynamic system that is influenced by a combination of factors that result in its current and projected further degraded state. Improving conditions within the Harpers Slough area is contingent upon addressing each of the ecosystem restoration objectives outlined in Section 5. Acknowledging that implementation of many of the identified measures alone or in combination would provide benefits to Harpers Slough, Alternative 2 includes an array of measures that would most cost-effectively address the majority of ecosystem restoration problems, opportunities, and objectives identified. While Alternative 5 produces slightly greater environmental benefits (effectiveness) than the tentatively selected plan, it was not as cost effective and could be controversial with resource agencies over waterfowl versus fish habitat.

7.8 RECOMMENDED PLAN

Based on the analysis of preliminary incremental cost; discussions of other benefits; consideration of components of the NER plan; and an evaluation of the acceptability, completeness, efficiency, and effectiveness of the Best Buy Alternatives, the Best Buy Alternative 2 is recommended for implementation (Figure 7-3). This alternative is the best array of project features that achieves most project objectives for the lowest incremental cost. Moreover, it balances acceptability, efficiency, and acceptability with emphasis on the EMP partnership. From a programmatic perspective, the cost savings of this alternative over a more expensive Best Buy alternative should be applied to and realized in other future HREPs in the upper Mississippi River.

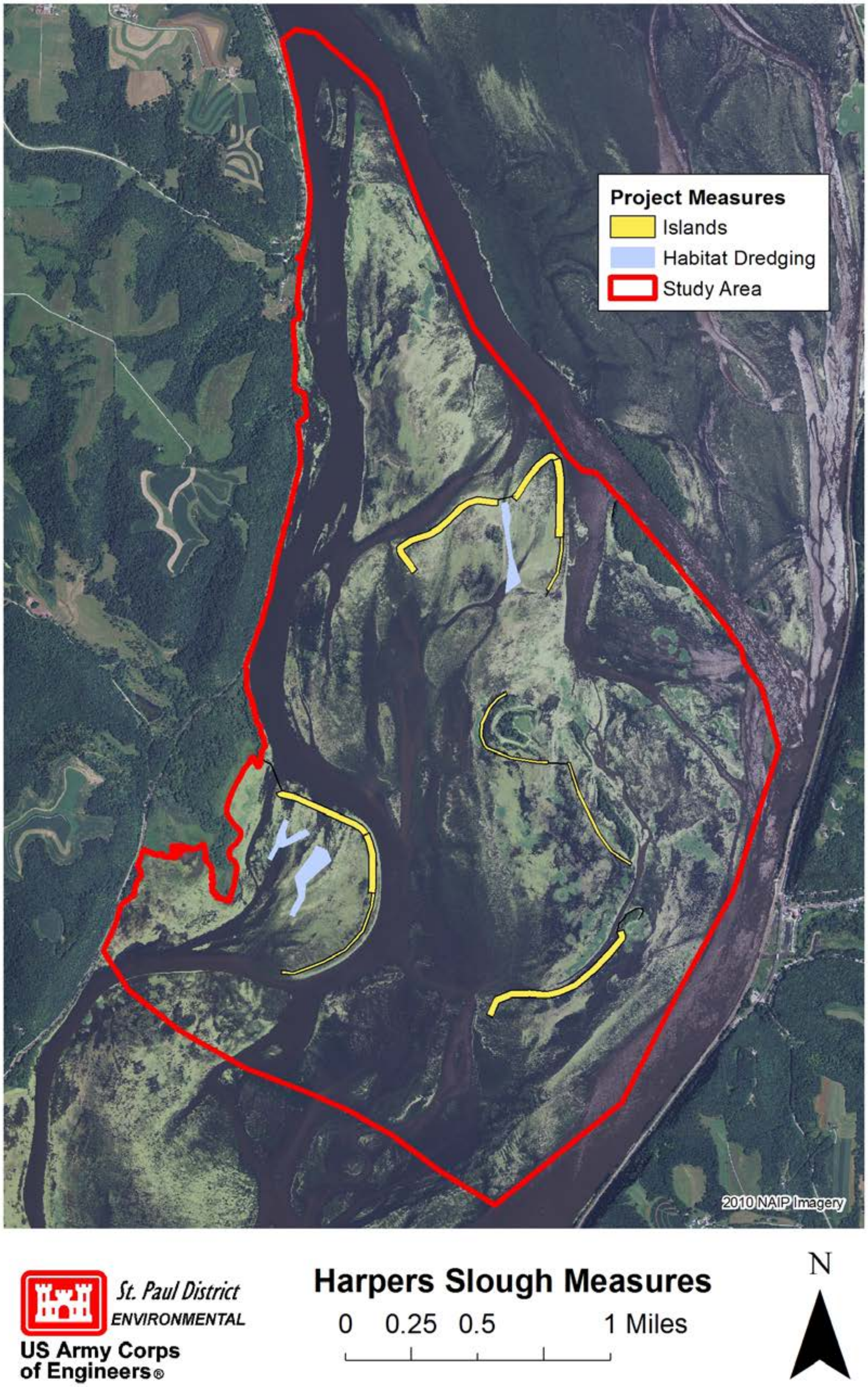

Figure 7-3. The Recommended Plan for the Harpers Slough HREP.

8. RECOMMENDED PLAN WITH DETAILED DESCRIPTION/DESIGN AND CONSTRUCTION CONSIDERATIONS

8.1 RECOMMENDED PLAN

This section provides details on the selected plan. The recommended plan is Alternative 2. The selected measures are shown on Plate 10. The estimated Project First costs are summarized in Table 8-1and detailed in Appendix I. Pertinent design parameters are summarized in Table 8-2 and Table 8-3. Details are provided in Sheets C-001 through C-305 of the Civil drawings.

Summary of the Recommended Plan Measures:
Island M2 (type A wide island)
EWM2 (emergent wetland)
Island M5 (type A wide island)
EWM5 (emergent wetland)
Rock Sill M4
HDM4 (habitat dredging)
Rock Mound M8
Island L1 (narrow island with rock)
Rock Sill L2
Island L3 (narrow island with rock)
Rock Mound L5
Island L6 (type A wide island)
EWL6 (emergent wetland)
Island W2 (type A wide island)
Rock Sill W1
HDW1 (habitat dredging)
Island W3 (narrow island with rock)
HDW2 (habitat dredging)

Table 8-1. Summary of Recommended Plan Costs.

Item	Cost
Lands and Damages	NA
Construction	$13,112,000
Planning, Engineering and Design (approx. 19%)	$2,481,000
Construction Management (approx. 14%)	$1,834,000
Total	**$17,427,000**

Table 8-2. Summary of Design Data.

Feature	Length (ft)	Top width (ft)	Exterior berm width	Exterior slope	Interior berm (ft)	Interior slope	Top elevation (ft)	Berm elevation (ft)
M2	2730	50	40	1V:5H	40	1V:5H	622.75	621.75
M5	1375	50	40	1V:5H	40	1V:5H	622.75	621.75
M5	1425	50	40	1V:5H	40	1V:5H	624.75	621.75
M5	1124	60	-----	-----	-----	-----	622.75	-----
M5	130	10	-----	-----	-----	-----	622.00	-----
M4	300	10	-----	-----	-----	-----	622.00	-----
M8	250	4	-----	-----	-----	-----	621.75	-----
L1	2500	60	-----	-----	-----	-----	622.75	-----
L2	390	10	-----	-----	-----	-----	622.00	-----
L3	2435	60	-----	-----	-----	-----	622.75	-----
L5	1000	4	-----	-----	-----	-----	621.75	-----
L6	3480	50	40	1V:5H	40	1V:5H	622.50	621.50
W2	2000	50	40	1V:5H	40	1V:5H	622.50	621.50
W2	1200	50	40	1V:5H	40	1V:5H	624.50	621.50
W1	800	10	-----	-----	-----	-----	621.75	-----
W3	2650	60	-----	-----	-----	-----	622.50	621.50

Table 8-3. Summary of Estimated Quantities of Materials for the Project (yd^3).

Feature	Granular Fill	Random Fill	Fines	Riprap	6" Chinking stone	Dredge Fill
Island M2 (Type A)	96,315	1,425	7,785	2,165		
Island M4 (Rock Sill)				2,205	145	
Island M5	94,320	9,090	10,580	5,275	65	
Island M8 (Rock Mound)				495		
Island L1 -NIRB	26,905		4,020	5,960		
Island L2 (Rock Sill)				1,660	160	
Island L3-NIRB	28,930		3,835	6,260		
Island L5 (Rock Mound)				1,285		
Island L6 (Type A)	91,790	1,765	9,640	2,830		
Island W1 (Rock Sill)				6,300	330	
Island W2 -Type A	98,600	7,535	9,355	2,716		
Island W3-NIRB	33,265		4,170	10,440		
Emergent Wetland M2	6,040	11,035				
Emergent Wetland M5	5,605	11,025				
Emergent Wetland L2 Island	8,620	1,935				
Emergent Wetland W2 Island	15,755	18,250				
Access Channels						14,920
Habitat Dredging M4						13,000
Habitat Dredging W1						13,015
Habitat Dredging W2						25,240
TOTALS	**506,145**	**62,060**	**49,385**	**47,591**	**700**	**66,175**

8.2 ROCK MOUND BANK STABILIZATION AND ROCK SILLS

8.2.1 ROCK MOUND

Rock mound bank stabilization would be placed along several narrow islands: L1, L3, and W3. The M8 L5 islands would also consist of a round mound. The purpose of using this type of bank protection is to avoid the shoreline disturbances associated with placing a riprap layer on the bank. Typical designs for the rock mound are shown in Sheet C-302 of the Civil drawings.

8.2.1 ROCK SILLS

The rock sill closures, M4 and L2 would have top elevations of 622.0 ft, and W1 would have a top elevation of 621.7 ft. All rock sills would have a top width of 10 ft. The primary purpose of the rock sills is to provide an initial overtopping point for high flow. The rock sills serve to decrease the head differential across the sand islands during overtopping events and minimize increases in water surface elevation for extreme flood events such as the 100-year flood. The sill structures would be rock with a top elevation 1 foot lower than the attached island or rock mound. Typical designs for the rock sills are shown in Sheet C-301 of the Civil drawings.

8.3 ISLANDS

8.3.1 NARROW ISLANDS

The narrow islands L1, L3, W3, and the downstream portion of M5 would have top elevations of 622.5 ft. All narrow islands would have a 60-foot top width and would be protected with a rock berm.

8.3.2 TYPE A WIDE ISLANDS

In general, wide islands would have outside and inside berms (each about 40 feet wide) at an elevation about 2 feet above the average water surface level, surrounding an inside berm (about 60 feet wide) that is 1 to 2 feet higher. The elevation difference is designed to develop into grasses, woody vegetation, and beach.

The islands M5 and W2 would begin as wide islands at the upstream end, and would be tapered on the downstream leg of the island, i.e., the islands would start off widest at the upstream end, and would get narrower as it progresses downstream. Likewise, these islands would start off at a finished elevation on the upstream side higher than on the downstream side. Wide islands would be built to an elevation range of 622.0 to 624.75 ft. The M2 island would not be tapered and would be 140-ft wide and have a top elevation of 622.75 ft.

8.3.3 EMERGENT WETLAND/MUDFLAT

All emergent wetlands are optional features and would be constructed based on need for disposal of excess access material. Potential locations for emergent wetlands include the M2, M5, L6, W2, and W3 islands. A low sand berm would be constructed along the outside edge of the designated emergent wetland area. This sand berm would serve as the containment berm for the material used to create the emergent wetland. Material would most likely be placed within the emergent wetland area by a small hydraulic dredge. The design elevation of the emergent wetland is 619.25 ft; however, a relatively wide tolerance will be allowed (such as ± 0.5 foot) to provide a diversity of elevations within the mudflat to promote vegetation by a variety of species. For the wetland interior, random fill or fine fill could be used. The design elevation for sand berms would be 621.75 feet, and these would be breached or allowed to erode naturally. The decision would be made after the emergent wetland is constructed and it can be determined how stable the material is.

8.4 WINTER HABITAT CREATION

Habitat dredging, in combination with the influence of islands on winter water velocities, would create suitable habitat conditions. HDW1, HDW2, and HDM would be dredged to 6 feet, elevation 614.1. The side slopes would be the angle of repose, which may flatten with time. All material for habitat dredging will be used as topsoil on the islands and/or placed in one of the optional emergent wetlands.

8.5 CONSTRUCTION METHODS

Construction of the rock measures would likely be a combination of marine plant and land based equipment. The equipment used to place the rock would likely be hydraulic backhoe on a barge or land-based from the newly constructed island. No site preparation work would be necessary aside from moving snags or fallen trees from the work area. They would be moved out of the way and placed along island shorelines.

How islands are constructed is generally left to the discretion of the contractor. The contractor is responsible for providing the finish product (the islands as designed) in a manner best suited to his/her operation. Experience with construction of other island projects with the St. Paul District -28 islands in 6 different locations - has shown that there is a general pattern to cost effective construction of islands.

The sand base for an island is placed using hydraulic or mechanical dredging equipment. Because of the large quantities involved, it is usually much more cost effective to use hydraulic dredging equipment than mechanical dredging equipment. The sand, as it is discharged from the pipeline, firms up quite rapidly and is capable of supporting bulldozers that are then used to generally shape the island.

The random fill sections of the islands can be filled using either hydraulic or mechanical dredging equipment. If the contractor does not need the random fill sections to dispose of access dredging materials, the most cost effective approach is to fill these sections with sand as part of the sand placement process. If excess access dredging material is used, the method of placement would depend on the type of equipment the contractor uses for access dredging.

Fine material is placed on islands by a variety of methods. Placement of fine material using mechanical equipment is slower and more costly in terms of actual placement. However, mechanically placed material dries more quickly so that it can be shaped and graded in a shorter time following placement. Initial placement of fine material using hydraulic dredging equipment is faster. However, hydraulically placed material must be contained and takes longer to dry before it can be shaped and graded. Meeting water quality limitations for the discharge of the dredge carriage water may affect the operation. These factors may negate the initial cost savings associated with the hydraulic placement.

New technologies are evolving which involve dredging of fine materials with a small hydraulic dredge and passing them through a mechanical dewatering process using flocculents and presses. The end product is dewatered fine material that can then be placed, shaped, and graded without an extensive drying period. This process was used on an island construction project in the St. Paul District in 2000 and holds promise in the future as a cost effective method of fine material placement. At a minimum, the contractor would be allowed to use these newer technologies if they are able to meet all other conditions, including any necessary State permits and/or water quality certifications.

Rock is barged to the islands and placed using hydraulic backhoes from either the new island base or from barges. The most limiting factor on rock placement is usually water depths for the rock barges and push boats. To limit the amount of access dredging or double handling of rock along the islands, contractors may place rock protection during periods of high water. Very limited access will be provided. Therefore, the islands were designed to facilitate trucking the rock to the placement sites. Passing lanes were incorporated into the narrow islands to increase the efficiency of trucking. Sand pads were incorporated to facilitate unloading of equipment and material.

Nothing in the design of the islands suggests that any innovative or unusual construction methods would be necessary.

8.6 CONSTRUCTION RESTRICTIONS

Construction restrictions could be applied for any number of reasons. Restrictions are generally applied in the construction of habitat projects to minimize the adverse effects of construction and to protect valuable habitat. The following are the basic construction restrictions that would likely be applied in the construction of the island measures.

a. Access dredging would be limited to the minimum considered necessary to construct the project and confined to the access areas on Plate 11. Alternative access dredging would be subject to the conditions in Section 8.7.
b. Water quality limitations would be imposed on the hydraulic placement of sand material for island bases. The criterion used in past island construction projects has generally been that a specified suspended solids concentration has to be met within a certain distance from the discharge point; e.g., 500 mg/l at 500 feet below the discharge point.

c. Contractors are usually allowed to propose alternative borrow sites. The contractor documents would define acceptable borrow areas. Alternate borrow sites would be evaluated on a case-by-case basis for approval. The Government would not approve alternative borrow sites in areas such as existing aquatic plant beds, mussel beds, or other environmentally sensitive areas.
d. In general, project activities will not be allowed within 660 feet of a bald eagle nest during the nesting season. Construction activities involving loud noises (e.g., pile driving) would have a ½ mile buffer zone during this period.
e. Construction activities are within the Closed Area of the USFWS Refuge. No construction shall take place during the waterfowl hunting season, generally September 30 to December 1. All construction activities and equipment must be removed from the Closed Area during this period.

8.7 ACCESS DREDGING

Access dredging would be required to construct the project. Generally, a balance must be struck to provide reasonable access for the construction while minimizing the environmental disturbances associated with the dredging. In addition, being able to incorporate the access dredging material into the islands avoids the costs of having to transport this material elsewhere for disposal.

Contractors are allowed to request alternate access routes. These requests would be evaluated on a case-by-case basis for approval. The contractor would be allowed to place access material in the optional emergent wetlands identified in Plate 11 or a random fill in the island cross sections.

8.8 SOURCES OF MATERIAL

8.8.1 GRANULAR FILL

A number of options for obtaining granular fill for the islands were evaluated and still may be considered during preparation of plans and specifications for project construction. The granular fill would need to meet the requirements of less than 10% fines (less than P200). Additional borings, as needed, would be collected during development of plans and specifications and the precise area of borrow would be defined.

<u>Main Channel of the Mississippi River</u>: The main channel of the river is a known source of sand. This source is considered the primary alternative, because no acceptable other source was found. Excavating holes in the main channel of the river would provide only limited secondary habitat benefits.

<u>9-Foot Navigation Channel Maintenance Material</u>: A review of historic dredge cuts in lower Pool 9 indicates the following channel maintenance cuts are in the vicinity of the Harpers Slough Project: Above Atchafalaya. The Atchafalaya cut (approximately 7 river miles away) could be used for the Harpers Slough project, however, because of the distance and the

availability of granular material adjacent to the site, it would not be economical to use this site. An Environmental Assessment for the “Atchafalaya Bluff Dredging, Operation and Maintenance of the 9-Foot Navigation Channel, Upper Mississippi River, Pool 9” has been completed, with the FONSI signed October 7, 2010. An estimated 30,000 cubic yards were available in Atchafalaya for a dredge cut in 2010.Use of this material to construct Harpers Slough project measures would be considered if it were found to be most-cost effective or cost neutral for both EMP and 9-foot Channel Operation and Maintenance programs.

Off-Channel Sites: Borrow dredging from off-channel areas would also be an option. Borrow dredging from off-channel areas, depending on location, could provide substantial secondary fish habitat benefits and would normally be the preferred source of material. However, no suitable off-channel sites were identified during the planning and design phases. The boring do indicate that if there was accost-effective way of removing the over-burden of fines, off-channel borrow areas might be used.

8.8.2 RANDOM FILL

It is expected that most random fill would come from access dredging material that contains too much fine material to be used in the sand sections of the islands and too little fine material to be considered fine fill for topsoil. Random fill could also come from habitat dredging. If the contractor does not need to use the random fill island sections for disposal of access dredging material or habitat dredging, it is expected that it would be most cost effective for the contractor to use sand for random fill. Excess random fill from access or habitat dredging could be placed in any of the optional emergent wetlands.

8.8.3 FINE FILL

It is expected that the fine fill (topsoil) would come from habitat dredging and access dredging.

8.8.4 ROCK

The rock would come from an approved local quarry. The loading site would depend on the location of the quarry. It is expected that the rock would probably be loaded in the Lansing area.

8.9 CONSTRUCTION SCHEDULE

The scope of the project would require a minimum of 3 years of construction. Because of the location and nature of the construction, nearly all the work would require use of marine equipment. Construction of this type is limited to the open water season on the Upper Mississippi River. Construction in certain years can begin in April, but May is more typical for beginning construction due to the constraints associated with spring high water. At the other end of the spectrum, late November is the end of the construction season due to winter freeze-up.

The construction schedule for the project would depend on the funds available for construction and other factors such as the potential for combining construction with District operation and maintenance activities or the need to accommodate other habitat measures such as pool drawdown. Based on current and expected UMRS-EMP budgets and project priorities within the St. Paul District, it is estimated that construction of the project would begin in 2014.

The optimum approach would be to construct the project under one construction contract. It would be possible to stage construction if necessary due to funding constraints. The lower island complex could be constructed first, as this complex protects existing islands. The second stage would be the middle island. The third stage would be the Wexford complex. The lower islands could be constructed in one contract, the middle islands in another contract and the south west island in another contract. The potential three stages are as follows:

Stage 1: L Complex
Stage 2: M Complex
Stage 3: Wexford Complex

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9. ENVIRONMENTAL EFFECTS

An environmental evaluation in accordance with NEPA (42 USC 4331) has been conducted for the recommended action, and a discussion of the impacts follows and is summarized in Table 9- 1. This discussion also examines the no action alternative. To maintain brevity, the discussion does not include those parameters where there are "no effects," but this information is included the table.

As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in Table 9- 1 were reviewed and considered in arriving at the final determination. In accordance with Corps of Engineers regulations (33 CFR 323.4(a)(2)), a Section 404(b)(1) evaluation has been prepared and is included in Attachment B of this DPR. A draft FONSI is attached at the end of the report. If determined appropriate, the FONSI will be signed after the public review.

The significant natural resources of the project area and its surroundings are described in Sections 3 and 4 (Existing Resources) of this integrated DPR and EA. Additional descriptions of the ecological effects and benefits associated with the no action, recommended plan, and alternative plans can be found in Section 7, Section 8, and Attachment D.

9.1 APPLICABLE ENVIRONMENTAL LAWS AND REGULATIONS

This integrated DPR and EA was prepared and the proposed work designed to comply with all applicable environmental laws and regulations (Table 9- 2). A highlight of compliance with the major environmental laws and regulations follows. In the final DPR, the status of compliance for several acts/orders are listed as only partial. Full compliance with these acts/orders has been or will be achieved before the signing of the FONSI.

In compliance with the Fish and Wildlife Coordination Act, project plans have been coordinated with the Upper Mississippi River National Wildlife and Fish Refuge and the Region 3 Offices of the USFWS and the Wisconsin and Iowa DNRs. The dredging and fill activities associated with island building would have effects on water quality. Under the Clean Water Act, the Corps will apply for a Chapter 30 and 401 Water Quality certification from the Iowa and Wisconsin DNRs based on final estimates of quantities of materials determined as part of the Plans and Specifications phase. Preliminary indications are that these permits will be issued without major restrictions. A 404(b)(1) analysis is also in the process of being finalized (Appendix B). Under the Floodplain Management Executive Order, Federal agencies "are to provide leadership and shall take action to reduce the risk of flood loss, to minimize the impacts of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains." This project has been designed to minimize the flood impacts by creating low-elevation islands (usually located adjacent to existing islands) that would become submerged during flood events. Minimal impact on flood flows would also be accomplished by orienting the topographic measures of new islands in relation to flow. This design is intended to have little to no measurable effect on the 100-year flood event (Appendix H). This project is also in compliance with the Protection of Wetlands Executive Order (EO) because it would create new wetland habitat. The Farmland Protection Policy Act does not apply to this project because no prime, unique, or State or locally important farmland would be converted to nonagricultural uses.

Table 9- 1. Environmental Assessment Matrix for Proposed Project.

	Section 122 of the River and Harbor and Flood Control Act of 1970 (Public Law 91-611)													
Alternative	**No Action**							**Recommended Alternative (Alternative 2)**						
	BENEFICIAL[a]				ADVERSE[b]			BENEFICIAL[a]				ADVERSE[b]		
PARAMETER	+++	++	+	**0**	-	--	---	+++	++	+	**0**	-	--	---
A.SOCAL EFFECTS														
1. Noise Levels				X								ST		
2. Aesthetic Values						X				X		ST		
3. Recreational Opportunities					X					X		ST		
4. Transportation				X							X			
5. Public Health and Safety				X							X			
6. Community Cohesion (Sense of Unity)				X							X			
7. Community Growth & Development				X							X			
8. Business and Home Relocations				X							X			
9. Existing/Potential Land Use				X							X			
10. Controversy					X						X			
B. ECONOMIC EFFECTS														
1. Property Values				X							X			
2. Tax Revenue				X							X			
3. Public Facilities and Services				X							X			
4. Regional Growth				X							X			
5. Employment				X						ST				
6. Business Activity				X						ST				
7. Farmland/Food Supply				X							X			
8. Commercial Navigation				X							X			
9. Flooding Effects				X							X			
10. Energy Needs and Resources				X							X			
C. NATURAL RESOURCE EFFECTS														
1. Air Quality				X								ST		
2. Terrestrial Habitat						X			X			ST		
3. Wetlands						X			X			ST		
4. Aquatic Habitat						X			X					
5. Habitat Diversity and Interspersion						X			X					
6. Biological Productivity						X			X			X		
7. Surface Water Quality					X						X			
8. Water Supply				X							X			
9. Groundwater				X							X			
10. Soils				X							X			
11. Threatened or Endangered Species				X							X			
D. CULTURAL RESOURCE EFFECTS														
1. Historic Architectural Values				X						X				
2. Pre- & Historic Archeological Values				X						X				

[a] Beneficial: '+++' = significant; '++' = substantial; '+' = minor.

[b] Adverse: '---'= significant; '--' = substantial; '-' = minor.

'0' = No effect.

X = Long-term effects; ST = Short-term effects.

Table 9- 2. Compliance review with all applicable environmental regulations and guidelines.

Environmental Requirement	Compliance[1]
Federal Statutes	
Archaeological and Historic Preservation Act	Partial
Bald and Golden Eagle Protection Act of 1940, as amended	Partial
Clean Air Act, as amended	Full
Clean Water Act, as amended	Partial[2]
Coastal Zone Management Act, as amended	N/A
Endangered Species Act of 1973, as amended	Full
Federal Water Project Recreation Act, as amended	Full
Fish and Wildlife Coordination Act, as amended	Full
Land and Water Conservation Fund Act of 1965, as amended	Full
Migratory Bird Treaty Act of 1918, as amended	Full
National Environmental Policy Act of 1969, as amended	Partial[3]
National Historic Preservation Act of 1966, as amended	Full
National Wildlife Refuge Administration Act of 1966	Full
Noise Pollution and Abatement Act of 1972	Full
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic Rivers Act of 1968, as amended	N/A
Farmland Protection Policy Act of 1981	N/A
Executive Orders, Memoranda	
Floodplain Management (EO.. 11988)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514)	Full
Protection and Enhancement of the Cultural Environment (E.O. 11593)	Full
Protection of Wetlands (E.O. 11990)	Full
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 30 August 1976)	Full

[1] The compliance categories used in this table were assigned according to the following definitions:

a. Full - All requirements of the statute, E.O., or other policy and related regulations have been met for the current stage of planning.

b. Partial - Some requirements of the statute, E.O., or other policy and related regulations remain to be met for the current stage of planning.

c. Noncompliance (NC) - Violation of a requirement of the statute, E.O., or other policy and related regulations.

d. Not Applicable (N/A) - Statute, E.O., or other policy and related regulations not applicable for the current stage of planning.

[2] 401 water quality certification and Chapter 30 permits required.

[3] Full compliance to be achieved with the District Engineer's signing of the Finding of No Significant Impact.

9.2 NO ACTION ALTERNATIVE

The No Action alternative would result in continued degradation of aquatic and terrestrial habitat over the long term as described in Section 4-4. As a result of losses in terrestrial habitat (islands), wetlands, and aquatic vegetation, there would be a corresponding loss in habitat diversity and interspersion and biological productivity. Surface water quality would also degrade somewhat, primarily through higher turbidities associated with island erosion and through less filtration by aquatic plants. State-listed threatened or endangered aquatic species would be adversely affected by degraded habitat and water quality. Under such conditions, non-native and/or invasive species could outcompete and become established. As degraded conditions provide less support for fish and wildlife, recreational opportunities in the project area (primarily hunting, fishing, and wildlife-viewing) would degrade as well. A loss of this type of ecosystem would result in reduced recreational opportunities and would adversely affect the aesthetic value of the area. This is likely to be viewed as controversial to the public.

9.3 RECOMMENDED PLAN

9.3.1 SOCIAL AND ECONOMIC EFFECTS

9.3.1.1 NOISE

The immediate vicinity around the project area and at access points (e.g., boat landings) would experience elevated noise generated by construction equipment, especially heavy machinery. However, the project study area is rather isolated and the impacts to residents in the general area should be negligible. This impact would be temporary, and adverse effects to the general public would be short-lived and minor.

9.3.1.2 AESTHETICS

In general, the aesthetic environment of the project area over the long term would be improved compared to either the existing condition or the future condition under the no action alternative in which islands are completely eroded. The project measures and the resulting aquatic vegetation would return the project area to a desirable condition similar to that found in the past. Existing islands would be preserved, and new ones would be created. However, rock measures would generally be considered aesthetically displeasing. During the period of construction, the aesthetic value of the area would be diminished as a result of disturbance. This effect would be temporary until vegetation establishes and matures, anticipated to be within 3 years of construction for aquatic vegetation and 30 years of construction for mature floodplain forest.

9.3.1.3 RECREATION

Recreation in the project area (primarily in the form of fishing, hunting, and wildlife-viewing) would likely be negatively affected during project construction. However, after completion, the project would likely have long-term positive effects on recreation. Improvements to overwinter habitat (via habitat dredging) for backwater fish would increase ice-fishing opportunities. Preserving natural islands and creating new ones will provide terrestrial habitat that could be used by migrating birds and mammals that are a source for wildlife viewing and hunting. The creation of emergent wetlands would promote use by dabbling ducks. Islands would also serve as wind-breaks that would create additional fishing and hunting areas as well as places for recreational boaters to anchor.

9.3.1.4 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES

The project is located in a natural setting of the Upper Mississippi River. Analysis of sediment samples in the area indicated that the levels of manganese, nickel, ammonia, and total organic carbon were above the Ontario Ministry of Environment’s (Persaud et al. 1993) Lowest Effect Level guidelines for sediment (see Appendix B). However, these results are not unusual for the Upper Mississippi River. There are no other known sources of hazardous, toxic, and radioactive wastes (HTRW) in the project area. Any material brought on-site would also be from sources free of HTRW. Therefore, no potential effects from HTRW are anticipated.

9.3.1.5 OTHER SOCIAL EFFECTS

The project might have slight effects on other social factors such as transportation, public health and safety, community cohesion and growth, and controversy. For example, during construction, materials such as riprap would have to be transported to the site, which might affect local traffic conditions between the rock source and the project site. Also, strong support for the habitat restoration might be somewhat tempered by a sentiment of fiscal constraint, thus triggering controversy. For most of these factors, it is difficult to determine the level of these effects. However, it is anticipated these effects would not rise to the level of even a minor effect; thus, they are identified as having no effect in Table 9- 1.

9.3.1.6 OTHER ECONOMIC EFFECTS

Improved habitat and water quality and the resulting increase in fish and wildlife populations would enhance recreation opportunities and business activities over the long term, primarily in the form of hotel accommodations, outdoor sporting equipment sales, and dining. Temporary benefits would also accrue to local businesses during project construction, contributing to employment opportunities. Other slight effects might be felt on other economic factors such as property values, tax revenue, public facilities, regional growth, commercial navigation, and energy needs and resources. For example, construction activities would be located near the 9-foot navigation channel, thus having the potential to affect commercial barge traffic. However, these effects would not be expected to rise to the level of even a minor effect.

9.3.1.7 ENVIRONMENTAL JUSTICE

Environmental Justice is a national goal and is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Project goals and objectives were established to provide environmental restoration and enhance the quality of the environment for all people. The proposed project would be constructed on public lands; no private lands would be acquired. Public involvement, via public meetings and distribution of information concerning the proposed project, has and will continue to be an integral part of planning for this project to ensure that concerns of all people will be fully considered in the decision-making process. In summary, the proposed action would not have a disproportionate adverse impact on any population.

9.3.2 NATURAL RESOURCE EFFECTS

Summary: The recommended alternative would improve aquatic habitat and island habitat within the approximately 3,500-acre project area of influence or study area in Pool 9 of the Upper Mississippi River. The restoration of island complexes and the effects on lessening wind/wave action would result in increases in vegetation and diversity in this area and would improve migration habitat for waterfowl. Increased vegetation diversity and extent, the creation of deep holes in selected areas, and the addition of rock sills would improve aquatic habitat for fish as well as many other aquatic species. The recommended alternative would also protect existing islands and create about 52 acres of island habitat in this area. These islands and associated mudflats would provide important habitat for a wide variety of wildlife species such as shorebirds, as well as important migration habitat for neotropical migrants. In addition, project measures would include the creation of deepwater areas which would benefit fishes by creating more depth diversity. Deep pools would also function as valuable overwintering areas.

9.3.2.1 AIR QUALITY

Emissions from heavy equipment used during construction would have a minor negative impact on air quality in the project area. Combustion of gasoline and diesel fuels would contribute hydrocarbons, nitrogen oxides, and carbon monoxide to the air. However, this effect would be short-term and would be most pronounced at the construction site, which is largely isolated from human populations.

The Clean Air Act General Conformity Rule (40 CFR parts 51 and 93) was designed to ensure that Federal actions do not impede local efforts to control air pollution. The final rule dictates that a conformity review be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more of the six National Ambient Air Quality Standards (NAAQS) criteria pollutants. Crawford and Allamakee Counties are in “attainment” of the NAAQS for each of the six criteria pollutants. Because of this, no detailed conformity analyses is required for this project.

9.3.2.2 TERRESTRIAL HABITAT

The proposed project would have a substantial positive effect on terrestrial habitat in the study area. Constructing islands would create about 52 acres of new terrestrial habitat (in the form of islands) and protect about 48 acres of existing islands.

Terrestrial habitat in the lower portions of the pools in this geomorphic reach (Pools 5 through 9) has been declining since the construction of lock and dams on the Upper Mississippi River and is projected to significantly decline in the future. By the year 2065, the habitat types present and/or likely to develop on the islands (including scrub-shrub, salix community, and wet floodplain forest) are projected to decline by 25 percent (9,691 acres) in this geomorphic reach (Theiling et al. 2000). This trend has also been observed within the Harpers Slough area. For example, in 1975 island habitat was estimated at 88 acres, and in 2010 it was estimated to be around 52 acres. The proposed project would help to offset the projected future losses of this habitat cover type and associated habitats. Soil cover around existing islands may initially experience disturbance with project construction; however, additional soil cover would be created (from dredged material) on new islands.

9.3.2.3 WETLAND HABITAT

The proposed project would likely disturb wetland habitats (i.e., emergent wetland, rooted floating aquatic vegetation, and submersed aquatic vegetation cover types) during the construction of project measures, estimated at 144 acres. Some of this disturbance would be temporary as vegetation becomes established and matures as this disturbed portion reverts back to wetlands. However, a portion of existing wetlands would be converted into other habitat types such as islands or pools.

The proposed project would have substantial long-term positive benefits from the creation of new wetland habitat. Up to 21 acres of mudflats could be constructed as part of project measures, which would lead to the establishment of emergent vegetation over a relatively short period (3 to 5 years). Moreover, in comparison to the no action alternative in which a complete loss of islands and wetlands is projected (discussed in the HEP analysis section); the project would protect the existing wetlands at the time of construction. By year 50 after project construction, the end result is projected to be a net gain of about 60 acres.

Newly-established or protected existing wetlands would provide habitat benefits for amphibians, aquatic insects, waterfowl, shorebirds, fish, and some mammals. In addition, improvements in habitat associated with the terrestrial-aquatic interface would benefit aquatic mammals such as muskrats (*Ondatra zibethicus*) and many species of reptiles and amphibians. Improvements to wetlands would help improve water quality by filtering nutrients and contaminants.

9.3.2.4 AQUATIC HABITAT

The proposed project would disturb about 175 acres of aquatic habitat during the construction of project measures. Some of this disturbance would be temporary as a part of habitat dredging. Access dredging for providing borrow material and equipment access for construction of the proposed island measures would disturb about 9 acres of aquatic habitat. Other short-term adverse effects will be from disturbance during construction activities, primarily as a result of sedimentation. However, this disruption would be temporary, and the increased depths associated with dredging would improve aquatic habitat for backwater fish species. Long-term adverse effects would include the conversion of about 52 acres of aquatic habitat to new islands.

Despite the loss in quantity of aquatic areas, project measures would result in a long-term increase in the quality of this habitat. Aquatic habitat in the area is currently of a lower quality due to sedimentation, lack of bathymetric diversity, extensive susceptibility to wind fetch, and lack of aquatic vegetation. The existing and future HSI value for bluegill under the no action alternative is 0.13 (Attachment D). However, the protections provided from new islands and habitat dredging for overwinter refuge areas would increase the HSI to 0.70 for bluegill over this same period. The expected increase in habitat quality (primarily in the form of deepwater areas) and the additional protection measures (e.g., wind breaks) are expected to more than offset aquatic habitat losses associated with construction. Island measures would provide protection from wave action, thereby decreasing sediment resuspension, increasing photic depth, increasing aquatic plant growth and diversity, and preventing uprooting. Vegetation beds in the form of submersed or rooted aquatic vegetation have higher HSIs for bluegill life requisites relative to open water. These areas are expected to expand substantially in comparison to the no action alterative.

Project measures would also provide long-term benefits to waterfowl using aquatic areas bordering islands. Specifically, the increased aquatic vegetation extent and diversity and restoration of island complexes affording protection from prevailing winds and disturbance would contribute to an increase in the value of the project area as waterfowl migration habitat. Evidence for this is observed for diving duck HSIs as it increased from 0.42 to 0.63 or greater when compared to the no action alterative over a 50-year period (Appendix D).

9.3.2.5 HABITAT DIVERSITY AND INTERSPERSION

Since the construction of Lock and Dam 9, the habitat in Harpers Slough has become less diverse for a number of reasons: islands have eroded, sedimentation has resulted in more shallow areas, and flow characteristics have become more uniform. The proposed project would have a substantial positive effect on habitat diversity and interspersion in the Harpers Slough area. Island construction would increase land form or shape, flow pattern, and improve aquatic vegetation diversity. The proposed rock structures would provide a unique substrate in the project area and would therefore increase substrate diversity. Proposed dredging activities would increase depths in some areas, resulting in greater bathymetric diversity. Construction of the island complexes and associated rock sills would restore the riverine process to a great degree, especially as it relates to channel flow, thus reducing sedimentation in key areas and restoring bathymetric and flow diversity.

The benefits of the project are especially pronounced when compared to the no action alternative. Without the project it is projected that the remaining islands will be completely lost and most of the river bottom in the area will level off to a relatively uniform shallow water depth, leading to reduced habitat diversity. Without the project it is also projected that the Harpers Slough secondary channel would continue to lose definition, with more diffuse river flows and a reduced ability to flush sediments.

9.3.2.6 BIOLOGICAL PRODUCTIVITY

The proposed project would have temporary minor adverse effects on biological productivity resulting from disturbance caused by construction activities. However, project measures would lead to a substantial positive effect on the overall long-term biological productivity in the study area. The existing high biological productivity would be maintained and increased as a more diverse and abundant aquatic vegetation community develops. Although the total area of aquatic habitat would be less, the shoreline interface and associated littoral areas, which are highly productive relative to open water, would increase. This would contribute to macroinvertebrate species diversity and community structure and function. This, coupled with other habitat improvements in the project area, could also lead to greater vertebrate productivity, especially shorebirds, waterfowl, and aquatic mammals. The increased productivity levels would be especially pronounced when comparing the recommended alterative to the no action alternative.

9.3.2.7 SURFACE WATER QUALITY

During construction, there would be a minor negative effect on water quality in the project area. Dredging activities and the placement of fill to construct the proposed measures would result in localized increases in suspended sediment and turbidity. However, the coarseness of the material used to construct the island bases would reduce the amount of resuspension of this material.

Minimal risk is associated with contaminants becoming resuspended in the water column from dredging activities. The general sediment quality in Pool 9 is described in Section 3. Sediment analysis of the fine-grained material used for fill has shown it to be fairly clean (Attachment F). No organic hits were above the Ontario Ministry of the Environment's lowest effects level guidelines for sediment. However, some results were above the lowest effects level guidelines for manganese, nickel, ammonia and total organic carbon, but those results are not unusual for the Upper Mississippi River.

The increase in aquatic vegetation following completion of the project could lead to an increase in denitrification of surface water. However, the project would also reduce water exchange in the area, which could have the opposite effect. Because of these and other complications of the nitrogen cycle, it is difficult to predict whether the proposed project would have a measurable effect on the nitrogen budget of the project area. If the effect is measurable, it would likely be minor.

9.3.2.8 AQUATIC AND TERRESTRIAL ORGANISMS

As described earlier, the project would have short-term adverse effects and long-term beneficial effects on most aquatic and terrestrial species that inhabit the area, especially waterfowl and fish. In addition to these effects, the placement of rock and sand to construct the channel measures would cover substrate and the associated benthic organisms that have limited mobility. Island construction activities could potentially impact benthic organisms by burying, crushing or physical removal by dredging. Access channel dredging would remove benthic organisms. Benthos taxa of particular concern include mussels. However, access is generally good in the area and it is anticipated that activities associated with access dredging would be minor. Impacts on mussels and other benthos would be temporary and benthic organisms would recolonize the dredge cuts.

Increased activity and noise would disturb fish and wildlife in the immediate project area during construction. Species that are mobile would relocate to a different area during construction. However, this disruption would be temporary, and no permanent effects would likely occur.

Over the long-term, the proposed project would benefit aquatic and terrestrial organisms through improvements to habitat. These habitat improvements are especially pronounced when comparing the recommended alternative to the no action alternative. The creation and protection of terrestrial habitat (in the forms of islands) and associated vegetation would incur numerous benefits to a wide variety of wildlife species including roosting habitat for raptors, migration and nesting habitat for neotropical migrants and nesting habitat for turtles. Fur-bearing mammals would also benefit from newly created and protection of existing floodplain forests. The creation of shallow water zones (in the form of mudflats) would provide marsh habitat for marsh and water birds such as grebes (*Aechmophorus* spp.), white pelicans (*Pelecanus onocrotalus*), double crested cormorants (*Phalacrocorax auritus*), bitterns, herons, egrets, terns, and shorebirds. The proposed habitat dredging would also create deeper backwater areas (greater than 4 feet) that would provide better overwintering habitat in the study area for backwater fish species. In addition, deeper pool areas that provide bathymetric diversity are within protected areas provided by new islands, which would promote winter temperatures more favorable to bluegill. Improvements to water quality and greater aquatic habitat diversity (associated with dredging and creation of shoreline) would promote use by benthic macroinvertebrates. In general, the resulting habitat would create a more diverse system that is resilient to stressors, including the threat from non-native and invasive species.

9.3.2.9 THREATENED AND ENDANGERED SPECIES

No effects to federally-listed species are anticipated with the proposed project. The only federally-listed species that occurs in the vicinity of the project area is the Higgins eye mussel. Although Higgins eye occurs within lower Pool 9 and in the general vicinity of the proposed project, only one was collected in a 1998 survey and none were found in the footprint of project features. For this reason, the Corps has determined that the proposed project will have no effects on endangered species including Higgins eye (Appendix M). The Corps will continue to evaluate impacts to Higgins eye and consult with the USFWS under section 7(a)(2) of the Endangered Species Act if new information indicates that no effect to Higgins eye might occur.

Other than Higgins eye, the only Iowa state-listed species that occur within the study area is yellow sandshell (*Lampsilis teres anodontoides*). Wisconsin state-listed species that occur within the study area include wartyback (*Quadrula nodulata*) and rock pocketbook (*Arcidens confragosus*). During mussel surveys between 1998 and 2011, the densities of these species were considered very low (Attachment M). While it is likely that these species will be initially adversely impacted during construction of the project, it is unlikely that populations of those species will be adversely affected throughout lower Pool 9. Overall, the project should improve aquatic habitat conditions and have long term benefits for mussels and their host fish populations.

9.3.2.10 OTHER NATURAL RESOURCE EFFECTS

Improved habitat and water quality as a result of the recommended alternative are expected to have de minimis effects on other natural resource components such as groundwater and water supply. For instance, improved quality of surface water with a connection to groundwater would have a corresponding effect on the latter. Determining the level of these effects is difficult, but it is anticipated that that they would not rise to the level of even a minor effect.

9.3.3 CULTURAL RESOURCE EFFECTS

Since the initial identification of archaeological sites 13AM353, 13AM354 and 13AM355 in 1994, the site evaluation at 13AM354 in 1995, and observations during 2003 and recently in 2013, the archaeological site conditions in the Harpers Slough area have undergone dramatic changes. For example, the 1994 Phase I surveys indicated that each of the three sites were experiencing moderate erosion. In fact, these sites were identified from cultural materials exposed along shorelines devoid of vegetation (Boszhardt 1995). In 1995, notes from the Phase II investigations at 13AM354 describe “intense erosion” due to “a lack of vegetation” covering the site (Overstreet n.d.). Unfortunately, it is likely that erosion continued to negatively impact these sites until sometime after 1998 when several island protection structures were constructed approximately one to two and a half miles upstream of the sites.

Corps archaeologists visited the area during the summer of 2003 and noted that erosion to the archaeological sites had dramatically declined. While prolific aquatic vegetation (e.g., lotus) and low water (approximately four-five inches below normal pool elevation) prevented physical access to the sites, abundant shoreline and island vegetation was well established throughout the area and no exposed beach areas were observed.

In August 2013, Corps archaeologists once again visited the Harpers Slough complex, this time making landfall on all of the landforms within the project area and completing surface reconnaissance of the shorelines. Aquatic, shoreline and island vegetation remains well established at the sites and along all of the project areas. Most of the land areas contain robust vegetation (e.g., grasses, oak, elm, maple, ash, willow) with surface visibility ranging from approximately 0-15 percent with occasional areas of exposed shoreline with approximately 10-20 percent surface visibility. The Corps was able to relocate the three previously identified sites (13AM353, 13AM354, and 13AM355). However, survey results could not relocate the exact site location of 13AM355 but found associated material, extending the original site boundaries specified in the 1994 Phase I surveys. It appears that, in general, the sites are still experiencing some effects from erosion, although greatly reduced from the 1990s conditions.

The design and construction of the various structures (e.g., islands, rock sills, vanes, groins, berms and mounds and access dredging) will not impact the three archaeological sites. No construction activities will take place on existing islands where the archaeological sites are located. Conversely, the construction of structures adjacent to the existing islands harboring the archaeological sites will prevent additional erosion and thereby protect the sites. Other project structures are located in areas that were historically side channels or wetlands and will not adversely impact cultural resources that may possibly be submerged. In other areas, the structures and intended results (e.g., sediment infilling) will serve to protect the lake bottom by preventing scouring and additional lake bottom erosion. Thus, the Corps has determined that the project will have no adverse effect to historic properties; beneficial effects are likely to be realized.

9.4 OTHER ACTION ALTERNATIVES

Other action alternatives would have similar effects on the parameters listed in Table 9- 1 as the recommended plan, but the effects would differ in level of magnitude. The extent of these effects would largely depend on the number and size of the different components or constructed measures and the anticipated changes to land cover types. These measures would affect the resulting acreages of land cover types, which may be used as a surrogate for determining the level of natural resource effect. Alternative 1, having fewer components than the recommended alternative, would have less impact on the listed parameters. However, Alternatives 3 through 5 have several more measures than the recommended alternative and, therefore, would have greater effects. None of the alternatives would have impacts falling into the “significant” category.

For socioeconomic factors, the other action alternatives would result in minor short-term adverse effects on noise level and aesthetic values but beneficial effects on employment. Business activities associated with increased recreational opportunities would experience long-term benefits. For natural resource factors, minor adverse effects on air and surface water quality, wetlands, aquatic habitat, and biological productivity would be short-term. Over the long term, most of these same factors would experience substantial beneficial effects.

9.5 CUMULATIVE EFFECTS

Cumulative effects, or the effects of the proposed action plus other past, present, and reasonably foreseeable future actions, were evaluated for all of Pool 9 rather than just the project area. A cumulative effects evaluation for all of Pool 9 is appropriate because of the strong relation between the configuration of project components (e.g., island-building, habitat dredging) and their effects (e.g., decreased wind fetch) to water levels, which are most closely managed at the pool scale (see section 4.3.2 – Pool Regulation). In addition, plans identifying common habitat goals and objectives for each pool of the Upper Mississippi River have been developed by stakeholders (River Resources Forum 2004). A description of conditions for Pool 9 is provided in section 3 – Assessment of Existing Resources. Additional discussion on cumulative changes to the UMRS can be found in *Ecological Status and Trends of the Upper Mississippi River System* (U.S. Geological Survey 1999) and *Upper Mississippi River and Illinois Waterway Cumulative Effects Study, Volume I and II* (WEST 2000).

The temporal limit for considering cumulative effects was identified as a 50-year period that begins when EMP was authorized (1986). This period was also targeted because it is anticipated that most of the ecological benefits associated with the proposed project would be achieved within 10 years.

Several EMP and Operation & Maintenance (O&M) projects in Pool 9 have either been constructed or are in the process of being constructed. In addition, several new projects are early in the planning process. In all, over 3,300 acres of floodplain habitat would be directly affected with implementation of all past, existing, and potential projects in Pool 9 (Table 9- 3).

Additional planned activities in Pool 9 include the continued operation and maintenance of the 9-Foot Channel, commercial traffic, public use, commercial and residential development, agricultural practices and watershed management, and habitat restoration projects. Other major factors that will affect the Pool 9 environment include hydrologic and hydraulic processes in an altered environment, point and nonpoint source pollution, and exotic species.

In addition to the above EMP projects, growing season water level drawdowns are being considered for Pool 9 to stimulate and restore aquatic vegetation. Other ecological restoration projects are also being proposed as part of the Upper Mississippi River National Wildlife and Fish Refuge, Comprehensive Conservation Plan and the Navigation Ecosystem Sustainability Program.

The proposed Harpers Slough HREP project alone would likely have minor additional cumulative ecological effects in Pool 9, none of which would be adverse. However, in conjunction with other ecological restoration and island reconstruction projects, Pool 9 would likely experience a significant cumulative increase in aquatic vegetation and habitat quality and diversity.

Table 9- 3. Past, existing, and potential future ecological restoration projects in Pool 9.

Project	**Year construction completed/proposed for construction**	**Acres affected (est)**[b]
Blackhawk Park	1990	282
Cold Springs	1994	35
Lansing Big Lake	1996	100
Bank Stabilization	1999	200
Pool 9 Island	1995	321
Pool Slough	2006	52
Small scale drawdown	1997	25
Hummingbird Slough	2002	297
Capoli Slough	2013	820
Conway Lake [a]	2017	561
Lake Winneshiek [a]	2018	1,200
Total		**3,360**

[a] currently in the planning phase; actual construction dates may change.
[b] does not give full consideration to an extended area of influence.

The majority of the nitrogen load to the Upper Mississippi River is derived from upland anthropogenic sources, and the river acts as a conduit for nitrogen. Natural bacterial processes occurring in the river have a minor de-nitrification effect on water before it is released to the Gulf of Mexico. The combination of HREP projects, including the Harpers HREP, could lead to a reduction in the extent of the hypoxic zone.

The cumulative effects of EMP projects are being monitored and reported through the LTRMP (U.S. Geological Survey 1999; Johnson and Hagerty 2008). Status and trends are summarized and provided in a Report to Congress every 6 years. The indices of primary interest involve water quality, aquatic vegetation, hydrology, sedimentation and habitat diversity, and land cover types and land use.

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10. SUMMARY OF PLAN ACCOMPLISHMENTS

The recommended plan would substantially improve and maintain habitat conditions over a large portion of lower Pool 9. The habitat improvements, while focusing on improving conditions for migratory waterfowl within the Upper Mississippi River National Wildlife and Fish Refuge, would also improve habitat for a variety of other fish and wildlife such as shorebirds, wading birds, aquatic mammals, terrestrial wildlife, turtles, lacustrine and lotic fish, and mussels.

The project would protect, restore and/or create about 97 acres of islands, compared to the 88 acres of islands that were present in the Harpers Slough area in 1975. The islands recommended for construction would protect approximately 3,500 acres of shallow and deep aquatic habitat from wave action, thereby decreasing sediment resuspension, increasing photic depth, increasing aquatic plant growth and diversity, and preventing uprooting. Acreage of rooted floating aquatic and emergent vegetation would be maintained at about 700 acres compared to the no action alternative, where the vegetation is estimated to be only about 400 acres. Acreage of submersed aquatic vegetation is expected to more than double from baseline conditions to around 1,500 acres.

Vegetation beds in the form of submersed or rooted aquatic vegetation have higher values for bluegill life requisites relative to open water. These areas are expected to expand substantially in comparison to no action alternative. The proposed habitat dredging would also create deeper backwater areas that would provide better overwintering habitat in Harpers Slough for backwater fish species. In addition, deeper pool areas that provide bathymetric diversity are within protected areas that could promote winter temperatures more favorable to bluegill. This type of habitat is of critical importance in the project area where overwintering habitat is almost nonexistent due to the loss of islands. The existing Habitat Suitability Index (HSI) value for bluegill is about 0.3. However, the protections provided from new islands, increased aquatic vegetation, and habitat dredging for overwinter refuge areas would increase the HSI to around 0.8 for bluegill.

Substantial habitat benefits to shorebirds and wading birds are expected to accrue due to the protection or creation of about 60,000 linear feet of sandy shoreline and several emergent wetland/mudflats. These features would also provide a substantial amount of area available for turtle nesting.

Project measures would also provide long-term benefits to waterfowl using aquatic areas bordering islands. Specifically, the increased aquatic vegetation extent and diversity and restoration of island complexes affording protection from prevailing winds and disturbance would contribute to an increase in the value of the project area as waterfowl migration habitat. This is evidenced by diving duck HSIs, which would increase from 0.4 to 0.6 if the recommended plan is implemented.

The 100 acres of islands protected or created would provide habitat for terrestrial and semi-aquatic species of wildlife. This type of habitat is nearly nonexistent in the areas where the islands would be constructed.

The islands would help maintain secondary channel habitat, which would contribute to aquatic habitat diversity in this area, primarily for riverine fish species and mussels.

The project would contribute significantly to the cumulative long-term habitat restoration goals for lower Pool 9. The Habitat Needs Assessment (U.S. Army Corps of Engineers, 2000) identified Pool 9 as having approximately 21,000 acres of contiguous impounded area and contiguous floodplain shallow aquatic area (the geomorphic habitat types predominant in lower Pool 9, including the project area). The Habitat Needs Assessment indicated that for lower Pool 9 the present need is to increase island habitat by 638 acres and contiguous floodplain shallow aquatic area by 4,200 acres. The protection/creation of 100 acres of islands, habitat improvement in the complex, and reduction in sediment suspension in additional 3,500 acres will contribute toward meeting this long-term goal.

The four goals of the project are:

- GOAL A: Maintain and/or enhance habitat in the Harpers Slough backwater area for migratory waterfowl birds.
- GOAL B: Create habitat for migratory and resident vertebrates with emphasis on marsh and water birds, shorebirds, bald eagles, aquatic mammals, turtles, and amphibians.
- GOAL C: Enhance channel habitat for riverine fish and mussel species.
- GOAL D: Create and maintain protected lacustrine habitat for backwater fish species.

Thirteen planning objectives were established at the beginning of the study to meet the goals. Table 10- 1summarizes how the recommended project meets or does not meet the planning objectives.

Table 10- 1. Project Objectives and Accomplishments.

Project Objectives	Met/Not Met/Partially Met	Discussion
Objective 1 – Protect wetland areas from river currents and wind/wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native emergent aquatic plant beds (> 500 acres).	Partially Met	There is approximately 100 acres of emergent wetlands in the study area. The project would maintain the acreage of emergent vegetation and create about 70 additional acres.
Objective 2 – Protect wetland areas from river currents and wind/wave action providing hydrodynamic conditions for maintenance and establishment/expansion of diverse, native floating leaf and submerged aquatic vegetation beds (> 1,800 acres).	Partially Met	The project would approximately double the number of acres of submersed aquatic vegetation to approximately 1,500 acres. Rooted floating leaf vegetation would increase to about 500 acres.
Objective 3 – Protect existing (40+ acres) and increase forested islands (100+ acres).	Partially Met	Project features would protect approximately 45 acres of existing islands and create 52 acres of new islands. New wide islands are anticipated to colonize with floodplain forest.
Objective 4 – Increase quality migrating waterfowl habitat, including maintenance of available aquatic plant tubers and seeds for fall migrating waterfowl of yearly minimum of 1,877 million kilocalories of gross energy production.	Met	Project features are anticipated to provide an estimated 2,422 million kilocalories of gross energy production. Without project features in place, this is estimated to fall to about 1,400 million kilocalories.
Objective 5 – Create 10 open to sparsely vegetated sand terrestrial areas (minimum 0.25 to 0.5 acres each) adjacent to sheltered backwaters for turtle nesting at various locations throughout Harpers Slough backwater complex.	Partially Met	4 sand tips and up to 9 sand pads are considered; however, some of the sand pads may be removed after construction.
Objective 6 – Create interspersion of forested islands to create habitat capable of supporting between 6-8 nesting pair of bald eagles.	Met	The study area currently has four bald eagle nests at a ratio of 0.08 nests/acre or 0.09 nests/habitat unit. With project features in place and enough time for forest establishment, the number of bald eagle nests is anticipated to be 6 nests. Without project features, the area is anticipated to support only 2 nests.
Objective 7 – Maintain/increase to a minimum of 80,000 lineal feet of sheltered bank and associated littoral habitat for use by marsh and water birds, shorebirds, aquatic mammals, amphibians and reptiles.	Partially Met	About 60,000 linear feet of sheltered bank.
Objective 8 - Create 2 – 4 isolated wetlands (1 to 5 acres each) for use by amphibians and water and shore birds.	Partially Met	One large isolated wetland is proposed on the W-2/W-3 island complex.
Objective 9 - Maintain/enhance existing slough habitat in the Harpers Slough complex as well-defined, self-maintaining running slough habitat, with a diversity of substrate and current velocity, and create a minimum of 10 acres of similar habitat where possible.	Met	About 880 acres of running slough habitat would result.
Objective 10 – Maintain/increase to a minimum of 40,000 lineal feet of tertiary, secondary and main channel bank and associated littoral habitat for riverine fish and mussels.	Partially Met	About 34,000 linear feet would result.
Objective 11 - Create "riffle/pool/gravel bar" habitat (approximately 5 acres each) in secondary or tertiary channel areas.	Not Met	The benefits associated with the alternative that included a cobble liner feature associated with M1 was not part of the selected plan.
Objective 12 – Enhance habitat for lacustrine fish, including creation of at least 4 discrete overwintering habitat areas similar in size to existing overwintering habitat within Lower Pool 9 which ranges from approximately 4 to 21 acres per site (average = 14).	Partially Met	The selected alternative would create 2 overwintering sites totaling over 60 acres.
Objective 13 - Create 2 – 4 sand/mudflats (1 to 5 acres each) for use by amphibians and water and shore birds.	Unknown	Construction of these features is at the discretion of the contractor and is dependent on need for access material disposal.

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11. OPERATION, MAINTENANCE, REPAIR, REHABILITATION, AND REPLACEMENT

11.1 GENERAL

Upon completion of construction, the USFWS would accept responsibility for the project in accordance with Section 107(b) of the Water Resources Development Act of 1992, 33 U.S.C. § 652(e)(7)(A). The operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) responsibilities of the USFWS are addressed in the proposed Memorandum of Agreement for the project (Appendix C).

Specific operation and maintenance requirements would be defined in project OMRR&R manuals, which would be prepared by the Corps of Engineers and coordinated with the USFWS.

11.2 OPERATION

The USFWS would not be responsible for any specific operational requirements for any of the project measures. The USFWS would be required to conduct periodic inspections and submit reports of inspection activities and OMRR&R performed.

11.3 MAINTENANCE

The USFWS would perform maintenance on the Harpers Slough project measures as necessary for the project to remain functional. As detailed in the Major Rehabilitation provision contained in the proposed Memorandum of Agreement, the Corps will be responsible for excessive damage caused by a catastrophic event such as a large flood.

The present value and estimated average annual OMRR&R costs for the USFWS are shown in Table 11- 1. The present and average annual costs are shown in September 2013 price levels, with a Federal discount rate of 3.75%. More detailed information can be found in Appendix I. The facilities repair, rehabilitation, and replacement could occur in one event or over several events.

Not all project measures will require maintenance. Table 11- 2 categorizes project measures as to the expected level of OMRR&R. Critical measures are those that must be maintained for structural integrity or for the feature to provide the majority of habitat benefits for which it was designed. Noncritical measures are those where minor changes are acceptable and the need for maintenance would be considered on a case-by-case basis. Dynamic measures are those where river forces will be allowed to shape the measures with no future maintenance anticipated.

Table 11- 1. Present Value and Average Annual Operation, Maintenance, Repair, Rehabilitation, and Replacement Costs – USFWS.

Complex	Present Value	Average Annual Cost
L	$94,400	$4,200
M	$53,700	$2,400
W	$101,100	$4,500
Total OMRR&R	$249,200	$11,100

Table 11- 2. Maintenance, Repair, Rehabilitation, and Replacement Cost Categorization of Project Measures.

Critical- Must be Maintained or Repaired	• Rock sill tie-in points with islands • Rock end protection • Rock vane tie-in points with island • Major damage to rock sills • Major damage to rock wedges and mounds
Noncritical – Maintained or Repaired if Determined Necessary	• Individual vanes • Island shorelines • Minor damage to rock sills, mounds, and wedges • Major damage to sand/fine portion of rock wedge narrow islands
Dynamic – No Maintenance	• Emergent wetlands • Access channels • Borrow sites/habitat dredging • Construction (or access or sand) pads • Sand tips • Turtle nesting areas • Mudflats, sandflats • Isolated wetlands

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12. PROJECT PERFORMANCE EVALUATION

Project performance evaluation was designed to directly measure the degree of attainment of the project objectives through monitoring and adaptive management. Table 12- 1 summarizes the overall monitoring approach used for UMRS-EMP projects. Table 12- 2 summarizes the monitoring plan identifying primary responsibilities of the team, timeframe, and estimated costs associated to meet the objectives and the performance criteria. This plan identifies and describes the setup of monitoring and adaptive management activities proposed for the Project at a conceptual level. The plan will be further developed in the preconstruction, engineering, and design (PED) phase as specific Project design details become available. Additional details are provided in Appendix Q.

Biological response monitoring would also be completed on the project. The Wisconsin DNR has been collecting pre-project fish data since 2007. The fisheries in lower Pool 9 were sampled using random stratified and fixed site electrofishing runs in early November each year when temperatures were at or below 10 degrees C. Fish begin moving to their overwintering sites when temperatures fall below 10 degrees C. The results of these pre-project data are contained in Appendix P. The Wisconsin DNR plans to repeat the sampling post-project to evaluate the response of the fisheries to the proposed Harpers Slough project.

Monitoring at other HREPs has shown it takes 5 to 7 years for an overwintering population to become established to the point where multiple year classes are present and Catch Per Unit Effort (CPUE) begins to stabilize. Therefore, project performance monitoring should take this into account by setting the targets as a 4 year averaged CPUE to be met by year 10 post project.

Table 12- 1. UMRS-EMP Monitoring and Performance Evaluation Matrix.

Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Problem Analysis	System-wide problem definition. Evaluate planning assumptions.	USGS	USGS (UMESC)	LTRM	Lead into pre-project monitoring; define desired conditions for plan formulation.
Pre-project Monitoring	Identify and define problems at specific sites.	Sponsor	Sponsor	Sponsor	Should attempt to begin defining baseline.
Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field stations or sponsors thru Cooperative Agreements, or Corps.*	HREP	Should be over several years to reconcile perturbations.
Data Collection for Design	1. Identify project objectives. 2. Design of project. 3. Develop Performance Evaluation Plan.	Corps	Corps	HREP	After fact sheet. Data may aid in defining baseline.
Construction Monitoring	Assure permit conditions met.	Corps	Corps	HREP	
Performance Evaluation Monitoring	Determine success of projects.	Corps	Field stations or sponsors thru Cooperative Agreements, sponsor thru O&M**, or Corps.*	HREP	After construction.
Analysis of Biological Responses to Projects	1. Determine critical impact levels, cause-effect relationships, and long-term losses of significant habitat. 2. Demonstrate success or response of biota.	USGS Corps	USGS (UMESC) Corps/USGS (UMESC)/Others	LTRM HREP	Biological Response Study tasks beyond scope of Performance Evaluation, Problem Analysis, and Trend Analysis.

*Choice depends on logistics. When done by the States under a Cooperative Agreement, the role of the UMESC will be to: (1) advise and assist in assuring QA/QC consistency, (2) review and comment on reasonableness of cost estimates, and (3) be the financial manager. If a private firm or State is funded by contract, coordination with the UMESC is required to assure QA/QC consistency.

**Some limited reporting of information for some projects (e.g., waterfowl management areas) could be furnished by on-site personnel as part of O&M.

Table 12- 2. Primary responsibility for implementation, costs, and duration for adaptive management and monitoring activities.

				Estimated Costs				
Objective	**Work Category**	**Activity**	**Primary Responsibility**	**PED**	**Years 1 – 5**	**Years 5 – 10**	**Total**	**EMP total**
Aquatic Vegetation (Objectives 1, 2, 4, 8)	Monitoring & Analysis	GIS cover mapping	USACE MVP UMESC		$2,500	$2,500	$5,000	$5,000
		Plant species diversity monitoring	USACE MVP		$30,000	$30,000	$60,000	$60,000
		Productivity assessment (tubers & seeds)	USFWS		$5,000	$5,000	$10,000	$0
		Amphibian, water bird, & shorebird surveys	USFWS, IDNR	$5,000	$10,000	$10,000	$25,000	$0
	Reporting	Every 5 years	USACE MVP		$5,000	$5,000	$10,000	$10,000
						Aquatic Vegetation Subtotal:	**$110,000**	$75,000
Floodplain Forest (Objectives 3, 6)	Monitoring & Analysis	LTRM forest protocols	CEMVP-OP-RNR		$10,000	$10,000	$20,000	$0
		Bald eagle surveys	USFWS		$2,000	$2,000	$4,000	$0
	Reporting	Every 5 years	USACE MVP		$1,000	$1,000	$2,000	$2,000
						Floodplain Forest Subtotal:	**$26,000**	$2,000
Fish Overwintering (Objective 12)	Earthwork	Extend islands to reduce effects of eddies or add material to rock sills	USACE MVP	$10,000	$40,000		$50,000	$50,000
	Monitoring & Analysis	Hydraulic assessment	USACE MVP		$3,000	$3,000	$6,000	$6,000
		Bathymetric assessment	USACE MVP		$2,000	$2,000	$4,000	$4,000
		GIS mapping	USACE MVP		$2,500	$2,500	$5,000	$5,000
		Water quality monitoring	IDNR/WIDNR		$10,000	$10,000	$20,000	$0
		Electrofishing surveys	IDNR/WIDNR		$25,000	$25,000	$50,000	$0
	Reporting	Every 5 years	USACE MVP		$5,000	$5,000	$10,000	$10,000
						Fish Overwintering Subtotal:	**$145,000**	$75,000
Shoreline (Objectives 5, 7, 13)	Monitoring & Analysis	Assessment of turtle nest use	IDNR, USFWS		$10,000	$10,000	$20,000	$0
		GIS mapping	USACE MVP		$2,000	$2,000	$4,000	$4,000
		Marsh, water bird, shorebird, aquatic mammal, amphibian, & reptile surveys	USFWS, IDNR		$10,000	$10,000	$20,000	$0
	Reporting	Every 5 years	USACE MVP		$5,000	$5,000	$10,000	$10,000
						Shoreline Subtotal:	**$54,000**	$14,000
Riverine (Objectives 9, 10, 11)	Monitoring & Analysis	Hydraulic assessment	USACE MVP		$3,000	$3,000	$6,000	$6,000
		Bathymetric assessment	USACE MVP		$2,000	$2,000	$4,000	$4,000
		GIS mapping	USACE MVP		$2,500	$2,500	$5,000	$5,000
	Reporting	Every 5 years	USACE MVP		$4,000	$4,000	$8,000	$8,000
						Riverine Subtotal:	**$23,000**	$23,000
						Subtotal Estimated Costs:	**$358,000**	$189,000
						Subtotal – Present Value	**$261,700**	
						I&A Factor (3.75%, 10 years)	**0.12176**	
						Average Cost	**$31,900**	
						Average Annual Cost with Contingency (20%)	**$38,200**	

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13. COST ESTIMATE

After a recommended plan was identified using preliminary costs in section 7, a more detailed cost estimate was completed for the recommended plan (Table 13- 1). The costs are expressed as Project First Costs and include construction, contingencies, engineering, planning, design, and construction management. The Project First Costs are the project costs at the effective price level of September 2013. The more refined cost estimate also involved updated quantities, an updated Abbreviated Risks Analysis to determine contingencies, Micro-Computer Aided Cost Estimating System (MCACES), and Total Project Cost Systems (TPCS) to determine Present Value costs. A detailed cost estimate is contained in Appendix I.

Table 13- 1. Estimated First Cost of Recommended Plan.

Complex	**Cost**
L	$5,858,000
M	$5,756,000
W	$5,813,000
Total	**$17,427,000**

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14. REAL ESTATE REQUIREMENTS

The Harpers Slough project is a backwater complex located primarily on the Iowa side of the Mississippi River in Pool 9, about 3 miles upstream of Lock and Dam 9 between River Miles 655 and 650. The project area includes an intermingled complex of stump fields, sloughs, vegetation beds, and island remnants. Although the project will have a positive long-term impact over approximately 3,500 acres, actual construction activity will be limited to 97 acres of federally-owned land.

Within the project footprint, approximately 97 acres are held in fee and managed by the U.S. Army Corps of Engineers. The remaining acreage is held in fee and managed by the U.S. Fish and Wildlife Service (USFWS). All acreage lies within the Upper Mississippi River National Wildlife and Fish Refuge. No additional real estate or relocations are deemed necessary.

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15. SCHEDULE FOR DESIGN AND CONSTRUCTION

A schedule for review and approval, major work tasks, and project construction is shown below. This schedule assumes the availability of funds to prepare plans and specifications and undertake construction will not be limiting.

Requirement	Scheduled Date
Submit draft Definite Project Report to Mississippi Valley Division, U.S. Army Corps of Engineers	February 2014
Submit final Definite Project Report to Mississippi Valley Division, U.S. Army Corps of Engineers	June 2014
Obtain construction approval by Mississippi Valley Division, U.S. Army Corps of Engineers	July 2014
Begin plans and specifications Stages 1, 2, and 3	June 2014
Complete plans and specifications Stage 1	July 2014
Advertise for bids (budget dependent)	July 2014
Award contract (FY14)	August 2014
Complete construction (Stage 1)	June 2016
Complete plans and specifications for Stage 2	October 2014
Advertise for bids (budget dependent)	December 2014
Award contract (FY15)	February 2015
Complete construction (Stage 2)	June 2017
Complete plans and specifications Stage 3	October 2015
Advertise for bids (budget dependent)	December 2015
Award contract (FY 16)	February 2016
Complete construction (Stage 3)	June 2018

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16. IMPLEMENTATION RESPONSIBILITIES

The responsibility for plan implementation and construction falls to the Corps of Engineers as the lead Federal agency. After construction of the project, project operation and maintenance would be required for measures of the project as outlined in Section 11 of this report. The USFWS would be responsible for operation and maintenance of the project.

Should rehabilitation which exceeds the annual maintenance requirements be required (as a result of a specific storm or flood) a mutual decision between the participating agencies will be made regarding whether to rehabilitate the project. If rehabilitated, the Federal share of rehabilitation would be the responsibility of the Corps of Engineers.

Performance evaluation, which includes monitoring of physical/chemical conditions and some limited biological parameters, would be a Corps of Engineers responsibility.

Appendix C contains a draft copy of the formal agreement that would be entered into by the Corps of Engineers and the USFWS. The Memorandum of Agreement formally establishes the relationships between the Department of the Army, represented by the Corps of Engineers, and the USFWS in constructing, operating, and maintaining those measures of the Harpers Slough project.

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17. COORDINATION, PUBLIC VIEWS, AND COMMENTS

The planning for the Harpers Slough project has been an interagency effort involving the St. Paul District, the USFWS, and the Wisconsin and Iowa DNRs. Interagency meetings and site visits were held on a periodic basis throughout the study phase. In addition to the meetings, informal coordination took place on an as-needed basis to address specific problems, issues, and ideas.

A Problem Appraisal Report was completed for the project in February 2012. This report addressed the existing conditions and habitat problems in the project area, identified habitat goals and objectives, and identified alternatives to be studied in detail that would address the habitat goals and objectives.

See Appendix A for pertinent coordination. The draft DPR/EA was sent to congressional interests; Federal, State, and local agencies; special interest groups; interested citizens; and others as listed in Appendix A. A public meeting will be held at a future date to present the tentatively selected plan to the public.

Coordination with the Iowa State Historic Preservation Office and consultation with various Native American groups is in progress.

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18. CONCLUSIONS

The Harpers Slough Habitat Rehabilitation and Enhancement Project provides the opportunity to restore habitat for fish, migratory birds, and other forms of fish and wildlife indigenous to the Upper Mississippi River. Loss of islands, a decline in aquatic vegetation, and changes in bathymetry have substantially reduced the value of the project area to fish and wildlife. With no action, these changes are expected to continue, resulting in further degradation of habitat values.

A number of measures are aimed at correcting existing habitat problems and improving habitat conditions. The stabilization of remaining islands and the construction of additional islands will substantially improve conditions for the growth of emergent and submersed aquatic plants, increase the amount of protected areas, improve other habitat parameters for diving and dabbling ducks, and improve overall habitat diversity and quality in the project area. The islands will also serve, to a certain degree, to protect the existing vegetation and natural island areas by reducing northerly and southerly wind and wave action. The islands and associated habitats will provide improved habitat conditions for a wide variety of wildlife ranging from shorebirds to mammals to neotropical songbirds.

The lack of overwintering fish habitat has been identified by natural resource agencies as an important factor to overall fish habitat quality in lower Pool 9. Protecting existing and increasing deepwater habitats with low current velocities so that they provide suitable overwintering habitat for centrarchids and other quiet water fish species will improve overall fish habitat quality.

Protecting existing islands and constructing new islands along the deeper water secondary channel portion of the study area would maintain and enhance riverine fish and mussel habitat. The proposed project would preserve baseline cover types and will provide a defined self-maintaining channel with coarser substrates, high recruitment of woody debris (as cover), and lower turbidities.

The habitat benefits that would be gained by the Upper Mississippi River System from implementation of the project justify expenditure of public funds for preparation of plans and specifications and for construction.

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19. RECOMMENDATION

The recommended plan in Alternative 2 which includes Island M2, M5, , L1, L3, L6 W2, W3; Habitat Dredging M4, W1 and W2; Rock Sill M4, L2, W1, Rock Mounds L5 and M8, and Emergent Wetland M2, M5 and L6.

Because the project is located on national wildlife refuge lands, project costs would be 100-percent Federal in accordance with Section 906(e) of Public Law 99-662, 33 U.S.C. § 2283 (e). The estimated cost of the project at current price levels is $17,427,000 (including sunk general design costs). Upon completion, the USFWS would be responsible for Operation, Maintenance, Repair, Rehabilitation, and Replacement at an estimated average annual cost at current price levels of $11,100. The recommended plan also includes a monitoring program at an estimated average annual cost at current price levels of $38,200. Total average annual project costs amount to $872,700.

The study area covers approximately 3,500 acres. The expected outputs include the protection, restoration, and/or creation of about 97 acres of islands. The islands recommended would protect approximately 3,500 acres of shallow and deep aquatic habitat from wave action, thereby decreasing sediment resuspension, increasing photic depth, increasing aquatic plant growth and diversity, and preventing uprooting. The recommended plan will contribute 618 average annual habitat units over the 50-year period of analysis to the National Environmental Quality Account at an average annual cost of $1,400 per average annual habitat unit.

I have weighed the accomplishments to be obtained from the Harpers Slough project against its cost and have considered the alternatives, impacts, and scope of the proposed project. Therefore, I recommend that the Harpers Slough project for habitat restoration and enhancement in Pool 9 of the Upper Mississippi River be approved for construction.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects under the continuing authorities Environmental Management Program. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works continuing authorities program nor the perspective of higher review levels within the Executive Branch.

Daniel C. Koprowski
Colonel, Corps of Engineers
District Commander

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20. FINDING OF NO SIGNIFICANT IMPACT

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
180 FIFTH STREET EAST, SUITE 700
ST. PAUL, MN 55101-1678

REPLY TO
ATTENTION OF

Regional Planning and Environment Division North

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act, Endangered Species Act, Clean Water Act, National Historic Preservation Act, Executive Orders, and other environmental laws and regulations, the Corps of Engineers, St. Paul District, has assessed the environmental impacts of the following project.

HARPERS SLOUGH HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 9, MISSISSIPPI RIVER, IOWA

The Upper Mississippi River System Environmental Management Program (UMRS EMP) in Section 1103 of the 1986 Water Resources Development Act (WRDA), as amended in WRDA 1999 (Public Law 106-53), 33 U.S.C. § 652, authorizes the planning, construction, and evaluation of fish and wildlife habitat rehabilitation and enhancement projects (known as HREPs) on the UMRS.

A total of 6 alternatives, including the no action alternative, were evaluated in detail. The proposed project alternative, at a first cost of approximately $17.4million, includes protection of 46 acres of existing barrier islands and construction of 52 acres of new islands and creation of deep-water overwintering fish habitat. Preservation and restoration of critical barrier island habitat in lower Pool 9 would reduce wind fetch and create more favorable conditions for aquatic vegetation. The purpose of the project is to maintain and improve fish habitat and resting and feeding habitat for migratory birds in approximately 3,500 acres in lower Pool 9.

A Definite Project Report and integrated Environmental Assessment and 404(b) Evaluation was prepared and sent out for agency and public review. Public meetings were held to solicit input. There are no unresolved issues resulting from this review.

This Finding of No Significant Impact is based on the following factors: the proposed project would have long-term beneficial impacts on the aquatic environment and fishery resources; short-term minor adverse impacts on the aquatic and terrestrial environment from construction activities; minor beneficial impacts on the economic and social environment; and no effects to federally listed species.

FINDING OF NO SIGNIFICANT IMPACT

HARPERS SLOUGH HABITAT REHABILITATION AND ENHANCEMENT PROJECT POOL 9, MISSISSIPPI RIVER, IOWA

The environmental review process indicated that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, an environmental impact statement will not be prepared.

15 AUG 14
Date

DANIEL C. KOPROWSKI
Colonel, Corps of Engineers
District Commander

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21. LEGAL CERTIFICATION

CERTIFICATION OF LEGAL REVIEW

The Definite Project Report for the Harpers Slough Habitat Rehabilitation and Enhancement Project, including associated documents required by the National Environmental Policy Act, has been fully reviewed by the Office of Counsel, St. Paul District, and approved as legally sufficient.

11 Feb 14
Date

District Counsel, CEMVP-OC

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