

**UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT**

**BEAVER ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT**

**POOL 14, UPPER MISSISSIPPI RIVER MILES 513.0-517.0
CLINTON COUNTY, IOWA**

APPENDIX K

MONITORING AND ADAPTIVE MANAGEMENT PLAN

**UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT**

**BEAVER ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT**

**POOL 14, UPPER MISSISSIPPI RIVER MILES 513.0-517.0
CLINTON COUNTY, IOWA**

APPENDIX K

MONITORING AND ADAPTIVE MANAGEMENT PLAN

I. INTRODUCTION.....	K-1
A. Authorization	K-1
B. Procedure: Drafting the Plan	K-1
C. Adaptive Management Team Structure.....	K-1
II. PROJECT ADAPTIVE MANAGEMENT PLANNING	K-4
A. Project Goals and Objectives	K-4
B. Sources of Uncertainty	K-5
C. Conceptual Model	K-5
III. MONITORING OF OBJECTIVES TO DETERMINE PROJECT SUCCESS	K-7
AND ADAPTIVE MANAGEMENT MEASURES	
A. Floodplain Forest Diversity.....	K-7
B. Backwater Fish Habitat	K-7
C. Side Channel Structure and Function Through Albany Island Protection and.....	K-8
Mussel Habitat	
IV. DOCUMENTATION, IMPLEMENTATION COSTS, RESPONSIBILITIES,	K-9
AND PROJECT CLOSE-OUT	
A. Documentation, Reporting, and Coordination	K-9
B. Costs.....	K-9
C. Responsibilities	K-10
D. Project Close-Out.....	K-10

FIGURES AND TABLE

Figure K-1	UMRR HREP Adaptive Management Planning Flowchart	K-2
Figure K-2	UMRR Communication Structure	K-3
Figure K-3	Beaver Island Conceptual Ecological Model.....	K-6
Table K-1	Estimated Adaptive Management and Post-Construction Monitoring Costs (\$).... (October 2016 Price Level)	K-11

**UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT**

**BEAVER ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT**

**POOL 14, UPPER MISSISSIPPI RIVER MILES 513.0-517.0
CLINTON COUNTY, IOWA**

APPENDIX K

MONITORING AND ADAPTIVE MANAGEMENT PLAN

I. INTRODUCTION

This appendix presents the feasibility level monitoring and adaptive management plan for the Beaver Island Habitat Rehabilitation and Enhancement Project (HREP). This plan identifies and describes the monitoring and adaptive management activities proposed for the Project and estimates associated costs and duration. This plan will be further developed in the planning, engineering, and design (PED) phase as specific details are made available.

A. Authorization. Section 2039 of the Water Resources Development Act (WRDA) of 2007 directs the Secretary of the Army to ensure, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration that the recommended project includes a plan for monitoring the success of the ecosystem restoration. The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires an adaptive management plan be developed for all ecosystem restoration projects.

At the programmatic level for the Upper Mississippi River Restoration (UMRR), knowledge gained from monitoring one HREP can be applied to other HREPs. Opportunities for this type of adaptive management are common within the UMRR, which builds upon lessons learned from other HREP projects and Long Term Resource Monitoring (LTRM).

B. Procedure: Drafting the Plan. The Upper Mississippi River Restoration Coordinating Committee (UMRR CC) collaborated to establish a general framework for adaptive management to be applied to all UMRR projects as part of the Implementation Issues Assessment. The framework for adaptive management is consistent with the implementation guidance provided in Section 2039 of the 2007 WRDA. The UMRR adaptive management framework includes systemic, set-up, and implementation phases (Figure K-1).

C. Adaptive Management Team Structure. To execute a systemic adaptive management strategy for the UMRR, a communication structure has been identified (Figure K-2). The structure establishes clear lines of communication and data exchange between UMRR Management, HREP Planning and Sequencing Framework Teams, LTRM, Project Delivery Teams (PDT), and stakeholders. Successful implementation will require the right resources being coupled at the right time to support the framework components.

Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report

Appendix K
Monitoring and Adaptive Management Plan

UMRR HREP AM Planning Flowchart

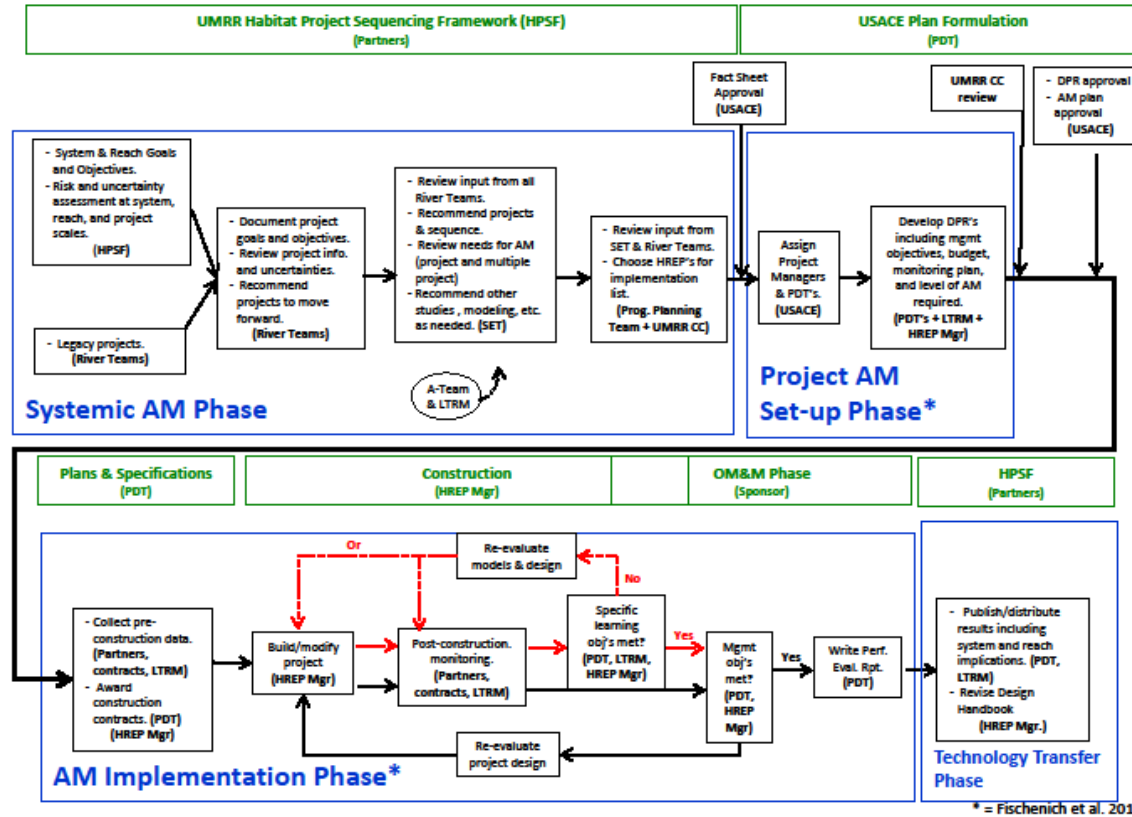


Figure K-1: UMRR HREP Adaptive Management Planning Flowchart

Beaver Island
 Upper Mississippi River Restoration
 Feasibility Study Report

Appendix K
 Monitoring and Adaptive Management Plan

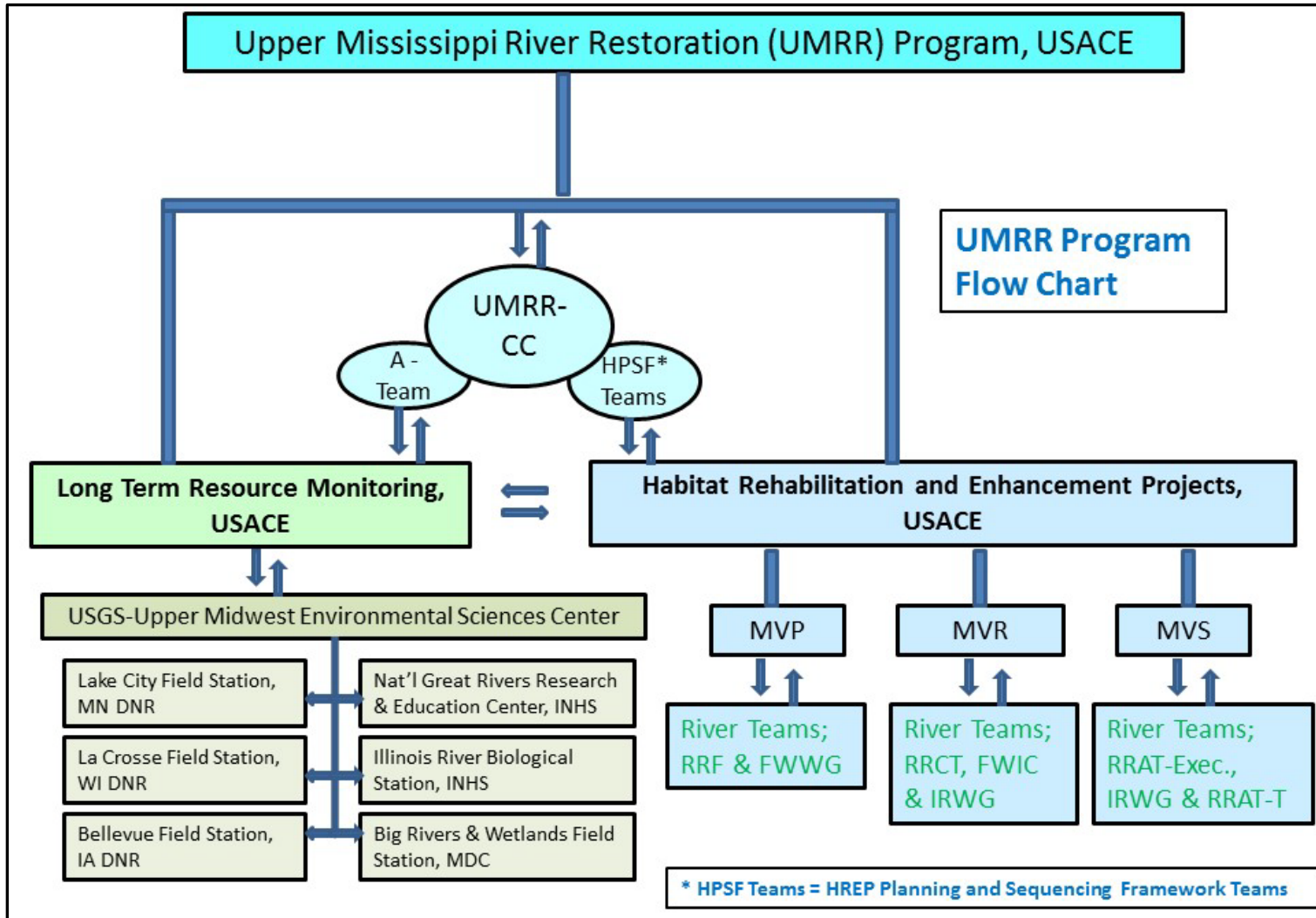


Figure K-2: UMRR Communication Structure

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

II. PROJECT ADAPTIVE MANAGEMENT PLANNING

The resulting adaptive management plan for the Beaver Island HREP describes and discusses whether adaptive management is needed in relation to the Recommended Plan identified in the Feasibility Study. The plan also identifies how adaptive management would be conducted and who would be responsible for specific adaptive management actions. The developed plan outlines how the results of the Project-specific monitoring program would be used to adaptively manage the Project, including specification of conditions that will define Project success.

The Adaptive Management Plan reflects a level of detail consistent with the Project feasibility study. The primary intent was to develop monitoring and adaptive management actions appropriate for the Project's restoration goals and objectives. The specified management actions permit estimation of the adaptive management program costs and duration. This Section of the Adaptive Management Plan:

- identifies the restoration goals and objectives;
- presents a conceptual ecological model that relates management actions to desired Project outcomes; and
- lists sources of uncertainty that would recommend the use of adaptive management.

Subsequent sections describe monitoring, assessment, and decision-making in support of adaptive management. The level of detail in this plan is based on currently available data and information developed during plan formulation as part of the feasibility study. Uncertainties remain concerning the exact Project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were similarly estimated using currently available information.

A. Project Goals and Objectives. The Beaver Island HREP is unique in that the features included in the Recommended Plan are interconnected to restore, not just certain habitat types, but the natural system processes within the island complex. The goal of the Beaver Island HREP is to restore the missing distinguishing features which collaboratively restore the interconnected transitional gradient of habitats characteristic of lacustrine and riverine systems. The following objectives are to be measured through monitoring:

- Diversify floodplain forest habitat on Beaver Island, as measured in acres of elevated topography and number of hard mast tree species present in Project area
- Increase year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing, and overwintering habitat.
- Increase the structure and function of side channel habitat, as measured by native freshwater mussel use.

The strategic locations and design of the features included for each objective work together to restore the missing characteristics of the Project. Beginning at the lowest elevation, deep water habitat will be restored for critical overwintering fish habitat. With increasing elevation on the dredged material placement site, habitat characteristics change from semi-permanently inundated to seasonally inundated emergent and scrub-shrub wetland. Finally, temporarily inundated forested wetland is incorporated.

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

The transitional structure between one habitat type to another functions to provide overall habitat that is currently missing at Beaver Island. This gap in the system has had an effect on everything from overwintering fish to mast tree production. The restoration of the missing distinguishing characteristics provides overarching habitat at the ecosystem level with fish, migratory birds, and everything in-between benefiting.

B. Sources of Uncertainty. Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any ecosystem restoration project. Following is a list of uncertainties associated with restoration of aquatic fish and floodplain habitat in the Beaver Island HREP.

- **Floodplain Forest Diversity**
 - The District evaluated the level of uncertainty and risk in the floodplain forest feature and determined it did not require using Adaptive Management to address the potential of the feature to meet performance criteria. Furthermore, the Huron Island HREP is currently in construction and has an elaborate adaptive management and monitoring design for forestry. Monitoring will be conducted to determine Project success. Information gained from the Huron Island HREP will be used to guide floodplain forest restoration.

- **Backwater Fish Habitat**
 - It is expected that overwintering and summer habitat in the dredged backwater will not be limited by dissolved oxygen or flow as a result of the closing structure construction. However, this expectation remains uncertain. If monitoring demonstrates a need for decreased flow, increased dissolved oxygen, or a combination of the two, an adaptive management measure to modify the closing structure will be implemented.

- **Side Channel Structure and Function through Albany Island Protection and Freshwater Mussel Habitat**
 - It is expected that implementation of the Chevron structure will not significantly alter hydraulic forces within Albany Slough side channel and will continue to provide stabilization of Albany Island. If monitoring demonstrates a significant impact to mussels within Albany Slough or continued erosion of Albany Island, a modification of the structure will be required.

C. Conceptual Model. Figure K-3 shows the conceptual ecological model.

Beaver Island
 Upper Mississippi River Restoration
 Feasibility Study Report

Appendix K
 Monitoring and Adaptive Management Plan

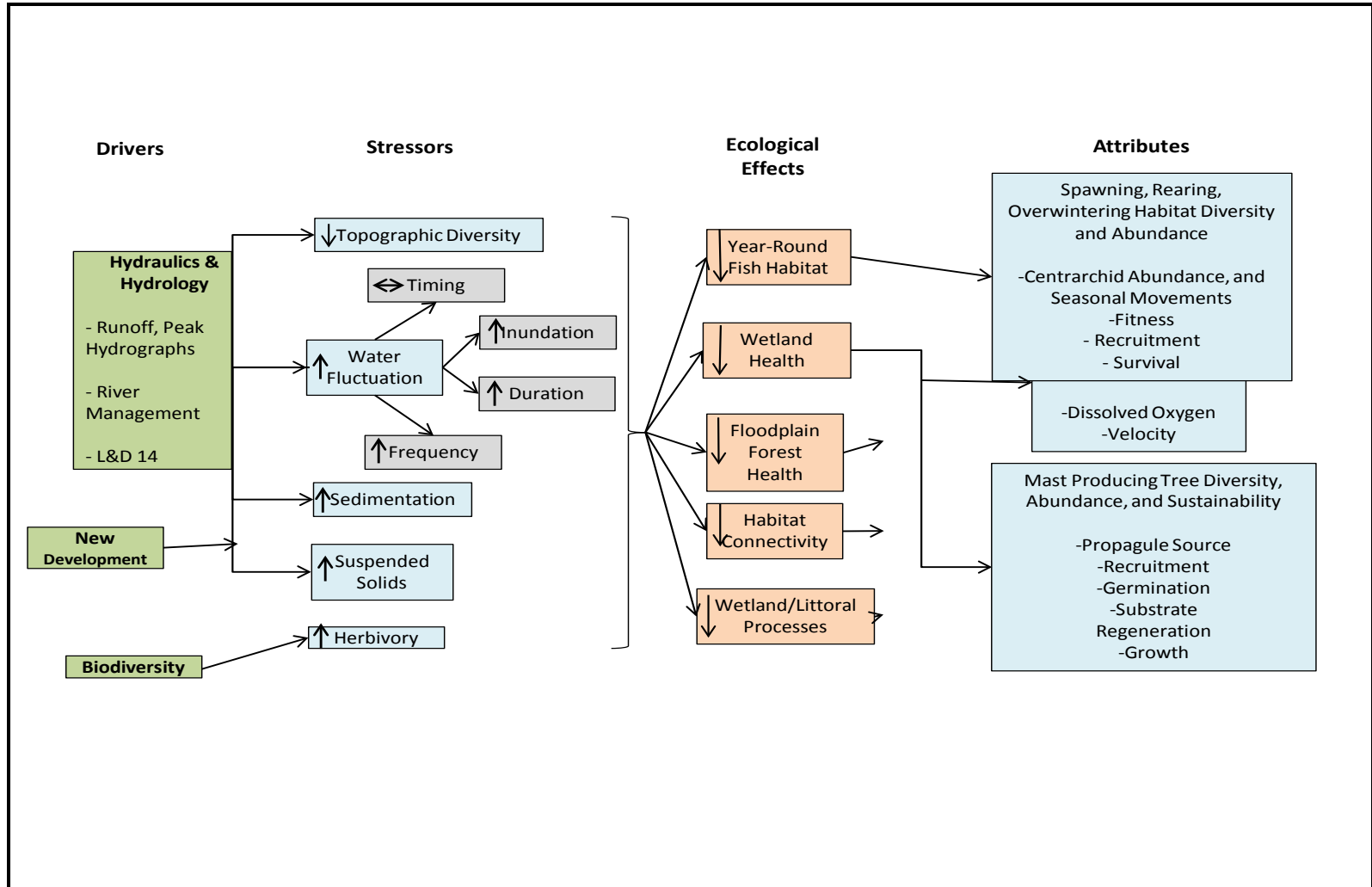


Figure K-3: Beaver Island Conceptual Ecological Model

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

III. MONITORING OF OBJECTIVES TO DETERMINE PROJECT SUCCESS AND ADAPTIVE MANAGEMENT MEASURES

The power of a monitoring program developed to support determinations of project success and inform adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management.

A. Floodplain Forest Diversity

1. Forest Plot Survey. Vegetative monitoring would be conducted by plot sampling that is generally consistent with methods outlined in the UMRR Forest Monitoring Protocols. Monitoring would be conducted annually for the first 5 years and then in Years 7 and 10.

Large trees, shrubs, seedlings, and saplings would be counted and measured in random plots placed along a diagonal transect located across the restoration site. Within each plot, all woody shrubs and trees (saplings and seedlings) >5 cm DBH will be identified to the species level, counted, and their height measured. Diameter at breast height measurements shall be taken for shrubs and saplings of adequate height.

Estimates of total percent cover in plots, percent cover by individual species, percent growth by species, and recruitment will be determined.

Success Criteria. An assumed success criterion of 75 trees per acre at Year 10 with at least 8 species of mixed hard mast identified. The success criteria will be verified by sampling during PED. Targets for tree density and diversity will be calibrated and validated based on reference forest stand.

2. Wetland Monitoring. A climate change scenario was implemented to establish the maximum elevation of 579.8 ft. However, following 1987 Corps Regulatory Wetland Delineation Manual, the maximum elevation to have the three wetland criteria (soils, vegetation, hydrology) was determined to be at 578.9 ft. Regulatory guidance does not include consideration of climate change and future hydrology. Future monitoring at the higher elevations will ensure these areas continue to function as a wetland and ultimately will provide information on how climate change policy influences wetland regulations for future projects.

An annual site visit will be conducted to sample 3-5 locations at the placement areas during the growing season at 579.8 ft over 5 years, beginning 1 year post planting. Sampling will include soil analysis, vegetation identification, and observation of hydrology indicators as stated in the Corps 1987 Wetland Delineation Manual and Midwest Regional Supplement.

Success Criteria. An assumed success criterion of established wetland at the higher elevations at 579.8 ft identified. According to the existing forest inventory, obligate wetland species are present at this elevation, but this will be verified by sampling during PED and used as a baseline.

B. Backwater Fish Habitat. Bathymetric surveys will be conducted upon Project completion to determine base depth conditions and construction compliance. A comparison survey will be

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

conducted at Year 5 to map and quantify the amount of backwater area greater than 4 feet in depth. The results of this study will inform Project success, inform adaptive management triggers and measures, and inform future HREPs by demonstrating the need for specific habitat types or ways to improve existing habitat. Improvements could lead to greater fish habitat quality, including overwintering habitat. Water quality data collected from the site annually for the first 5 years post-construction will be used to determine dissolved oxygen concentrations, water flow, and temperature throughout the year.

Comparisons of fish habitat use during the year will be compared with pre-Project habitat use and fish use of other backwater areas within Beaver Island and UMR backwater lakes to aid in determining Project success. The Iowa Department of Natural Resources (IADNR) will complete the fish surveys used to conduct this comparison. Fish collection methods will be similar to those used by the UMRR LTRM element protocols and will occur annually for the first 5 years post-construction. Sufficient sites will be sampled pre- and post-Project in restored areas and in control sites (i.e., sites without restoration). All collected fish will be identified and measured for length and weight.

Success Criteria. Retain 160 habitat units of overwintering and summer backwater habitat at Year 5. This measurement takes into account percent of the backwater greater than 4 feet in depth, average winter water velocity, and dissolved oxygen concentrations between 5-20 mg/L on average in winter and summer.

Adaptive Management Trigger and Measure. If monitoring results indicate an inability to reach success criteria for 2 consecutive years, modifications to the closing structure will be implemented to decrease water flow, increase dissolved oxygen, or a combination of the two.

C. Side Channel Structure and Function through Albany Island Protection and Mussel Habitat

1. Albany Island Bank Stabilization. Bathymetric and topographic surveys of Albany Island will be completed upon completion to determine base conditions and construction compliance. A comparison survey will be conducted annually for 3 years to map and quantify acreage of the island, and determine structural persistence of the Project components. Additionally, Acoustic Doppler Current Profiler (ADCP) measurements will be collected along seven transects pre- and post-Construction under Q95 (19,800 cfs) and Q5 (130,000 cfs) discharges to determine significant increases in water velocity. Q5 and Q95 represent the discharges identified as critical for mussel presence. Data analysis will include evaluation of post-construction computed shear stresses, based on ADCP measurements, to verify conditions remain suitable for mussel habitat.

Success Criteria 1. The Albany Island chevron construction will be considered successful if after 3 years, the acreage of Albany Island is not less than the as-built acreage.

Success Criteria 2. The Albany Island chevron construction will be considered successful if after 5 years, the post-construction velocities indicate a Q95 shear stress above 0.18 dynes/cm² and a Q5 shear stress below 8.88 dynes/cm².

Adaptive Management Trigger and Measure. If monitoring results indicate an inability to reach success criteria for 2 observations, modifications to the chevron will be implemented to increase protection of Albany Island, decrease water velocities within

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

Albany Slough, or a combination of the two. Preliminary information suggests an increase in the chevron to 576 feet would be warranted.

2. Albany Slough Freshwater Mussel Habitat. A series of mussel survey methodologies including pollywog, dive surveys, timed searches, and randomized quadrat surveys will be used to survey the mussel substrate feature. This will occur with a multi-agency team pre-Project, immediately after construction, and at 3, 6, and 9 years post-construction. Surveys will determine species diversity, age structure, substrate relationships, and density. Data analysis will include simple analyses of mussel diversity, density, age structure, and relationships to river rock size or location. Results of the analyses will be used to inform Project success and to guide future projects in the UMRS.

Success Criteria. Successful recruitment of freshwater mussels will be identified when >4 species of mussels of at least 5 mussels/m² are present.

IV. DOCUMENTATION, IMPLEMENTATION COSTS, RESPONSIBILITIES, AND PROJECT CLOSE-OUT

A. Documentation, Reporting, and Coordination. The PDT will document each of the performed assessments and communicate the results to the HREP program manager and partners designated for the Project. Periodic reports will be produced to measure progress towards the Project goals and objectives as characterized by the selected performance measures.

B. Costs. The costs associated with implementing monitoring and adaptive management measures were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. Because uncertainties remain as to the exact Project features, monitoring elements, and adaptive management opportunities, the estimated costs in Table K-1 will need refinement in PED during the development of the Detailed Monitoring and Adaptive Management Plans.

C. Responsibilities

1. Floodplain Forest Diversity.

- **Forest Plot Survey.** Feasibility and PED activities are limited to one pre-construction evaluation of the existing forest characteristics at Beaver Island. Monitoring would be conducted annually for the first 5 Years and then in Years 7 and 10. Responsibility for these features will be a coordinated effort between the Corps, the IADNR, and the U.S. Fish and Wildlife Service (USFWS).
- **Wetland Monitoring.** Feasibility and PED activities are limited to one pre-construction evaluation of the existing wetland characteristics at Beaver Island. Monitoring would be conducted over 5 years. Responsibility for these features will be coordinated by Corps, Rock Island District personnel.

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

2. Side Channel Structure and Function through Albany Island Protection and Mussel Habitat

- **Albany Island Bank Stabilization.** PED activities will be limited to one evaluation to reassess existing hydraulics. Following construction, chevron performance will be evaluated for 3 years. Responsibility for these features will be a coordinated effort between the Corps, the IADNR, and the USFWS.
- **Albany Slough Freshwater Mussel Habitat.** PED activities will be limited to one evaluation to reassess existing mussel resources. Following construction, monitoring will occur at Years 1, 3, 6, and 9. Responsibility for these features will be a coordinated effort between the Corps, the IADNR, and the USFWS.

3. Backwater Fish Habitat. Feasibility and PED data collection will consist of pre-Project data collection and analyses. Following construction, a backwater bathymetric survey will be conducted at Year 5 and water quality sampling will occur annually for 5 years. Fish community sampling is scheduled annually for 5 years (IADNR). The need for changes will regularly be evaluated and if needed will occur within 5 years of construction. Responsibility for these efforts will be a coordinated effort between the Corps, the IADNR, and the USFWS.

D. Project Close-Out. Close-out would occur when it is determined that the Project has successfully met the Project success criteria described in Section III, *Monitoring of Objectives To Determine Project Success and Adaptive Management Measures*. Success would be considered to have been achieved when the Project objectives have been met, or when it is clear that they will be met based upon the trends for the site conditions and processes. Project success would be based on the following:

- Success criteria met;
- Continued site inspections to determine continued Project status; and
- Continued O&M into the future

*Beaver Island
Upper Mississippi River Restoration
Feasibility Study Report*

*Appendix K
Monitoring and Adaptive Management Plan*

Table K-1: Estimated Adaptive Management and Post-Construction Monitoring Costs (\$) (October 2016 Price Level)

Objective	Work Category	Activity	PED	Post-Construction Years										Total
				1	2	3	4	5	6	7	9	10		
Floodplain Forest Diversity	Monitoring and Analysis	Forest Plot Survey and Wetland Monitoring	-	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	-	\$6,000	-	\$6,000	\$42,000	
<i>Floodplain Forest Diversity Subtotal: \$42,000</i>														
Albany Island Bank Stabilization	Monitoring, Analysis, Reporting	Site Inspection												
		ADCP Data Collection	\$12,000	\$12,000	\$12,000	\$12,000	-	-	-	-	-	-	\$48,000	
	AM: Riprap/Chevron Rock Install/Remove	-	\$25,000				-	-	-	-	-	-	\$25,000	
<i>Albany Island Protection Subtotal: \$73,000</i>														
Albany Slough Freshwater Mussel Habitat	Monitoring, Analysis, Reporting	Mussel Survey												
		Data Analysis	\$8,000	\$7,000	-	\$7,000	-	-	\$7,000	-	\$7,000	-	\$36,000	
<i>Mussel Habitat Subtotal: \$36,000</i>														
Backwater Fish Habitat	Monitoring, Analysis, Reporting	Backwater Bathmetry ¹												
		Water Quality												
		Data Analysis	-	\$8,000	\$8,000	\$8,000	\$8,000	\$13,000	-	-	-	-	\$45,000	
	AM: Notch Closing Structure		\$35,000						-	-	-	-	\$35,000	
<i>Aquatic Habitat Subtotal: \$80,000</i>														
TOTAL \$231,000														

¹ Fish surveys completed by the IADNR will aid in determining success of the aquatic habitat component.

