POST-CONSTRUCTION
PERFORMANCE EVALUATION REPORT

BAY ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

2015

US Army Corps of Engineers ®
Rock Island District

POOL 22

MISSISSIPPI RIVER MILES 311-312

MARION COUNTY, MISSOURI

ACKNOWLEDGEMENTS
&
POINTS OF CONTACT

Many individuals from the U.S. Army Corps of Engineers, Rock Island District, the U.S. Fish and Wildlife Service, and the Missouri Department of Conservation contributed to the development of this Post-Construction Performance Evaluation Report for the Bay Island Habitat Rehabilitation and Enhancement Project. These individuals are listed below:

U.S. Army Corps of Engineers, Rock Island District				
Erica Stephens, PE	Project Engineer	P.O. Box 2004 Clock Tower Bldg Rock Island, IL 61204	309-794-5925	erica.l.stephens@usace.army.mil
Steve Gustafson	Report Preparer	P.O. Box 2004 Clock Tower Bldg Rock Island, IL 61204	309-794-5202	stephen.j.gustafson@usace.army.mil
Charles Theiling, PhD	Biologist	P.O. Box 2004 Clock Tower Bldg Rock Island, IL 61204	309-794-5636	charles.h.theiling@usace.army.mil
U.S. Fish and Wildlife Service				
Robert Clevenstine	Wildlife Refuge Biologist	1511 47th Avenue Moline, IL 61265	309-757-5800	robert_clevenstine@fws.gov
Aleshia Kenney	Ecological Services	1511 47th Avenue Moline, IL 61265	309-757-5800	aleshia_kenney@fws.gov
Missouri Department of Conservation				
Mike Flaspohler	Biologist	653 Clinic Road Hannibal, MO 63401	573-248-2530	michael.flaspohler@mdc.mo.gov

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EXECUTIVE SUMMARY

General. The purpose of the Bay Island Habitat Rehabilitation and Enhancement Project (HREP) was to provide the physical conditions necessary to improve and enhance wetland habitat quality. As stated in the Definite Project Report (DPR), the Bay Island HREP was undertaken to address several problems. The quality, extent, and diversity of this area's wetland habitat were rapidly decreasing. The migratory waterfowl and other wetland species which currently depend upon and utilize this habitat type for resting and feeding, as well as reproduction and brooding, were adversely affected by its declining availability. Pool 22 of the Mississippi River lacks sufficient wetland habitat to maintain the historic abundance of waterfowl, shorebirds, and furbearers in this area. Prior to construction of the levees and development of agriculture in the floodplain adjacent to this pool, bottomland forest wetland habitat was available during annual waterfowl migrations.

Purposes. The purposes of this Performance Evaluation Report (PER) are to:

1. Document the pre- and post-construction monitoring activities for the Bay Island HREP
2. Summarize and evaluate project performance on the basis of project goals and objectives as stated in the DPR
3. Summarize project operation and maintenance efforts, to date
4. Provide recommendations concerning future project performance evaluation
5. Share lessons learned and provide recommendations concerning the planning and design of future HREPs

Project Goal and Objectives. The specific goal and objectives as stated in the DPR were to:

Goal: Enhance wetland habitat for migratory waterfowl

Objectives

1. Provide Controlled Water Levels During Waterfowl Migration - Forested and Non-Forested.
2. Increase Mast Tree Dominance - Forested Wetland
3. Increase Total Wetland Values for Migratory Waterfowl

Project Performance Monitoring. Pre and post-project monitoring, both qualitative and quantitative, was performed in accordance with Table 12-3 Post-Construction Quantitative Measurements from the original DPR. Monitoring and performance evaluation was conducted by the U.S. Army Corps of Engineers Rock Island District, the Missouri Department of Conservation, and the U.S. Fish and Wildlife Service. The period of data collection covered in this report includes the pre-project monitoring 2002, quantitative and qualitative post-project monitoring through 2014, and anecdotal information through 2014.

Evaluation of Project Objectives. For the evaluation period of 2002 to 2014, observations were made with regard to the efficacy of the objectives in meeting the HREP goal. In addition, general conclusions were drawn regarding project measures that may affect future project design.

1. **Provide Controlled Water Levels During Waterfowl Migration - Forested and Non-Forested**
    a. **Evaluation Criteria**: 348 acres of Wetland Management Units by Year 50
    b. **General Observation:** The site is managed as a seasonal wet prairie subject to spring flooding. Water drains from the site through undetermined subsurface pathways, and moist soil plant species colonize mudflats dependent on annual hydrology. The site provides abundant seeds when flooded in the fall for migratory waterfowl.
    c. **Results:** Forest and wetland response is acceptable throughout the Bay Island project area.
    d. **Success:** The HREP is successful for seasonal waterbird migrations.
    e. **Conclusion:** The HREP operates as intended after minor adjustments during the first few years of operation and in response to flooding. Water loss due to leakage is manageable.
    f. **Lessons Learned & Recommendations:** The HREP provided experience with submerged pump design and operation that influenced later projects. The water holding capacity of the HREP was less than anticipated, but within management requirements. Efforts to reduce seepage with bentonite were unsuccessful because it is exceedingly difficult to locate buried sand lens and drain tiles.

2. **Increase Mast Tree Dominance - Forested Wetland**
    a. **Evaluation Criteria:** 36.9 acres of mast tree dominant forested wetland by Year 50.
    b. **General Observation:** Many trees are 7-10 inches in diameter and well into canopying over the planting area.
    c. **Results:** Estimated greater than 80% survival rate.
    d. **Success:** The mast tree planting efforts appear moderately successful.
    e. **Conclusion:** Significant acreage of mast trees is present in the HREP.
    f. **Lessons Learned & Recommendations:** One factor for the survival of the trees was the routine maintenance the site received through MDC mowing. Recommend discontinuing monitoring.

3. **Increase Total Wetland Values for Migratory Waterfowl**

    a. **Evaluation Criteria:** HREP assessed a 0.62-0.64 Habitat Suitability Index and 420.5-434.0 Habitat Units by Year 50.

    b. **General Observation:** The habitat model used to design the HREP is no longer used, but the Bay Island HREP provides about 400 acres of mixed floodplain forest, forested wetland, and herbaceous wetland habitat which is consistent with the objectives.

    c. **Results:** Land cover data for 1989, 2000, and 2010 are presented in Figure 2.

    d. **Success:** The HREP is achieving desired habitat targets.

    e. **Conclusion:** The Bay Island HREP achieves the desired project objectives to provide emergent wetland and forested wetland habitat.

    f. **Lessons Learned & Recommendations:** Estimate potential benefits in units that will be repeatable in subsequent evaluations. Recommend discontinuing monitoring.

Evaluation of Project Operation and Maintenance. The Operation and Maintenance Manual was completed in September 2002. Periodic maintenance of the perimeter and immediate levees, pump station and water control structures is required. Features that require operation for HREP function are the pump station and water control structures. Extreme flooding in 2008 damaged the pump station electrical controls. The Missouri Department of Conservation hired a local contractor who raised the electrical panel and replaced damaged equipment for ~$13,000. The repairs were completed by spring 2009.

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INTRODUCTION

The Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) is a Federal-State partnership established to manage, restore and monitor the UMR ecosystem. The UMRR-EMP was authorized by Congress in Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662) and reauthorized in 1999. Subsequent amendments have helped shape the two major components of EMP—the Habitat Rehabilitation and Enhancement Projects (HREPs) and Long Term Resource Monitoring (LTRM). Together, HREPs and LTRM are designed to improve the environmental health of the UMR and increase our understanding of its natural resources.

Habitat Rehabilitation and Enhancement Project construction is one element of the UMRR-EMP. In general, the projects provide site-specific ecosystem restoration and are intended and designed to counteract the adverse ecological effects of impoundment and river regulation through a variety of modifications, including flow introductions, modification of channel training structures, dredging, island construction, and water level management. Interagency, multi-disciplinary teams work together to plan and design these projects.

The Bay Island HREP is part of the UMRR-EMP. The Bay Island HREP was constructed to provide high quality, dependable wetland habitat for migratory waterfowl. Water level management capabilities were achieved through the construction of a levee system, pump station, and water control structures. Construction of the levee system created two independent wetland management units (WMUs). A pump station and multiple stoplog structures were built into the levee system to facilitate control of water levels. Mast producing trees were planted to provide additional food resources. Overflow spillways; riprap protection; bentonite lining to reduce seepage; and a gatewell structure were added to the WMUs in the fall of 2000 to increase water control and reduce flood damage impacts. A new sluice closure gate at the pump station was added to reduce sediment build up in the pumping pit.

1. Purpose of Project Evaluation Reports. The purpose of this Project Evaluation Report for Bay Island HREP is to:

a. document the pre- and post-construction monitoring activities for the Bay Island HREP;
b. summarize and evaluate project performance on the basis of project goals and objectives as stated in the Definite Project Report (DPR);
c. summarize project operation and maintenance efforts, to date;
d. provide recommendations concerning future project performance evaluation; and
e. share lessons learned and provide recommendations concerning the planning and design of future HREPs.

2. Scope. This report summarizes available monitoring data, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) information, and project observations made by the U.S. Army Corps of Engineers, Rock Island District (District), the U.S. Fish and Wildlife Service (USFWS), and the Missouri Department of Conservation (MDC). The period of data collection covered in this report includes the pre-construction monitoring 1989 to post-construction monitoring as of 2015.

3. Project References. Published reports which relate to the Bay Island HREP include:

- *Definite Project Report (R-8) with Integrated Environmental Assessment, Bay Island Rehabilitation and Enhancement Project, Pool 22, River Miles 311-312, Upper Mississippi River, Marion County, Missouri, March 1990.*
- *Operation and Maintenance Manual, Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River Environmental Management Program, Pool 22, River Miles 311-312, Marion County, Missouri, September 2002 (O&M Manual).*
- *Operation and Maintenance Manual, Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River Environmental Management Program, Pool 22, River Miles 311-312, Marion County, Missouri, November 1995 (O&M Manual).*
- *Post-Construction Initial Performance Evaluation Report (IPER4F), Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River System Environmental Management Program, Pool 22, Mississippi River Miles 311-312, Marion County, Missouri, December 1999.*
- *Post-Construction Supplemental Performance Evaluation Report (PERS1), Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River System Environmental Management Program, Pool 22, Mississippi River Miles 311-312, Marion County, Missouri, April 2002.*
- Bay Island HREP, 10-Year Performance Evaluation Report, 2003. Memorandum for Record. Carmack, Sunderman, and Swenson.

4. Project Location. The Bay Island HREP is located in Marion County, Missouri, on the right descending bank of the Mississippi River, between River Miles 311-312 (Figure 1). The HREP is operated by the MDC under an agreement with the USFWS and the District.

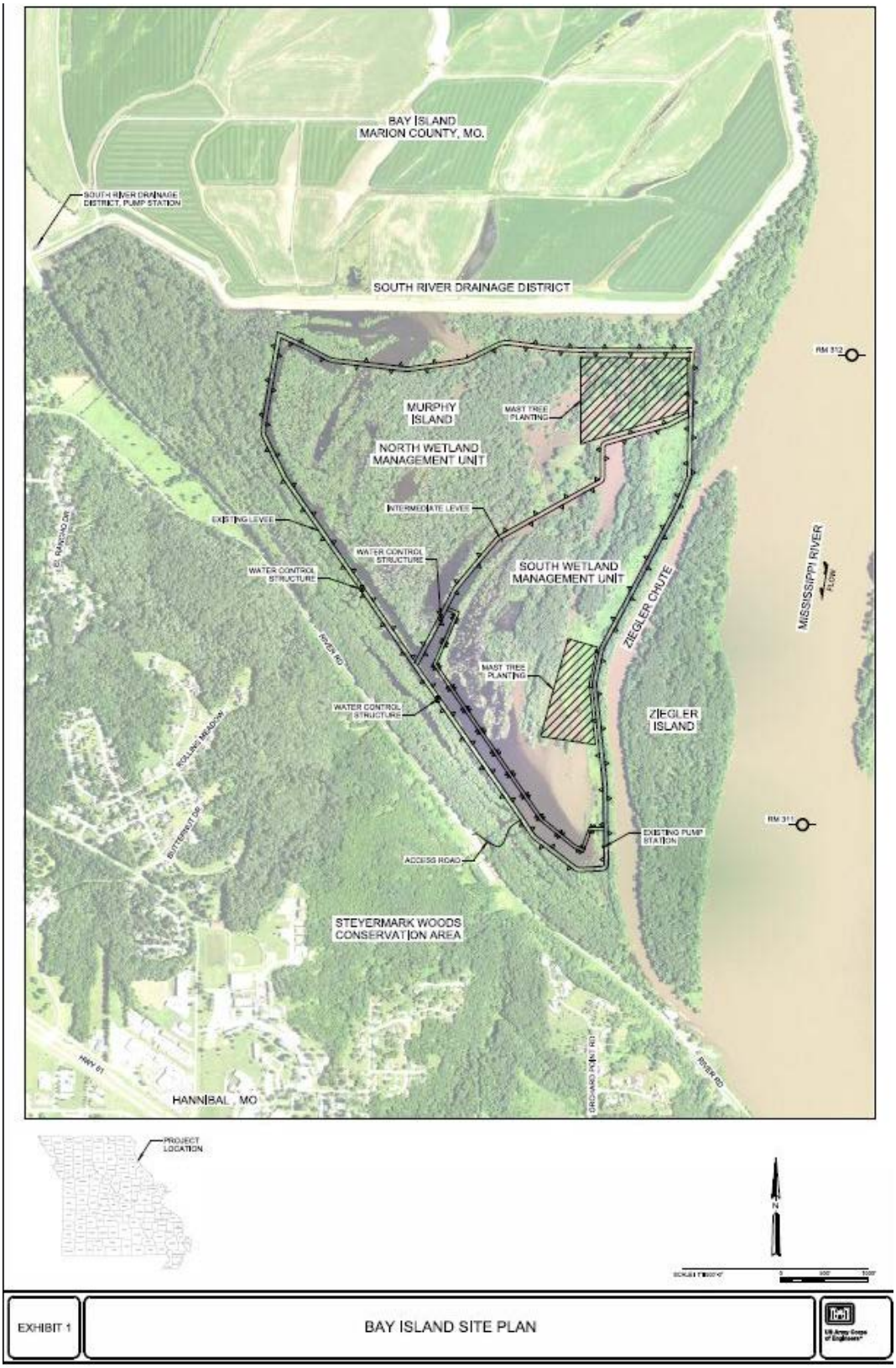

Figure 1. Bay Island Project Area

PROJECT PURPOSE

1. Overview. The design of the Bay Island HREP was to provide the physical conditions necessary to improve and enhance wetland habitat quality. The specific goals as stated in the DPR were to: enhance wetland habitat for migratory waterfowl. In order to achieve this goal, sedimentation and limited open water and emergent wetlands at the site needed to be addressed. These problems were contributing to the direct loss of wetland habitat. The problem, opportunity, goal, objectives, and restoration measures implemented to address the goals and objectives are listed in Table 1.

2. Management Plan. No formal management plan was developed for this HREP. The HREP is generally operated as outlined in the project's Operation and Maintenance Manual dated September 2002.[1]

[1] More recent UMRS-EMP HREPs have included the development of formal management plans.

Table 1. Problems, Opportunities, Goals, Objectives, and Measures

Problem	Opportunity	Goal	Objectives	Restoration Measures
Loss of Wetland Habitat	Restoration of Wetland Habitat Value	Enhance Wetland Habitat for Migratory Waterfowl	Provide controlled water levels during waterfowl migration-forested and non-forested	Earthen levee, pump station, stoplog structures
			Increase mast tree dominance-forested wetland	Mast tree plantings
			Increase total wetland values for migratory waterfowl	Earthen levee, pump station, stoplog structures, mast tree plantings

PROJECT DESCRIPTION

1. Project Measures. The Bay Island HREP includes two WMUs surrounded by a perimeter levee that provides at least a two-year level of protection, water supply pump station, stoplog control structures, mast tree plantings, and an access road with bridge. See Figure 1 for locations of measures. A detailed description of each of these original measures is provided below. New features and maintenance items were added to the original project through a construction contract substantially completed in the fall of 2000. New features included overflow spillways, a new gatewell on the water supply berm and a new sluice closure gate installed on the pump station. Maintenance items include the riprap slope protection added to the perimeter levee, bentonite lining installed in the water supply ditch, and clay fill added to raise the water supply berm.

- **Wetland Management Units.** The Bay Island HREP consists of two WMUs, encompassing approximately 400 acres, delineated by a low-level perimeter levee and cross dike. Water levels are controlled independently in the two units through the use of a pump station and water control structures.

    - **Perimeter Levee.** The 19,194-foot-long perimeter levee provides at least a two-year level of flood protection. The levee has a 10 to 12 foot crown with 4H:1V side slopes. An intermediate levee subdivides the area enclosed by the perimeter levee, creating two WMUs, a north and a south unit, NWMU and SWMU, respectively.

    - **Pump Station.** The pump station consists of a 6,000-gpm submersible propeller-type pump. This pump has the capacity to fill in the NWMU in 15 days and both units in 23 days. The pump station, located on the south end of the project, pumps water from Ziegler Chute. The pump is housed in a vandal-resistant cast-in-place building. The intake entrance is equipped with a trash rack. Underground single-phase electrical power is provided to the site. All necessary electrical equipment is located on an overhead platform.

    - **Water Control Structures.** The WMUs have three water control structures. Two water control structures, each having four 5-foot-wide stoplog bays, are located on the perimeter levee. The intermediate levee has one water control structure with two 3-foot-wide stoplog bays. Wood stoplogs are inserted into the control structure bays to establish water ponding elevations. The perimeter levee water control structures are sized to preclude the need for an armored levee overflow section. All of the water control structures have a steel grate deck to allow for vehicle passage overhead.

    Overflow spillways on the perimeter levee were added to both the NWMU and the SWMU in 2001. The armored overflow spillways allow rising floodwaters to fill WMUs prior to overtopping the perimeter levee thus minimizing damages of a flood event.

- **Mast Tree Plantings.** Approximately 30 acres within the two WMUs were planted with mast trees (pin oaks). Acorns, seedlings, and larger stock were used.
- **Project Access Road.** Access to the Project is gained by a crushed stone access road. The majority of the eastern segment of the access road followed an existing access road alignment. The road is 10 feet wide and surfaced with 6 inches of crushed stone. The road is used by MDC personnel for operation and maintenance activities and farmers to access leased crop areas within the site.
    - **Prefabricated Deck Bridge.** A new prefabricated deck bridge with concrete abutments provides project access over Clear Creek. The span length is 42 feet and the deck width is 15 feet. The bridge carries a standard water loading designation. The bottom elevation of the bottom chord of the bridge is 464.4 MSL and was designed to allow passage of a 100-year flow of Clear Creek plus the drainage outflow from the South River Drainage District with 1 foot of clearance.

2. Project Construction. The Bay Island HREP was approved for construction in June 1991. The contract was awarded to Northwest Construction Corporation and was completed in November 1992.

Significant damages to the levee and pump station resulted from the record flooding that occurred during the summer of 1993. The original project construction contract was modified to allow repair of project damages resulting from the 1993 flood. These repairs were completed by November 1994. A second construction contract was awarded to Geode Resource Conservation and Development Inc. to replace tree plantings lost during the 1993 flood was completed in November 1994.

Overflow spillways on the perimeter levees and a slide gate at the pump station outlet were added through a construction contract awarded in April 2000. The contract was awarded to Gunterman Brothers, Inc. and was considered substantially completed in the fall of 2000. The overflow spillways allow rising floodwaters to fill the WMUs prior to overtopping the perimeter levee.

3. Project Operation and Maintenance. In the original DPR, it was estimated that the Bay Island HREP would require little or no maintenance. Operation and maintenance responsibilities for the Bay Island HREP were originally outlined in the DPR. The acceptance of these responsibilities was formally recognized by an agreement signed by the MDC and the Rock Island District.

A detailed description of all operation and maintenance requirements can be found in the HREP Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (OMRR&R Manual). The OMRR&R Manual for the Project delegated responsibilities and procedures for post project activities. Project operation and maintenance generally consists of the following:

a. mowing and maintaining the perimeter levee

b. operating the pump station and water control structures to achieve desired water elevations and minimize overtopping erosion

c. maintaining (e.g. removal of silt, debris, and undesirable vegetation) the interior drainage and outlet and inlet channels

d. controlling vegetation between planted trees

PROJECT PERFORMANCE MONITORING

1. General. Performance monitoring of the Bay Island HREP has been conducted by the District to help determine the extent to which the design meets the habitat improvement objectives. Information from this monitoring will also be used, if required, for adaptive management.

The monitoring and performance evaluation matrix is outlined in Table 2. Pre- and post-project monitoring, both qualitative and quantitative by each of the involved agencies is as follows.

U.S. Army Corps of Engineers, Rock Island District: The success of the HREP relative to original project objectives shall be measured utilizing data, field observations, and project inspections provided by the MDC, USFWS, and the Rock Island District. The District was responsible for post-project analyses, including performing an aerial survey within the first year following construction, then at intervals of every 5 years, a timber inventory every 10 years, and a WHAG analysis at 1, 15, and 50 year intervals. The District has overall responsibility to measure and document project performance.

The Missouri Department of Conservation: The MDC is responsible for operating and maintaining the Bay Island HREP. Through the USFWS, the MDC is to submit annual field observations to the District, reporting on the migratory waterfowl response and the survival of the mast tree plantings.

U.S. Fish and Wildlife Service. The USFWS does not currently conduct any monitoring specific to the HREP.

Table 2. Monitoring and Performance Evaluation Matrix

Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Pre-Project Monitoring	Establish need of proposed project features	MDC	MDC	MDC	Attempts to begin defining baseline.
Baseline Monitoring and Data Collection for Design	Establish baseline conditions; meet specific design and data requirements	USACE	USACE	USACE (HREP)	See DPR for location and sites for data collection and baseline information.
Construction Monitoring	Assess construction impacts; meet permit requirements	USACE	USACE	USACE (HREP)	Environmental protection specifications included in construction contract documents. Inter-agency field inspections accomplished during project construction phase
Performance Evaluation Monitoring	Continue monitoring and assess physical, chemical, and vegetation performance of project relative to design goals and objectives	USACE (quantitative) MDC (field observations)	USACE MDC	USACE (HREP) MDC	Comes after construction phase of project
Analysis of Biological Response to Project Features	Evaluate biological response predictions and assumptions	USACE	USACE	USFWS	Intensive biological response monitoring of this Project, as part of the HREP element of the UMRS-EMP, is not scheduled.

2. Project-Induced Habitat Changes. The Bay Island HREP was constructed to enhance migratory waterfowl habitat. The Project included a perimeter levee to minimize flooding during the growing season. The site is managed as a seasonal wet prairie that grows on mudflats as spring floods dissipate through seepage and evaporation in two separate WMUs. The site is flooded for the fall migration to make wetland herbaceous growth available to migrating birds.

Migratory bird annual wetland food value is dependent on hydrologic conditions. Land cover data available from UMRR LTRM shows a decrease in agriculture and replacement with shrub-scrub or shallow marsh since project implementation (Figure 2). Annual hydrology and refuge management are important determinants of habitat in any year. The period 2003 to 2007 was dry and a larger portion of that could be classified as both agriculture and shallow marsh. Starting in 2008, a wet phase reduced agriculture acres and allowed more shallow marsh acres.

Mast tree plantings with RPM trees were more successful than planting from acorns or seedlings. Aerial imagery indicates good survival of trees planted after the 1993 flood. There is a potential need to thin plantings to ensure success of the best trees (Ben Vandermyde, Rock Island District forester, personal communication).

A habitat benefits evaluation model, Wildlife Habitat Appraisal Guide (WHAG), was used to assess the Project design in 1990 was revisited in 2006. Anecdotally, the re-evaluation showed the Project performed better than the original model predicted, but there is no formal report. An abundance of caution should also be used when using planning models to assess project effects, especially old models. First, planning models assess project alternatives, they do not predict project outcomes. Second, the planning model used in 1987 has not achieved peer review certification by the District. The WHAG model is no longer supported by the District. The District now uses other tools for project planning and does not revisit models on completed projects.

3. Non-Project-Induced Habitat Changes. In July 1993, a flood of record on the Mississippi River resulted in flooding of the Project prior to completion. The most significant damage was the inundation and subsequent loss of the mast tree plantings. As such, a new contract had to be awarded for the tree replanting.

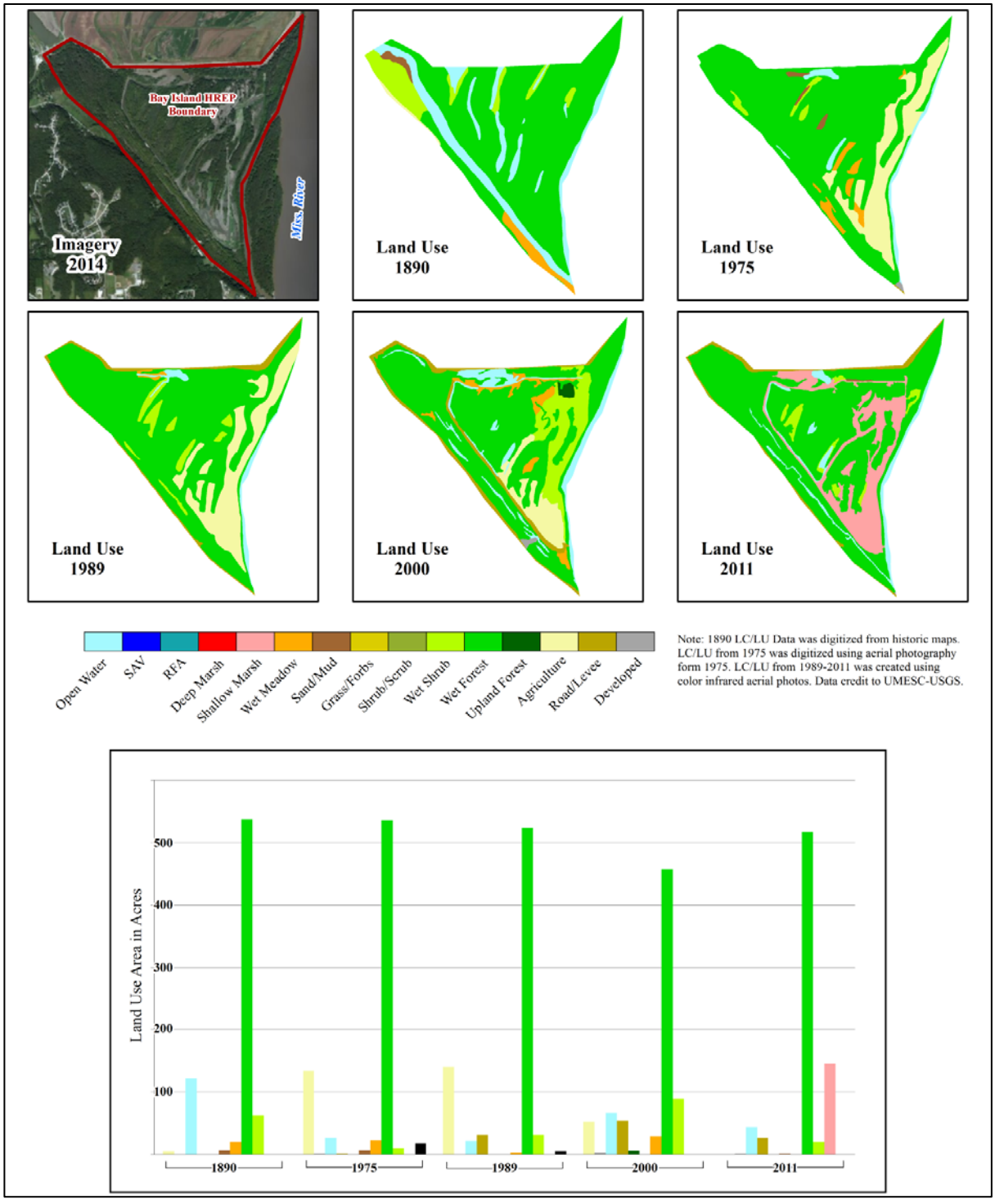

Figure 2. Bay Island HREP Land Use Changes 1890-2011

PROJECT EVALUATION

1. Construction and Engineering. The Project construction contract was awarded on June 18, 1991, to Northwest Construction Corp. under Contract No. DACW25-91-C-0057. Project construction was considered substantially completed on November 18, 1992. Significant damages to the levee and pump station resulted from the record flooding that occurred during the summer of 1993. The original project construction contract was modified to allow repair of project damages resulting from the 1993 flood. These repairs were completed by November 21, 1994. A second construction contract (DACW25-94-C-0073) to replace tree plantings lost during the 1993 flood was completed November 1994.

2. Costs. In the original DPR, cost estimates for the entirety of the Project were $1,302,500. Initial construction costs were $1,498,397. As of the 2002 OMRR&R, the total cost of the Bay Island HREP was $2,821,250.

Contract DACW25-94-C-0073 repaired damages from the 1993 Mississippi River Flood. The contract included tree replacement activities at a cost of $63,057 and was concluded in November 1994.

Contract DACW25-00-C-0010 repaired seepage issues in the SWMU, added overflow spillways on the perimeter levees and a slide gate at the pump station inlet. Total cost was $315,731 and was completed in October 2001.

3. Operation and Maintenance. In the original DPR, over the 50-year project life the estimated cost was $470,000. From the estimate, an average annual operation and maintenance cost was calculated to be $9,400. This amount included (riprap replacement, levee mowing, erosion repair, water control structure operation, pump station operation, trash rack cleaning, slide gate maintenance, interior ditch debris removal, and tree planting area mowing. Table 3 provides sponsor provided OMRR&R history and cost for the Bay Island HREP.

Table 3. Operation and Maintenance History for the Bay Island HREP

Year	Years in O&M	Actual Sponsor Costs	Activities
2009	17	$13,219	Raise and replace flood damaged pump controls/platform
2014	22	$17,271	Pump Station Repairs

4. History of Major Disturbances. The 1993 Mississippi River Flood caused inundation and subsequent loss of the mast tree plantings, scattered surface erosion, loss of material along the perimeter levee, stone displacement, water control sedimentation, and loss of road surfacing materials. Flooding in 2009 and 2014 also caused damage to the pump station.

5. Ecological Effectiveness. Table 4 summarizes the performance evaluation plan and schedule of Bay Island HREP goals and objectives.

Table 4. Performance Evaluation and Monitoring Schedule

				Monitoring Target Values			
Goal	**Objective**	**Enhancement Measure**	**Units**	**Year 0 w/out Project (1992)**	**Year 23 w/ Project (2015)**	**Year 50 Target w/ Project (2042)**	**Monitoring Schedule**
Enhance Wetland Habitat for Migratory Waterfowl	Provide controlled water levels during waterfowl migration - forested and non-forested. Increase reliable food production area (moist-soil species)	Earthen Levee, pump station, stoplog structures	Acres	40 (uncontrolled)	Not quantified; see Section 4.A for further detail	400	USFWS and MDC will observe the presence of waterfowl annually. The Corps will perform aerial surveys every 5 years.
	Increase mast tree dominance	Mast tree plantings including seedlings and acorns	Acres	6.9	Not quantified; see Section 4.B for further detail	36.9	MDC will observe the survival of plantings annually. The Corps will take a Timber Inventory every 10 years.
	Increase total wetland values for migratory waterfowl	All project features are intended to enhance wetland values	Habitat Units Acres	0.14 99.1	Not quantified; see Section 4.C for further detail	0.62-0.64 420.5-434.0	USFWS and MDC will observe the presence of waterfowl annually. The Corps will perform WHAG Analysis at 1-, 15-, and 50-year intervals.

a. Provide Controlled Water Levels During Waterfowl Migration - Forested and Non-Forested; Increase Reliable Food Production Area (Moist-Soil Species)

General. One of the specific project objectives for the Bay Island HREP was to provide controlled water levels during migration and to increase the reliable food production area. Stoplog structures were installed to rapidly drain summer spring floods to achieve summer growing season drawdowns. The earthen levee was constructed to prevent untimely summer floods that can reduce wetland productivity. The pump station is required to re-flood the site for the fall migration so migratory birds can access the energy rich wetland foods.

Pre- and Post-Project Conditions. The Bay Island HREP provides greater water level management capacity than pre-project conditions. The site does not retain water year-round because there are unidentified agricultural drainage tiles or sand lenses draining water from the site. The bentonite remediation of water supply ditches in 2000 did not resolve seepage problems.

Conclusion. The Project measures were successful in providing the ability to achieve controlled water levels during waterfowl migration - forested and non-forested. There is increased reliable food production area (moist-soil species). Despite the leakage issues in the SWMU, there is adequate water management capacity to maintain water levels during waterfowl migration.

b. Increase Mast Tree Dominance

General. One of the specific project objectives for the Bay Island HREP was to increase mast tree dominance. The mast tree plantings, including seedlings and acorns, were installed to provide food resources for wildlife.

Pre- and Post-Project Conditions. Pre-project conditions for the floodplain forest habitat were typical of river bottom lands. Silver maple was dominant, and floodplain forest habitat was the main component of the total project area.

In order to increase mast tree dominance, four methods of planting pin oaks were employed. These consisted of container grown stock, bare-root seedlings with tree shelter protection, bare-root seedlings without protection, and planting of acorns.

By October 1995, 99% of the container trees, 45% of the acorn seedlings, and 84% of the bare-root trees had survived. Flooding, silt deposition in tubes, and aggressive herbaceous competition such as more than 10 foot tall ragweed were some of the factors for limited survival of the acorn and bareroot stock. In 2000 MDC planted root prune method (RPM) trees in berms in the SWMU, alongside 100 two-year-old bare-root seedlings. In 2003, it was determined that only 12 trees in the original acorn/bare-root planting area (10 acres) had survived. At that time MDC converted the acorn/bare-root area to RPM, and planted pin oaks, pecans, swamp white oaks and persimmon.

A 1996 photo (Figure 3) shows excessive silt in tree tubes after flooding. Additional photos show the container stock planting in 2000, 2004, and 2008. The District has completed periodic reviews of the

mast tree planting area including 2000, 2003, 2004, 2008, and 2013. Rock Island District forestry staff has not taken a detailed inventory in recent years but estimate the survival to exceed 80 percent. Many trees are currently 7 to 10 inches in diameter and are well into canopying over the site. One factor for the survival of the trees was the routine maintenance the site received through MDC mowing.

1996

2000

2004

2008

Figure 3: Rock Island District Site Visit Photos

While mowing is no longer needed in the container stock planting area, yearly observation of the site should be continued. Given the close spacing and the tree species involved, oak wilt will be a concern for the life of the plantings. This species tends to root graft together and the pathogen can infect multiple trees in the stand through root connections. Early detection will be key to ensure the survival of the remaining trees. As the trees age and canopy over the site, periodic timber stand

improvement should be completed to continue the health and maintain the nut production of the remaining trees.

C. Increase Total Wetland Values for Migratory Waterfowl

General. One of the specific project objectives for the Bay Island HREP was to increase total wetland values for migratory waterfowl. All of the Bay Island HREP features were installed to achieve non-forested and forested wetland habitat objectives

Pre- and Post-Project Conditions. Pre-project land cover documented in the DPR shows the Bay Island project area was mostly forested with little open water and no water management capability prior to HREP construction. Land cover data available from the UMRR, LTRM shows a decrease in agriculture and replacement with shrub-scrub or shallow marsh since project implementation. Annual hydrology and refuge management are important determinants of habitat in any year. The period 2003 to 2007 was dry and a larger portion of that could be classified as both agriculture and shallow marsh. Starting in 2008, a wet phase reduced agriculture acres and allowed more shallow marsh acres.

Conclusion. The HREP measures were successful in providing the ability to meet total wetland values for migratory waterfowl. Working at the site demonstrated the subsurface soil variability that can have significant project impacts by effecting water holding capacity and limit management options. The seasonal wetland habitat objectives are achieved by this HREP because it has pumps to flood summertime wetland production to provide food for migratory waterfowl.

LESSONS LEARNED AND RECOMMENDATIONS FOR FUTURE SIMILAR PROJECTS

- Acorn and bare-root planting methods may be difficult to establish in flood prone areas. One should be mindful of flooding chances and how the plantings would be maintained during establishment as part of consideration for another project.
- Continue to utilize container stock for tree plantings. Utilize a variety of species to minimize future risk from tree pathogens and damaging insects.
- The use of this style of tree tube is problematic in flood prone areas due to the potential for increased siltation around the tree. Tube selection and installation on future projects should reflect consideration for flood chances and anticipated performance under flooded conditions.
- Consider the practicality of lifting/operating stop logs for management personnel during the design process. In addition, wood stop logs retain water after prolonged inundation, and the subsequent weight gain makes operations more difficult.
- Based on the adequate water level management capacity, tree survival rates, and total wetland values, it is recommended to discontinue monitoring and Project Evaluation Reporting.

REFERENCES

Definite Project Report (R-8) with Integrated Environmental Assessment, Bay Island Rehabilitation and Enhancement Project, Pool 22, River Miles 311-312, Upper Mississippi River, Marion County, Missouri, March 1990. This report presents a detailed evaluation of alternatives to enhance wetland habitat for resident species and migratory waterfowl. Recommended alternatives include low elevation levees, stoplog structures, pump station, mast tree planting, and access improvements. This report marks the conclusion of the planning process and serves as a basis for approval of the preparation of final plans and specifications and subsequent project construction.

Plans and Specifications, Bay Island, Pool 22, River Mile 311, Upper Mississippi River System, Environmental Management Program, Marion County, Missouri, Contract No. DACW25-91-C-0057. These documents were prepared to provide sufficient detail to allow construction. Project features include two wetland management units surrounded by a 2-year event perimeter levee, water supply pump station, stoplog control structures, mast tree planting and an access road with a bridge.

Plans and Specifications, Post Flood Tree Replanting, Bay Island, Pool 22, River Mile 311, Upper Mississippi River System, Environmental Management Program, Marion County, Missouri, Contract No. DACW25-94-C-0073.

Operation and Maintenance Manual, Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River Environmental Management Program, Pool 22, River Miles 311-312, Marion County, Missouri, September 2002 (O&M Manual). This manual was prepared to serve as a guide for the operation and maintenance of the Bay Island HREP.

Post-Construction Initial Performance Evaluation Report (IPER4F), Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River System Environmental Management Program, Pool 22, Mississippi River Miles 311-312, Marion County, Missouri, December 1999.

Post-Construction Supplemental Performance Evaluation Report (PERS1), Bay Island Rehabilitation and Enhancement Project, Upper Mississippi River System Environmental Management Program, Pool 22, Mississippi River Miles 311-312, Marion County, Missouri, April 2002.