UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
INITIAL PERFORMANCE EVALUATION REPORT

LAKE CHAUTAUQUA
REHABILITATION AND ENHANCEMENT

JULY 2005

LA GRANGE POOL
ILLINOIS WATERWAY,
RIVER MILES 124-128
MASON COUNTY, ILLINOIS

US Army Corps
of Engineers ®
Rock Island District

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT CORPS OF ENGINEERS
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REPLY TO ATTENTION OF:
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Many current and former staff members of the following agencies participated in the planning, design, construction and monitoring of the Lake Chautauqua Rehabilitation and Enhancement Project, and contributed to the development of this Interim Performance Evaluation Manual:

U.S. ARMY CORPS OF ENGINEERS
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US FISH AND WILDLIFE SERVICE
Illinois River National Wildlife Refuge

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UMRS-EMP Long-Term Resource Monitoring Program

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Illinois Natural History Survey

US Army Corps of Engineers ®
Rock Island District

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science for a changing world

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Cover Photo: September 16, 2003 aerial view looking downstream into the lower (south) pool of Lake Chautauqua. Interior drainage channels (Stage IV construction) can be seen in the background. The cross dike and a portion of the upper (north) pool can be seen in the lower right foreground. Photograph by Michelle Horath, Illinois Natural History Survey.

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EXECUTIVE SUMMARY

The Lake Chautauqua Habitat Rehabilitation and Enhancement Project (HREP) was initiated with an approved feasibility study in June 1991. The project was constructed from 1992 to 1999. This HREP involved 4 construction contracts awarded by the U.S. Army Corps of Engineers, Rock Island District (District), for a total of $10,729,137.65, to rehabilitate and enhance fish and wildlife facilities on Chautauqua National Wildlife Refuge. The U.S. Fish and Wildlife Service (USFWS) also performed extensive rehabilitation work during this timeframe, improving features that were not part of the Corps construction contracts.

Lake Chautauqua is a 4,388-acre National Wildlife Refuge (Refuge) and a component of the Illinois River National Wildlife and Fish Refuge complex. The primary fish and wildlife facilities consist of an upper lake of approximately 1,186 acres protected by a 4-mile long levee, and a lower lake of approximately 2,396 acres protected by a 7-mile long levee. The upper lake is spring fed and is managed to function as permanent shallow aquatic habitat for migratory birds and fish. The lower lake is managed to function as wetland habitat with water levels controlled to mimic the seasonal fluctuations of the historic Illinois River floodplain. Project features include improvements to the cross dike and perimeter levees, construction of a pump station that serves both the upper and lower lakes, water control structures in both the upper and lower lakes, drainage channels, riprap or stone erosion protection, access roads, parking area and boat ramp.

Monitoring to assess biological response to construction of project features was initiated in 1991 with pre-construction collection of fisheries and aquatic vegetation data, and with aerial waterfowl surveys conducted annually during spring and fall migration periods from 1991 through 2001. Monitoring of larval fish production in the lower lake was initiated in 1996 and continued through 2000, with more limited data collection in 2001 and 2002. Additional post-construction biological monitoring efforts focused on the response of moist-soil vegetation to enhanced water management capability in the lower lake from 1999 to 2002, and on the use of the project area by a wider range of migratory birds, as measured through weekly year-round ground inventories from 1996 through 2002.

Results of project performance evaluation and biological response monitoring have shown substantial improvements in habitat function and positive changes in migratory bird usage and fish community structure. Increased water management capability in the lower lake has resulted in increased productivity of native moist-soil vegetation and enhanced availability of this and other important food resources for migratory waterfowl and shorebirds. Drainage improvements in the lower lake have helped to prevent outbreaks of avian botulism that previously threatened waterfowl populations and jeopardized Refuge management efforts. Restoration of water control and independent management capability to the upper lake has measurably increased stability of the aquatic habitat and facilitated the establishment of a viable native sportfish community that greatly enhances public use of the Refuge. Construction and operation of

this HREP has helped to ensure that this Refuge—which hosts more than 100 species of migratory and resident birds, including several federally- and state-listed threatened and endangered species—will sustain a high ecological value to the Illinois and Upper Mississippi River system.

Lake Chautauqua was one of the earliest HREPs planned and designed by the District and Environmental Management Program partner agencies. Lessons learned from Lake Chautauqua have been applied to subsequent HREPs and to other ecosystem restoration efforts on the Upper Mississippi River System. Construction in large river floodplain environments with saturated, uncompacted sediments is challenging, but possible. Improvements in developing plans and specifications and preparing construction scopes of work allow contractors to be more aware of the difficulties in working in floodplain environments. Flexibility and ease of operation with reductions in maintenance requirements are now a primary focus of project design efforts. Biological response monitoring does not always result in dramatic and attributable changes to targeted organisms, but can provide useful information on relationships between physical and biological factors, and may sometimes reveal evidence of unanticipated benefits to organisms and communities beyond the original scope of project planning and design.

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I. INTRODUCTION

The Lake Chautauqua Habitat Rehabilitation and Enhancement Project (HREP) was completed as part of the ongoing Upper Mississippi River System Environmental Management Program (EMP). The project was operationally completed in November 1998. The purpose of this Initial Performance Evaluation Report is to:

1) summarize the history and performance of the Lake Chautauqua HREP, based on the project goals and objectives;
2) review the monitoring plan and revise if necessary;
3) summarize project operation and maintenance efforts to date; and
4) review project design and engineering criteria to aid in the development of future projects.

This report identifies original project goals and objectives, reviews planning, design and construction activities, and summarizes available project monitoring data, inspection records, and observations made by the U.S. Army Corps of Engineers, Rock Island District (District) for the period from August 1992 through July 2004.

All the EMP HREPs include a project monitoring plan which outlines proposed strategies and actions to collect water quality, sedimentation, and limited biological data for several years following construction. The collected information is then used to evaluate the project's effectiveness in altering the physical habitat parameters important to waterfowl, fish, or other targeted biological resources. This level of effort, however, falls short of determining whether or not the targeted resources or organisms themselves responded to the habitat alteration. Since performing biological response studies on all HREPs completed to date or proposed for construction would be extremely costly, key projects in the St. Paul, Rock Island, and St. Louis Districts were selected for more extensive biological response monitoring. In the Rock Island District, the selected "bio-response" projects were the Peoria Lake HREP and the Lake Chautauqua HREP.

II. HISTORICAL SUMMARY

A. Project Authorization. The District, in cooperation with the U.S. Fish and Wildlife Service (USFWS) constructed this project with authority granted in the 1985 Supplemental Appropriations Act (Public Law 99-88) and Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662). Financing for this project was 100 percent Federal expense.

B. Project Location The Chautauqua National Wildlife Refuge (Refuge) is a 4,388-acre waterfowl refuge located within the floodplain of the Illinois River north of Havana, Illinois between river miles 124 and 130 in the LaGrange navigation pool (plate 1). The Refuge was created in 1936 with the purchase of an agricultural levee and drainage district that was organized in 1916 and abandoned in 1926 due to recurrent flooding. Lake Chautauqua was formed by a 9-mile perimeter levee and a cross dike that divides the area into an upper lake covering approximately 1,000 surface acres of shallow water and a lower lake of approximately 2,200 acres of seasonally flooded wetland

C. Project Goals and Objectives. Two resource problems and opportunities—Sediment and Turbidity and Water Level Management—were identified through the HREP planning process, which was initiated in 1989 and documented in a Definite Project Report (DPR) with integrated Environmental Assessment completed in June 1991.

The USFWS manages Lake Chautauqua as one of four individual refuges that comprise the Illinois River National Wildlife and Fish Refuges. Primary objectives of the refuges are to provide resting, nesting and feeding habitat for waterfowl and other migratory birds; to protect endangered and threatened species; to provide for biodiversity; and to provide public opportunities for outdoor recreation and environmental education.

1. Sediment and turbidity were identified as the principle resource problems associated with Lake Chautauqua. Results of a 1950 sedimentation analysis (Stall and Melsted, 1951) indicated that Lake Chautauqua was filling in at a rate of 0.38 inches per year. A second analysis of sedimentation in the lake from 1950 to 1976 (Lee, 1976) concluded that the sedimentation rate during the study period was 0.3 inches per year. A study of turbidities due to wind and wave action and fish activity (Jackson and Starrett, 1959) concluded that these factors contributed to degraded water quality in the upper lake, and also concluded that important waterfowl food plants had been adversely affected by a combination of sedimentation and severe flooding.

2. Water level management was another identified resource problem. Deficiencies of the original levees and water control structures limited the ability of the USFWS to manage water levels and drastically reduced waterfowl food plant production on the Refuge. The Corps and the USFWS focused on rehabilitating deteriorated management infrastructure and addressing overall Refuge management goals in formulating the HREP goals of enhancing waterfowl habitat and enhancing fisheries habitat.

The original project goals, objectives, proposed features, and enhancement potential are listed in table 1. Project objectives identified during the planning process were:

1) to increase the area of reliable food plant production for waterfowl, focusing particularly on the category of native plants referred to as “moist soil” species;

2) to create flowing side channel and deepwater slough habitat for fish; and

3) to reduce sedimentation. Improvements to water control infrastructure (levee rehabilitation and pump station construction) and construction of barrier islands in the upper lake were potential features evaluated to meet the waterfowl habitat objective. Excavation of the Liverpool Ditch side channel and raising the perimeter levee above the minimum management plan requirements were potential features evaluated to meet fisheries habitat objectives.

D. Summary of Planning and Design. The Corps and the USFWS formulated and evaluated design alternatives to meet identified project goals and objectives. Additional information on planning considerations and design details and modifications can be found in the 1991 DPR and the 1996 Flood Repair Design Memorandum prepared by the Corps. Several features were recommended in the original recommended plan for the Lake Chautauqua HREP. Two of the evaluated alternatives were not constructed. A summary of these features is shown in table 2.

Table 1. Original Project Goals and Objectives

Goals	Objectives	Features	Units of Measure	Enhancement Potential: Without Feature	Enhancement Potential: With Feature
Enhance Waterfowl Habitat	Increase reliable food production area (moist soil species)	Provide Water Control (Upper and Lower Lake)	Acres of Submergent/Emergent Vegetation	200	3,250
		Barrier Islands (Upper Lake only) [1]	Acres of Submergent Vegetation	0	300
		Side Channel Excavation [2]			
Enhance Fisheries Habitat	Create flowing side channel and deepwater slough habitat [2]	Raise levee above minimum management plan requirements [1]	Surface Acres of Flowing Side Channel [2]	0 [2]	10 [2]
	Reduce sedimentation		Annual Acre-Feet of Sedimentation [1]	100 [1]	50 [1]

[1] Not included in recommended plan
[2] Included in recommended plan but not constructed

Table 2. Project Features

Feature	Original Recommended Plan	Stage of Construction
Raising approximately 3.8 miles of the upper lake levee and cross dike to a 10-year level of protection from Illinois River flooding	x	1, 2
Modifying the existing radial gate structure to function with the increased level of protection	x	1
Providing a pump station with 41,000 GPM capacity to improve water level management capability for the upper and lower lakes	x	1, 2, 4
Providing gated gravity outlets for the upper and lower lakes	x	1, 2
Constructing a boat ramp for upper lake management purposes	x	2
Excavating a selected reach of side channel adjacent to the lakes (Liverpool Ditch)	x	NA
Constructing a side channel entrance closure structure	x	NA

E. Construction - Stages 1 through 4. The Corps administered and supervised four contracts—designated Stages 1 through 4—to construct the Lake Chautauqua HREP. The USFWS also conducted substantial construction to improve the lower lake levee, overflow structures, and the upper lake levee by placing riprap along erosion prone areas.

Stage 1 contract, awarded on July 31, 1992, included modifications to the existing radial gate structure in the upper lake to make it functional to a higher elevation, repair of the cross dike levee, and rehabilitation and raising of the upper lake levee. Excessive flooding on the Illinois River in May and June 1996 delayed the project and substantially increased construction costs. The floods also caused the failure of the levee adjacent to the radial gate structure, displacing the structure into a scour hole created by the levee failure. The Corps prepared a Design Memorandum to study repair alternatives. As a result of this analysis, the design height of the levee was lowered to 447.0 (from 449.0 as originally recommended in the DPR) and original design criteria were modified and redefined. A new water control structure was designed to replace the original radial gate structure. This new structure is a steel sheet pile cellular structure containing three 10 by 10 foot heavy duty sluice gates.

Stage 2, awarded on July 31, 1997, included the construction of the cellular water control structure and required the contractor to finish other incomplete features of the project. The Stage 2 contract also experienced some flood delays. To compensate for these delays and complete the project in November 1998, the earthwork on the cross dike levee was changed. Rather than complete the upper lake levee slope and drainage channel excavation, reinforcing slopes with riprap was pursued. The contractor graded the slope and placed riprap bands in vulnerable locations on both the upstream and downstream slopes of the cross dike levee. The drainage ditch was not completed. There was no net increase in project cost for this change. The USFWS agreed to complete the drainage channel if and when needed.

Stage 3 construction contract was awarded on April 3, 2000. This contract included placement of riprap along the riverside slope of the perimeter levee, about 1,000 feet from the cellular water control structure. The riprap band is about 450 feet long by 35 feet wide. The purpose of this riprap is to protect a portion of the perimeter levee that was susceptible to wave fetch from the north when river levels were high. Most of the perimeter levee's riverside slope has sufficient growth of vegetation to break up waves. The original HREP design did not include upgrade of the riverside slope.

Stage 4. During hot dry summer months when the lower lake is dewatered to allow moist soil vegetation to grow, the Refuge typically has problems with outbreaks of avian botulism. The USFWS manages the outbreaks to minimize bird loss; however, the USFWS and Corps concluded that the potential for outbreaks could be reduced by increasing drainage in the lower lake. The Stage 4 contract was awarded on July 10, 2001, to extend the existing drainage channel, Stage 2, through the lake. This action allowed more complete dewatering and also increased the moist soil production area.

USFWS Construction. The USFWS at Lake Chautauqua managed and constructed their own project to upgrade the levee system around the lower lake. The levee upgrade consisted of raising approximately 5.2 miles of levee to elevation 443.5 feet and increasing the levee cross section. The average top width of the improved levee is about 16 feet, and the average slopes are flatter than 5 horizontal to 1 vertical. The levee includes two overflow structures, each

700-feet long. The overflow structure crest at the lower end of the project is at elevation 441.2 feet, providing protection just below the 50 percent probability of overtop in any given year or the 2-year event. The project was completed in 1999. The District developed as-built drawings of the lower lake levee and performed a required state inspection of the entire Refuge in August 1999.

Operation and Maintenance. A draft Operation and Maintenance Manual was prepared in June 1999. The manual was finalized in April 2005.

III. DESCRIPTION OF PROJECT FEATURES

A. Project Data. Features constructed for the Lake Chautauqua HREP were designed to restore degraded ecosystem functions and to repair and enhance the infrastructure to allow USFWS to more effectively manage the Refuge to benefit wildlife and fish.

The Illinois River's natural cycle of spring flooding and summer drying has been greatly altered by human activities during the last century. Raising and repairing the perimeter levee structure along the north, west, and south sides of Lake Chautauqua provides greater protection against unseasonal flood events and allows the Refuge to be managed to more effectively re-create the historic natural river cycle. The repaired and strengthened cross dike restored the capability for independent management of the upper and lower lakes. This allows the Refuge to provide greater benefits for a wider range of wildlife and fish species. Replacement of the boat ramp provides better lake access for Refuge staff to conduct operation and maintenance activities. The ramp is also available for public use.

The new pump station allows the USFWS to dewater the lower or upper lake or to direct inflow from the upper lake into the lower lake or from the river into the lower lake. The pump station also improves water management flexibility by allowing gravity feed or forced flow. The new stoplog water control structure was constructed for gravity drainage and incremental water control of the lower lake. The sheet pile cellular water control structure (built to replace the original radial gate) in the upper lake affords upper lake water control. The cellular structure can quickly flood the upper lake in the event of expected levee overtop and can also be used to gravity drain the upper lake or provide incremental water control.

The lower lake provides a low level of protection from the river (2 year event) and will primarily be operated as a seasonally flooded impoundment (moist soil unit). The upper lake provides a higher level of protection (5 year event) and will primarily be operated as a stable lake habitat. This provides year-round habitat for fish as well as feeding and resting areas for waterfowl. Flooding of the lower lake but not the upper lake during the growing season may reverse the normal operating plan. The USFWS has the capability to dewater the upper lake and operate it as a moist soil unit. Since project completion, the upper lake has not been operated as a moist soil unit.

The following paragraphs provide summary descriptions of individual project features. More detailed information on project features is included in the Operation and Maintenance Manual. Table 3 presents a summary of project data. A general description of the overall project and specific project features follows the tabular summary.

Table 3. Project Data Summary

Item	**Quantity/ Measurement**	**Remarks**
Cross Dike Levee		Divides upper and lower lake
Embankment Fill	150,000 cy	
Length	4,950 ft	
Crown Elevation	449.1 ft(NGVD)	Surfaced with crushed stone
Side Slopes	6:1	Lower Lake side of levee
	4:1	Upper Lake side of levee
Northern Perimeter Levee		Separates upper lake from river
Embankment Fill	200,000 cy	Strengthened and raised existing levee
Length	15,500 ft	
Effective Crown Elevation	447.0 ft	Station 25+00B to 55+00B. Remainder of levee was constructed higher to control area of overtop and provide for expected consolidation.
Side Slopes	4:1	Constructed to inside or lake side or existing levee
Sheet Pile Cellular Water Control Structure		Provides water control for upper lake
Main Cells	4 each	74.0 ft diameter, top elevation 452.0 ft, driven to bedrock, EL 400
Arc Cells	3 each	Top EL 430.0 ft, Supports flood wall and gates
Heavy Duty Sluice Gates	3 each	10 ft by 10 ft operator controlled sluice gates, sill EL 430.5 ft.
Aluminum Stop Logs/Jib Crane		Purchased for 1 gate only to control upper lake level and assist with gate
Top elevation of Bridge Decks	454.0 ft	3 concrete beam and deck bridges
Bridge Load Capacity	HS 20	
Pump Station		Provides water control for upper and lower lakes and is connected to the river
Submersible Pump	1 each	41,000 GPM at 8.2 TDH. 25,000 GPM at 21.0 TDH Pumps from lower floor to upper floor of pump station

Table 3. Project Data Summary

Item	Quantity/ Measurement	Remarks
Sluice Gates	6 each	5 feet x 5 feet. Control pump inlet and outlet locations
Operating Elevations		
Upper Lake	430 to 440 MSL	
Lower Lake	430 to 440 MSL	
Sump floor elevation	424.0 MSL	
Electric power source with equipment on raised platform	250 HP	3 phase, buried in cross dike levee
Intake Tubes/Trash Racks	3 each	3 ea; 5ft by 5ft cast in place concrete tubes supply the pump station and connect the upper lake, lower lake, and the river
Stoplog Water Control Structure		Provides water control for the lower lake
Concrete with Stoplog Slots	4 bays	Each bay is 5 ft wide
Invert or Sill	429.0 ft	
Top Elevation of Bridge Deck	442.6 ft	
Drainage Channels		
Lower Lake	7,000 LF, bottom elevation 429.0 ft	2 channels facilitate lake dewatering to the stoplog structure and the pump station
Upper Lake	4,000 LF, bottom elevation 425.0 ft	Facilitates dewatering of the upper lake. North side cross dike levee.
Liverpool Ditch	2,500 LF, bottom elevation 419.4 ft	Feeds pump station and provides deep water habitat

Table 3. Project Data Summary

Item	Quantity/ Measurement	Remarks
Access Road, Parking Area, and Boat Ramp		Provides access to boat ramp and pump station. Crushed stone surface.
Road Length	1,220 ft	
Width	30 ft including shoulders	
Parking Area	50 ft by 300 ft	Located on cross dike levee near boat ramp.
Boat Ramp	Concrete, 16 ft wide, 13.6% slope	Provides boat access into upper lake
Riprap Closure Structure		Reduces flow into Liverpool Ditch and reduces sediment inflow
Riprap	1,366 tons	
Weir Width	15 ft	
Weir sill elevation	426.0 ft	Flat pool is EL 429.4 ft; (Gage zero = EL 424.4 ft)
Riprap Levee Reinforcement		
Access road	600 LF	Protects sand embankment from lower lake wave wash
Parking Area, Boat Ramp	Levee protection; both sides of levee	Protects boat ramp, parking area and guard rail from erosion damage
Pump Station	Intake areas and around sumps	Minimizes erosion into sump areas
Perimeter Levee Near Closure Structure	300ft by 60ft band along outside of levee	Prevents levee scour along erosion prone area near river inlet
Stoplog Structure/Cellular Structure	Protects adjacent levee	
Cross Dike Levee Upper Lake Side	18 ft band, EL 437 to 441, 3H:1V, Riprap placed on filter fabric	Protects levee and eliminated additional earth work to flatten slopes
Cross Dike Levee Lower Lake Side	10 ft band near upper portion of levee, Riprap placed on bedding	Protects levee from wave wash erosion

Table 3. Project Data Summary

Item	**Quantity/ Measurement**	**Remarks**
Perimeter Levee Down from Cellular Structure	400 ft by 30 ft; Riprap placed on nonwoven geotextile fabric	Protects area of levee from north wind. Area does not have tree growth to break wind fetch
Lower Lake Levee	USFWS Project	Protects the lower lake from River levels up to 441.2 ft
Length	31,000 Feet	USFWS reconstructed this levee. 8,600 LF is new levee (Set-back), and 19,000 LF was reinforced and raised.
Crown Elevation	443.5 Feet NGVD)	Surfaced with crushed stone
Spillways	2 spillways each 700 ft long	Lower spillway is at EL 441.2 ft, Upper spillway is at EL 442.0 ft.
Side Slopes	5.4:1	Riverside of levee (Average slope)
	5.7:1	Lakeside of levee (Average slope)
Water Control Structure (Existing)	3 by 3 concrete box culvert	Connects Quiver Creek
	Sluice gate control	
	433.0 ft	Invert elevation
Quiver Creek Dam (Existing)	Controls flow through Quiver Creek	Used to back up water in Quiver Creek and allow diversion of water through the 3 by 3 water control structure.

B. Cross Dike Levee. The repaired and improved cross dike structure creates two separate pool areas in Lake Chautauqua. The 10-year flood elevation for the project site is elevation 449.1 feet MSL, which represents the elevation of the cross dike levee. The top width is 15 feet wide to provide sufficient room for frequent vehicular access. Granular surfacing provides access during wet conditions. The lower lake side slope is constructed at a 6H to 1V side slope and seeded to minimize wave wash erosion. The upper lake side slope is constructed at a 4H to 1V side slope. The upper lake side has slightly less wind fetch and is somewhat sheltered from the predominant wind direction. The lake bottom gradually rises near the levee toe to about elevation 435. The levee is approximately 14 feet high. The cross dike levee was originally constructed from sand. The new construction levee fill that encapsulates the sand core is clay material and is more resistant to erosion.

C. Northern Perimeter Levee. The 5-year flood elevation for the project site is elevation 447.0 feet MSL, which represents the elevation of the overflow reach of the levee, approximately 3000 feet in length. The project is designed to allow a future raise of the perimeter levee to the 10-year level. The 1996 Flood Repair design memorandum recommended lowering the levee to the 5-year event as a cost saving feature. The top width of the perimeter levee is 12 feet. The interior side slope is 4H to 1V. The exterior side slope was left in its natural state to minimize disturbance and construction induced erosion. The original levee consists of clay and sand fill. The new construction consists of clay fill. Most of the fill was obtained from adjacent lake bottom borrow. The average height of the perimeter levee is approximately 13 feet.

D. Sheet Pile Cellular Water Control Structure. This structure provides water control for the upper lake. It consists of 4 main sheet pile cells approximately 74 feet in diameter with a top elevation of 452.0 feet. The main cells are connected with 3 arc cells. The arc cells are built at a lower elevation of 430.5 feet. Within each arc cell, an H-pile supported concrete cap supports a 10 ft by 10 ft heavy duty sluice gate and associated flood wall. Bulkhead slots can be filled with aluminum stop logs. The stop logs are used to control upper lake water levels or can be closed for gate maintenance. The project included a truck mounted jib crane used to install and remove the stop logs. During an impending flood, the gates can be opened and the interior flooded to equalize water levels and prevent costly erosion damage.

E. Pump Station. The pump station is located on the cross dike levee at the intersection of the upper lake, lower lake and the river. The power lines that feed the pump station are buried in the cross dike levee. The gate controlled pump station allows dewatering or filling capability from or to the upper lake, lower lake, or the river. Water flows through 1 of 3 trash racks, a 5 ft by 5 ft concrete box culvert, and a 5 ft by 5 ft sluice gate into the lower floor of the pump station. The culverts, gate openings, and pump station sill are at elevation 424.0 feet. The pump is a 41,000 GPM, single stage, submersible, propeller pump driven by an integral 250 Hp 3-phase motor. It pumps the sump inflow to the upper floor where it exits through an upper gate into 1 of the 3 box culverts. The pump is manually initiated and will operate automatically to maintain either lake in a dewatered condition between elevations 428.0 and 430.0. The pump was sized to evacuate the lower lake in approximately 30 days. The gates and culverts also allow gravity fill.

F. Stop Log Water Control Structure. The stop log water control structure is located at the south end of the lower lake. The water control structure consists of four 5-foot wide stop log bays. The sill of the structure is at elevation 429.0 feet. The upper level of protection is elevation 442.0 feet. The primary purpose of the water control structure is to incrementally control lower lake water levels. It is also used to gravity drain the lower lake which is why the sill is lower than the bottom of the lake. During an impending levee overtop, stop logs can be removed to expedite filling of the lower lake;

however, under normal conditions the two new overflow spillways have sufficient inflow capacity and the stop log structure is not needed to equalize water levels prior to levee overtop.

G. Drainage Channels. Two drainage channels were initially constructed in the lower lake to facilitate dewatering. Later, these channels were reshaped and connected during Stage IV construction. The new channel is approximately 19,000 feet long and connects the pump station at the north end of the lower lake to the stoplog structure at the south end of the lake. This channel is 15 feet wide with a dredged bottom elevation of 429.0 feet. A channel on the outside of the perimeter levee at the upper end of Liverpool Ditch was excavated to provide a direct feed from the river to the pump station. This channel was excavated 35 feet wide with a bottom elevation of 419.4 feet.

H. Access Road, Parking Area, and Boat Ramp. The access road is approximately 1,200 feet long and 24 feet wide. The access road connects a Refuge road to the cross dike levee for both site access and maintenance activities. The eastern end of the cross dike levee was widened to 50 feet to provide a parking area connected to a new boat ramp to allow access into the upper lake. Two turn-around circles facilitate boat launching and parking along the edge of the levee. Both the access road and cross dike levee have granular surfacing to allow all-weather access and minimize maintenance.

I. Rock Weir and Riprap Reinforcing. The entrance to Liverpool Ditch side channel at its upstream junction with the river channel was reinforced and reduced in size with the construction of a rock weir and bank protection. The weir has a sill 15 feet wide at elevation 426.0 feet. The upper portion of the weir is approximately 50 feet wide at elevation 429.4 feet. The purpose is to minimize river channel silt from entering the side channel and to control the amount of inflow. It has a secondary purpose of stabilizing the river banks where the river enters Liverpool Ditch. Riprap reinforcing was also added to the riverside slope of the perimeter levee across from the weir. This area was eroded due to incoming flow from the river during high river stages. The riprap area is approximately 300 feet long by 60 feet wide.

Riprap was placed around the boat ramp and parking area on the cross dike levee to minimize maintenance and protect these structures. Riprap around the pump station area is intended to minimize wave wash erosion to prevent excess sediment from entering the pump station sump. Two riprap bands were placed on each side of the cross dike levee. The upper lake slope has a band of riprap near the levee toe to protect the levee from wave wash during high winds. Riprap on the lower lake slope of the levee is placed fairly high on the levee slope. At the higher elevation, wave height can be significant. At lower water elevations, the lower depth and wind blocking effects of the vegetation prevents more erosive waves from forming. Riprap was also placed at the cellular structure and the stop log structure to tie the structures into the levees. The stop log structure has riprap placed at the inlet and outlet to minimize erosion from water flow through the structure. A riprap blanket was placed on the exterior of the north perimeter levee about 1,000 feet west of the cellular structure.

IV. BIOLOGICAL MONITORING OF CONSTRUCTED FEATURES RELATIVE TO PROJECT GOALS AND OBJECTIVES

The project goals included enhancing waterfowl habitat and enhancing fisheries habitat. To monitor that these goals were achieved, vegetation, waterfowl, and fisheries were monitored before and after construction was completed.

A. Pre-Construction Biological Monitoring. The Lake Chautauqua HREP was one of two Rock Island district EMP projects selected for intensive pre- and post-biological response monitoring (Peoria Lake HREP was the second). Pre-construction biological response monitoring at Lake Chautauqua began in 1991. Fisheries and vegetation monitoring was conducted by staff of the Illinois Natural History Survey (INHS) at the Long-Term Resource Monitoring Program (LTRMP) Field Station in Havana, Illinois. Waterfowl monitoring was conducted by staff of the INHS' Forbes Biological Station near Havana. Initially, a plan was developed and initiated to use standard LTRMP sampling protocols for monitoring fish communities. Due to changes in project schedules and designs, sampling problems, and requests for additional data collection, numerous modifications and adjustments were made to original monitoring objectives and sampling designs. Preconstruction monitoring activities summarized in the following paragraphs are discussed in greater detail in supporting documents referenced in Appendix E.

1. Vegetation. Aerial photography for Lake Chautauqua was flown during October 1992. Photo delineation and ground-truthing was not completed during 1993 because of flood conditions that prevailed throughout much of the year. Similarly, routine LTRMP aerial photography of LaGrange Pool including Lake Chautauqua was not carried out because of persistent high water conditions and the resulting limited moist soil and aquatic plant communities. Aerial photography of the project area was flown in 1995 and mapping of photointerpreted vegetation data was completed in 1996; however, because construction of the lower lake levee and water control structure were largely completed prior to the date the photography was flown, this information (for the lower lake) is considered more relevant to post-construction conditions.

2. Migratory and Resident Bird Species. Aerial waterfowl inventories of the Lake Chautauqua HREP site were conducted by staff of the Forbes Biological Station, Illinois Natural History Survey, in conjunction with their annual fall and spring aerial inventories of the entire Illinois River corridor. Inventories were conducted from light aircraft flying at low levels. These aerial inventories recorded estimated numbers of ducks, geese, mergansers, coots, eagles, and pelicans. Inventoried species are listed in table 4. Pre-construction inventories of the HREP site were initiated in the fall of 1991 and continued on an annual basis throughout the pre-, during- and post-construction period until 2000. Inventories were generally made on a once-weekly basis during the fall (September-January) and spring (February-April) migration periods.

The HREP site was subdivided into two inventory areas, the upper (north) pool and the lower (south) pool. Inventory data (number of each species observed) was tabulated by date for each area and totaled for the entire site. The data was also summarized in tabular form displaying the peak (highest number counted for all inventories) population count by species for each area and also for the entire site. The peak number for the entire site may not represent the sum of the peaks for both areas because the peak number in each area may have occurred on different flight dates.

Table 4. Aerially-Inventoried Waterfowl and Other Bird Species (Pre-construction Monitoring)

Dabbling Ducks	Mallard
	American black duck
	Northern pintail
	Blue-winged teal
	Green-winged teal
	American widgeon
	Gadwall
	Northern shoveler
Diving Ducks	Lesser and greater scaup
	Ring-necked duck
	Canvasback
	Redhead
	Ruddy duck
	Common goldeneye
	Bufflehead
	Lesser and greater scaup
Mergansers	Common merganser
	Red-breasted merganser
	Hooded merganser
Geese	Canada goose
	Snow goose
Coots	American coot
Bald eagles	Adult
	Immature
Cormorants	
Pelicans	

3. Fisheries. Specific monitoring objectives for fisheries response to HREP construction included assessing changes in fish community composition and structure, and overall condition of the fishery based on pre-construction and post-construction data collection.

4. Data Collection Methods. Several types of collecting gear were employed in response monitoring. Standardized fish collection gears were used during both pre-construction and post-construction sampling periods following standard LTRMP protocols and typically included day electrofishing and fyke netting. Gill nets also were used to further sample open water areas. Fish were identified to species in the field and measured for total length.

5. Sampling Parameters. A subsample of target management species (bluegill, black crappie, fathead minnow, largemouth bass, and channel catfish) was weighed during fall sampling. Several basic water quality parameters were also measured: conductivity (S/cm), dissolved oxygen or DO (mg/l), secchi disk (cm), turbidity (NTU), and water temperature (C), following LTRMP protocols. The sampling time design targeted a spring/early summer (June 15-July 31), summer (August 1-September 15), and fall (September 16-October 31) sampling schedule to document seasonal habitat use and recruitment among other aspects of the fish community. Recording and analysis of data included number and species of fish collected, catch per unit effort by species and gear type, and age and length distribution of several target species.

6. Sample Locations. A summary of preconstruction sampling is shown in table 5.

Table 5. Fisheries Sample Locations

Sample Location	1991	1992	1993
Shoreline Near Cross Dike (North Pool)	x	x	x
Open Water near East Side of North Pool	x	x	x
Shoreline Near Northern Gate Structure	x	x	x
Shoreline Along West Side of North Pool	x	x	x
Liverpool Ditch Side Channel	x	x	Not conducted
Rice Lake Reference Site	x	x	Not conducted
Snicarte Slough Reference Site	x	x	Not conducted

Pre-construction sampling was conducted annually during the 1991-1993 time period. Similar pre-construction monitoring efforts were also being conducted at the Peoria Lake HREP during this time period, as well as the ongoing long-term resource monitoring within the LaGrange Pool. In 1991, data was collected at four sampling sites within what would become the north pool following construction: shoreline near the cross dike, in open water near the east side of the north pool, shoreline near the northern gate structure, and shoreline along the west side of the north pool. The fifth sampling site was located within the Liverpool Ditch side channel. Control or reference sites were originally proposed to be in Rice Lake (for the north pool sites), and Snicarte Slough (for the Liverpool Ditch site).

Sampling could not be initiated until August of 1991 and drawdown conditions in Lake Chautauqua during that season limited the amount of sampling that could be completed. Sampling continued at the five sites during 1992, although low water levels again limited the amount of sampling completed. Sampling at the Rice Lake and Snicarte Slough reference sites was also conducted during 1992. Major flooding during 1993 resulted in persistent high water levels on the Illinois River severely limited the amount of sampling that could be conducted, and adversely affected monitoring conditions and efficiencies when sampling could be undertaken. Nevertheless, fish community sampling was conducted during the spring of 1993 until rising flood levels required suspension of efforts. One new sampling site was added to the community sampling effort. This site was located in the (planned) south pool and was intended to act as a reference for comparison after complete isolation of the north pool. After water levels dropped in August, sampling efforts were redirected to collection of three target species for age and growth analysis. The age and growth sampling was conducted at only one of the original fixed sites, but eight additional shoreline were added to potentially increase the numbers of the target species collected. Sampling at the Liverpool Ditch, Rice Lake, and Snicarte Slough sites was not conducted in 1993. Sampling efforts under the original monitoring plan were suspended until after completion of construction activities in the north pool (in 2000).

7. Sample Results. Preconstruction sampling efforts from 1991 through 1993 collected a total of 12, 276 adult fish representing 45 species and 2 hybrids. Numerically, gizzard shad were the most abundant species collected (5037), followed by freshwater drum (2744), bluegill (1145), common carp (745), brown bullhead (399), black crappie (394) and white bass (368). The greatest number of individuals (4653) were collected during 1991 sampling; however, the highest species diversity (43 species and 2 hybrids) was recorded during the 1993 sampling year. The higher species diversity observed during 1993 could be attributed at least in part to the overtopping of the levee which allowed fish from the Illinois River to enter the impounded area before and during sampling.

B. Post-Construction Biological Monitoring. The following paragraphs are excerpted from reports referenced in Appendix E summarizing post-construction biological monitoring efforts.

1. Vegetation

a. North Pool Aquatic Vegetation. Little submergent or emergent vegetation was present in the north pool during the pre-construction monitoring period (1991-1993). Post-construction monitoring of submersed aquatic vegetation (SAV) and rooted floating-leaved vegetation was initiated in 2000 following completion of HREP construction and continued in 2001 and 2002. Data was collected at 42 sites (37 in the north pool, 5 outside) following LTRMP stratified random site sampling methods. Transect sampling of the north pool consisted of 2 transects, one parallel with the east shoreline extending the length of the lake, and one perpendicular to the shoreline extending to the west bank. Sampling sites along transects were at estimated intervals of 100 meters. In addition to the stratified random site and transect sampling, informal surveys of the north pool were made throughout the growing season.

Submersed aquatic vegetation encountered in both the north pool and adjacent sites was minimal during post-construction sampling. Results of informal surveys and transect sampling were similar to the stratified random sites in 2000. Lotus (*Nelumbo lutea*) was found in low numbers (<30 plants) during informal surveys, usually as individual plants at offshore locations and predominately in the northeast corner of the lake. One submergent species, slender pondweed (*Zannichellia palustris*) was found during sampling along the perpendicular transect. These findings were similar to results of sampling other contiguous backwaters in the same reach of the Illinois River (Rice Lake and Big Lake, RM 135.0) in 2000.

While construction and management of the HREP has provided more stable water conditions in the north pool that should be favorable to plant germination and growth, permanent stands of aquatic vegetation have yet to become established. The presence of two species of aquatic plants within the upper lake two years after completion of the HREP suggest that the return of submersed aquatic vegetation is still possible. However, the findings within Lake Chautauqua were similar to monitoring results in contiguous backwaters in the same region of the Illinois River (Rice Lake and Big Lake) in 2000. Several possible limiting factors may contribute to the lack of improvement in aquatic vegetation coverage within Lake Chautauqua and other contiguous backwaters of the Illinois River. Potential limiting factors include wind and wave action, presence of invasive herbivorous fish such as grass carp, seed bank limitations, water quality, and flood events.

a. South Pool Emergent ("Moist Soil") Vegetation. Staff of the Forbes Biological Station of the INHS monitored the post-construction vegetative response to water level management in the south pool for a period of 4 years (1999 to 2002). Monitoring efforts focused on evaluating the effects of the timing of drawdown on the diversity and density of moist-soil plants and the resulting use by waterbirds in and adjacent to Lake Chautauqua to provide information for optimizing habitat management. Analysis of collected data included calculation of plant stem density and seed production for 18 common waterbird food plant species found in the south pool. Vegetation cover maps of the south pool also were produced for each of the three sampling years. Vegetative response to water level fluctuations in an adjacent unmanaged and unprotected area outside the levee (labeled the "setback site" in supporting documentation) was monitored during the same period for purpose of comparison to the HREP.

Stratified random sampling techniques were used to sample vegetation in the south pool and the setback site based on the size of vegetative zones. Line transects were established along the north and south levees of the south pool (24 total) and along the east side of the setback site (6 total). Due to standing water or lack of vegetation, several transects were not sampled in 2000 and 2001. Covermapping was initiated after drawdown and 3 to 5 weeks after plants had germinated, generally in late August or early September. Sampling of vegetation was initiated after the majority of plants had matured, generally coinciding with the first frost in October and lasting 2 to 3 weeks. Species diversity and density were identified within each sampling plot, and representative specimens of the 18 food plant species were collected for determination of seed production. In addition to the plant species targeted for density and seed production data collection, any other plant species encountered during sampling was identified and added to the species list for the site.

The timeline of drawdowns in the south pool during post-construction monitoring is summarized below in Table 6. During the study, the timing of drawdown depended on Illinois River stages. Because water levels in the south pool are generally lowered by gravity drainage, the river's level must be lower than that in the south pool to complete the drawdown. High river stages during spring and early summer in all three years of the sampling period prevented drawdown from being initiated before July of each year. In 1999, drawdown was initiated on 13 July, mudflats began appearing on 16 July, and drawdown was completed on 19 July (4 days), considered a fast, midseason drawdown. In 2000, a fast, late-season drawdown began on 25 July, mudflats began to appear on 26 July, and drawdown was completed by 4 August (10 days). In 2001, the drawdown began on 26 June, mudflats appeared on 5 July, and drawdown was completed by 23 July (19 days), making it a slow, mid-season drawdown.

Table 6. Drawdown Timeline for Chautauqua South Pool 1999-2002

Year	Category	Start Drawdown	Expose Mudflats	Drawdown Complete	Acres Exposed
1999	fast mid-season	7/13	7/16	7/19	1,494
2000	fast late-season	7/25	7/26	8/04	1,321
2001	slow mid-season	6/26	7/5	7/23	2,102
2002	slow mid-season	7/5	7/11	7/25	2,287

In 2002, the Illinois River at Havana experienced its fourth highest flood stage in recorded history, resulting in overtopping of both the lower and upper lake perimeter levees. High river stages prevented initiation of the south pool drawdown until 5 July. On 11 July, the first mudflats appeared in the upper end of the south pool, and the lowest lake level achievable without pumping (431.2 msl) was reached on 25 July. The 2002 drawdown was considered a relatively slow, mid-season drawdown. The following sequence of four photographs illustrates conditions observed at a single photopoint in the south pool.

Photograph 1. North End of South Pool 1 Week After Start of Drawdown (First Exposure of Mudflats), July 18, 2002

Photograph 2. North End of South Pool 3 Weeks After Start of Drawdown, August 1, 2002

Photograph 3. North End of South Pool 5 Weeks After Start of Drawdown, August15, 2002

Photograph 4. North End of South Pool 8 Weeks After Start of Drawdown, September 5, 2002

The abundance and seed production of moist-soil plants is a function of the total area capable of supporting such vegetation (specifically, dewatered and unshaded mud flats not dominated by herbaceous perennial or woody vegetation). A total drawdown of the south pool (all water drained from the surface) was not accomplished in any of the three years of study. However, a complete drawdown was nearly impossible without ideal weather conditions and river stages. In 1999, about 324 ha (800 acres) of open water remained after drawdown. In 2000, over 394 ha (973 acres) of open water remained after the late drawdown. In 2001, conditions were near optimal for drawdown and all be 80 ha (198 acres) were dewatered. The varying amounts of open water resulted in differences in the amount of exposed mudflats for moist-soil plant production. The total area available for moist-soil plant colonization in the 1999-2001 period was 605 ha (1494 acres), 535 ha (1321 acres) and 851 ha (2102 acres), respectively. In 2002, the total area available for moist-soil plants after 25 July was approximately 926 ha (2287 acres). However, on 23 August 2002 a 3-4 inch local rainstorm re-flooded a large area in the center of the lake for about a week, killing approximately 300 ha (741 acres) of vegetation.

Management of the northeast and northwest corners of the south pool was conducted throughout the 4 years of the sampling period to control the growth of willows and cocklebur. The northeast management area was the largest and consisted of about 89 ha (220 acres). In the summer of 1999, the northeast area was mowed to remove dominating willows. In the fall of 2000, much of the area was mowed again, but a small patch in the northeast corner was treated with herbicide. In 2001, time constraints prevented mowing, but the south side of the management area was chemically treated in the fall of the year. The northwest management area, about 40 ha (100 acres) in size, was mowed in the fall of 1999 and treated with herbicide in the fall of 2000, then mowed again late in the summer of 2001. Although willows were controlled in both management areas, cockleburs continued to flourish.

The setback site experienced a late season/fast drawdown in 1999 and 2000 and a mid-season/fast drawdown in 2001. These fast drawdowns were not conducive to moist-soil plant production. Analysis of variations in stem density and seed production between the south pool and the setback site indicated that seed production in the south pool consistently exceeded that of the setback site, whereas cocklebur stem densities were consistently higher in the setback site. Results for the setback site also emphasize the importance of controlling willow growth in the south pool. Willows are quickly overtaking the setback site and out-competing moist-soil vegetation. Willows are rarely affected by spring floods and thrive in unmanaged areas of the Illinois River floodplain.

The vegetation response and how this is shown as a food source for birds is summarized in Table 7 and described following the table.

Table 7. Vegetation Response

Year	Total Seed Production	Best Species	Potential DUDs (# seeds x GE/E)	Potential DUDs (using TME)	Observed DUDs	SUDs	Covermapping
1999	176,000 kg	Redroot	7.8M	4.5M	4.1M	?	?
2000		Teal grass	2.7M	1.6M	3.5M	?	?
2001	1,000,000 kg	Hooded arrowhead	17.4M	9.5M	5.3M	?	?

A projection of the total amount of seeds produced by monitored food plants during 1999-2001 was generated by multiplying the mean seed production estimate of each species by the total vegetated area in the south pool. Total seed production in the south pool ranged from just over 176,000 kg of seed in 1999 to over 1 million kg in 2001. Species with the best yields by year were redroot nutgrass in 1999, teal grass in 2000, and hooded arrowhead in 2001.

Potential duck-use-days (DUDs) were calculated by multiplying the projected total amount of seeds present by their gross energy (GE) obtained from review of the literature, and then dividing the product by the estimated daily energy required by free-flying mallards. The GE multiplier used was the average GE of all study plants except for teal grass (for which no average GE could be found in the literature). Based on these calculations, vegetation in the south pool was estimated to provide energy for more than 7.8 million DUDs in 1999, 2.7 million DUDs in 2000, and 17.4 million DUDs in 2001.

According to INHS aerial inventories of Lake Chautauqua during fall migration (1948-2000), estimated DUDs have been greater than 2.7 million in 33 years, 7.8 million in 8 years, and 17.4 million in 1 year.

Weekly ground counts of waterbirds were conducted on Lake Chautauqua during the moist-soil vegetation study. Using ground counts for the fall (Aug. 1-Dec. 31), observed DUDs were calculated and compared with the potential DUDs based on seed production/GE estimates. In 1999, actual DUDs were estimated at 4.1 million, while seed production estimates indicated about 7.8 million DUDs were available. In 2000, ground counts indicated over 3.5 million actual DUDs, while an insufficient 2.7 million DUDs of GE were produced from seeds. In 2001, actual DUDs were estimated at 5.3 million, and estimated seed/GE production exceeded 17.4 million DUDs. During the springs (Jan. 1-May 31) of 2000, 2001, and 2002, respectively, an estimated 2.0 million, 138,000, and 751,000 DUDs were documented by ground counts. This data is shown below in Figure 1.

While these estimates indicate that the project area produced sufficient food for migrating waterfowl in 1999 and 2001, available energy was recalculated using values for true metabolizable energy (TME) derived from known TME values for 7 of the common food plants monitored. The use of TME in projecting available plant food resources reflects the results of past studies showing that waterfowl and other animals do not utilize all of the energy within the foods they consume. Estimates of potential DUDs calculated using TME values indicated that 4.5 million DUDs were available in 1999, 1.6 million in 2000, and nearly 9.5 million DUDs were available in 2001. In comparing this actual use to potential use estimates previously discussed, the project area provided sufficient food resources for both spring and fall in 1999 and 2001 using the GE estimate, but if TME estimates were used, the project area only provided sufficient plant food for waterfowl in 2001. Some species of waterfowl (e.g. mallards) supplement their energy demands outside of the project area in cornfields near the Refuge. However, many waterfowl species were very dependent on the plant and invertebrate resources of the Refuge in spring and fall, particularly during hunting seasons when disturbance outside the Refuge is high.

Shorebird use of the project area was evaluated using data collected by weekly ground counts (Bjorklund unpublished data). Use-days for some individual species and for all shorebirds during fall migration were compiled. Analysis of this data showed a strong positive correlation between the amount of open water in the south pool and the number of shorebird use-days (SUDs) during 1999-2001. As the amount of open water in September-October increased, SUDs increased. In addition, a strong positive correlation was noted for most individual species of shorebirds monitored. In 2001, most of the water was drained from the south pool, leaving very little open water in the center. Shorebird use estimates were lower in 2001 than in any other year since ground count monitoring began in 1997. The decreased visibility of shorebirds caused by the increase in vegetation on the mudflats may have been a factor in the apparent decline in shorebird use in 2001. However, lower observed shorebird use may also have been a function of less desirable (shorebird) habitat created by more prevalent moist-soil vegetation growing in the south pool.

In 2002 (after completion of Stage 4 construction), the INHS conducted a more limited follow-up monitoring effort to evaluate moist-soil vegetation response. This effort focused on monitoring established transects and covermapping the south pool. Vegetation was not collected for stem density and seed production estimates, and the setback site was not included in the 2002 monitoring and covermapping plan. Covermapping in 2002 was conducted between September 23 and September 27, approximately 2-3 weeks later than in previous years and about 8 weeks after plants had germinated. While water levels in the south pool fluctuated throughout the growing season, moist-soil plant production appeared to be good overall and excellent in the areas that remained dry after initial drawdown. For the first time in four years, high quality food plants dominated segments of the managed areas without the aid of mechanical and/or chemical control. Willows continued to encroach on highly productive moist-soil plant areas in several portions of the south pool. Shorebird use of the south pool was high. However, use of the area by waterfowl was negatively affected by an early freeze-up and was lower than in the previous three years of study.

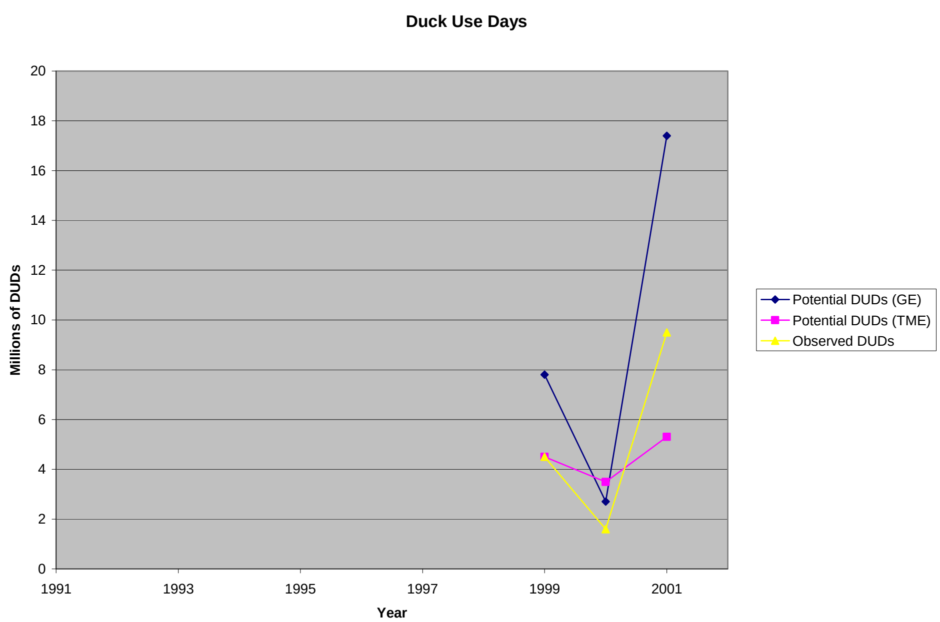


Figure 1. Duck Use Days

2. Migratory and Resident Bird Species

a. Aerial Inventories. Aerial inventories of waterfowl at the Lake Chautauqua HREP that were initiated as part of pre-construction biological response monitoring were continued through the construction period and the post-construction period up to the fall 2000-spring 2001 sampling period.

b. Ground Inventories, Aerial inventories are effective in estimating peak numbers of ducks, geese, swans, coots, cormorants and eagles using the Refuge during fall and spring months. However, the Refuge supports a wider variety of migratory and resident birds throughout the year, beyond those species and seasons covered in the spring and fall aerial census. A series of detailed ground inventories were initiated on the Refuge and adjacent properties in 1996. These inventories were conducted on a weekly basis by two qualified Refuge volunteers, Richard and Sigurd Bjorklund, when weather and habitat conditions permitted. Data were collected on all bird species observed at several standardized census locations encompassing the Refuge and between stops from a slow-moving vehicle. All species and individuals present were recorded. Inventories were made approximately weekly up to 40 times per year except when severe weather conditions prevailed (e.g. flooding, deep snow). Supporting information such as water levels, weather, and ice conditions were also recorded. Fall periodic inventories were conducted from July through November (1997-2001), winter inventories from December (1997-2001) through February (1998-2002) and spring inventories from March through May (1996-2002). The 1996-1998 data precedes the completion of the HREP in late 1998 and provided baseline information to compare with post-construction bird use of the project area.

c. Total Ground Inventories. Between 1996 and 2002, ground inventories documented the presence of 101 bird species within and adjacent to the project area. This number included 14 state-listed endangered or threatened species, listed in table 8.

Table 8. State-listed Species Observed During Ground Inventories 1996-2002

Species	State-listed Endangered	State-listed Threatened
Snowy egret	x	
Little blue heron	x	
Black-crowned night heron	x	
Osprey	x	
Northern harrier	x	
Peregrine falcon	x	
Piping plover	x	
Wilson’s phalarope	x	
Common tern	x	
Forster’s tern	x	
Black tern	x	
Pied-billed grebe		x
Bald eagle		x
Red-shouldered hawk		x

d. Fall Ground Inventories. From 1 August to 31 December, 1997-2001, a total of 95 species were observed within and adjacent to the project area. Mallards were present in the highest numbers, with peak counts ranging from 95,000 to more than 139,000 individuals. Other non-waterfowl species with substantial numbers included American white pelicans, double-crested cormorants, great egrets, great blue herons, bald eagles, lesser yellowlegs, semipalmated sandpipers, and ring-billed gulls. A total of 14 species were observed during the fall period after project completion that were not documented during the pre-construction phase. Overall, fall peak populations were higher for 54 species during the post-construction period (1999-2001), while 37 species declined in numbers, and 4 species remained the same. Fall use-day estimates were more evenly split, with 48 species having higher fall use-day values during the pre-project period while 47 species had higher use-day values during the post-construction monitoring period. These changes are shown in figure 2.

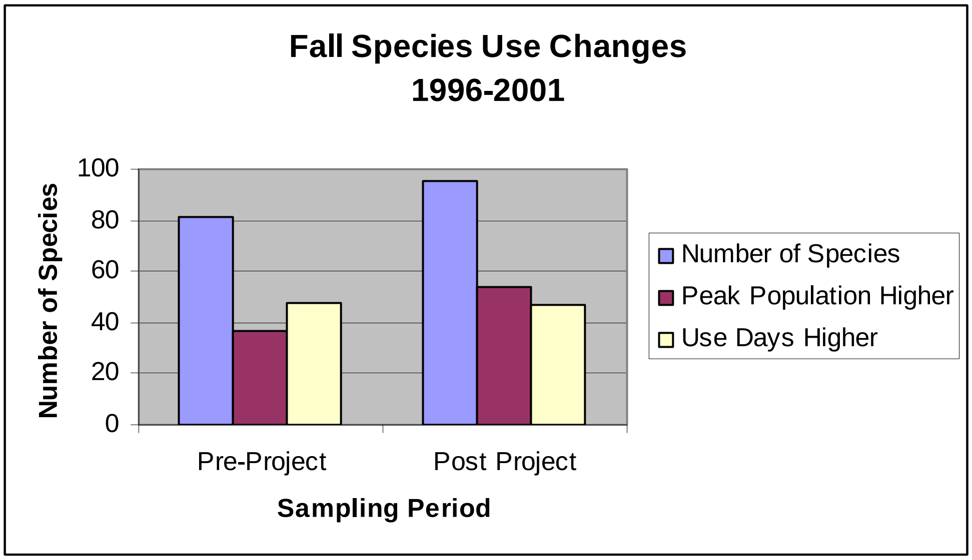


Figure 2. Fall Species Use Changes

e. Spring Ground Monitoring. From January 1 to May 31, 1996-2002, 82 species were observed within or adjacent to the project area. Similar to the fall monitoring period, the mallard was the most abundant species in spring. Threatened or endangered species with noteworthy peak population numbers during the spring seasons included the pied-billed grebe, bald eagle, Wilson's phalarope, common tern, Forster's tern, and black tern. Mallards expended the most use-days on Chautauqua Refuge during spring, with diving ducks such as canvasback and lesser scaup also well represented. Non-waterfowl species that were abundant included the American white pelican, double-crested cormorant, and great blue heron.

There were 17 species present at the Refuge during the post-construction period that were not observed during the pre-construction phase. Spring peak populations were higher for 50 species during the post-construction monitoring period, while 27 species experienced higher spring peaks during the pre-construction monitoring period. With respect to use-days, 50 species used the Refuge more during the post-project monitoring period, while 31 species had higher use-values in the pre-construction phase. These changes are shown in figure 3.

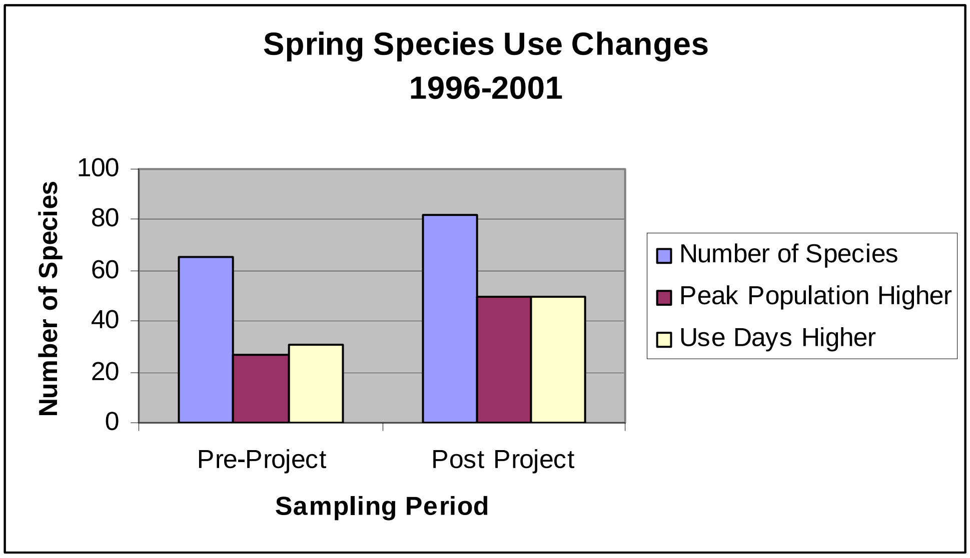


Figure 3. Spring Species Use Changes

Table 9. Lake Chautauqua botulism outbreaks:

Year	Waterfowl Mortality
1997	8,000
1998	2,500
1999	250
2000	900

Sick birds generally appear in late August when water levels are low (2 to 10 inches), low precipitation, and high temperatures for extended periods. These conditions set the stage for the botulism organisms to start reproducing. Birds pick up the toxin and die. Flies lay eggs on the carcasses and the maggots concentrate the toxin to the point where only 3 maggots will kill a duck. The botulism problem usually subsides after the first killing frost. Drying the lake bottom will force the birds to go elsewhere and therefore, avoid the botulism toxins.

Extending the dewatering channels allowed the exposure of another 500 acres of the lower lake. Some of this acreage is in willow trees where it is extremely difficult to find sick and dead birds which increase the loss of birds to botulism. With the channel extensions the FWS will be able to dewater completely. This will remove the habitat for waterfowl and shorebird use and allow complete searches of any remaining small wet areas. If dewatered early enough, the dewatered areas will produce moist soil plant foods that can be used by waterfowl and other wildlife when re-flooded in the fall. It will also allow the bottom to dry to get equipment into the area to control invasive vegetation such as willow.

3. Fish and Invertebrates

a. North Pool Fish Community Response. A total of 77,341 fish representing 54 species and 3 hybrids were collected during the pre- and post- construction periods (17,168 pre-construction, 60,173 post-construction). Both pre- and post-construction sample periods collected 46 species with eight unique species collected in each period. Three of the unique species caught during post-construction – bighead carp, silver carp, and white perch (Morone americana) are non-native species that became established in the LaGrange pool in the mid-1990s.

Changes in the fish community were desired and expected as a result of this HREP based on the original goals and objectives, and the proposed management plan. Analysis of similarity between the two sample periods initially indicated no significant difference between pre- and post-community composition, likely due to the species composition being nearly identical. Utilizing a cluster analysis of the composition data in comparing the 1991 and 1992 (pre-construction) sample years to the 2000 and 2001 (post-construction) sample years resulted in a fairly distinct delineation between the two sample periods. The 1993 (pre-construction) and 2002 (post-construction) sample years do break out as being composed of different species. The north pool was physically connected to the Illinois river during these two years, so it is probable that the Illinois River fish community contributed some species to Lake Chautauqua at those times that resulted in differences in species composition.

The community composition analyses revealed few differences between the two sample periods because the overall species richness did not change substantially. However, a more meaningful assessment of the fish community may be accomplished by assessing community structure in the form of how each species contributes to the overall make-up of the community. While collective assessment using data from a combination of all gears was not feasible, gear specific analyses were used to provide some insight into the response to HREP management at Lake Chautauqua. Tests comparing pre- and post-construction electrofishing, fyke net, minnow fyke nets and gill nets all showed significant differences between the two sample periods, highlighted by increases in some targeted (managed) species such as white crappie, largemouth bass, and channel catfish, and by decreases in some undesired species such as common carp.

Changes in the size structure of several of the managed species also suggested a positive response to HREP management. During the pre-construction period, largemouth bass numbers were relatively low and had low annual recruitment, and both proportional stock density (PSD) and relative stock density (RSD) estimates indicated the population structure was biased towards larger individuals. By 2000, however, the largemouth bass population was represented by multiple year-classes that included young-of-year individuals and post-construction indices, though variable, appear to be stabilizing at values that indicate a healthy population. Bluegill population was very similar to largemouth bass in that the population was dominated by larger individuals during the pre-construction period. The post-construction period documented more year-classes and a more desirable size structure. PSD values indicated fairly good abundances of bluegill larger than stock size (80-mm); however, the number of fish larger than the preferred class (200-mm) has remained consistently low and may require additional fisheries management practices to sustain a balanced population. Recruitment and size structure for black crappie generally showed a lack of consistent reproduction during sample periods. Although white crappie were not specifically identified as a management species, they followed a similar trend to that observed for black crappie. Few channel catfish were collected prior to construction in the north pool of Lake Chautauqua, and for this reason reliable size structure assessments could not be made. However, a wide range of size-classes of catfish were found in the lake during the post-construction period that indicate successful reproduction and recruitment in the sport fish population.

As noted at the beginning of this subsection, the species composition of Lake Chautauqua did not change significantly from the pre-construction to post-construction sampling periods. There are two possible explanations for this. First, the lack of any chemical treatment to remove remaining fish in the standing water during the construction drawdown period may have allowed some species to survive and re-establish in the post-construction lake. Secondly, the connection to the Illinois River during 1993 and 2002 likely had a strong influence on community composition because source populations of many riverine fishes had at least intermittent access to the lake. Some minor discrepancies in species composition also can be explained by the establishment of three non-native fish species (bighead carp, silver carp, and white perch) in the LaGrange reach of the Illinois River after the pre-construction monitoring period.

While initial assessments of community composition did not show a significant change following HREP construction, a more ecologically meaningful assessment of the fish community may be made by examining changes in fish community structure based on relative abundance data. Here, every gear type showed a dramatic change in the fish community highlighted by increases in most of the key management species as well as several other desirable sport and forage species, coupled with a decline in the abundance of common carp as an undesirable species. These changes suggest a positive response to the HREP's ability to provide stable water levels. Prior to HREP construction, water levels in the north pool were subject to the same seasonal fluctuation and high variability found in the Illinois River, which resulted in an unstable environment that was conducive to the establishment and propagation of less desirable fish species. Construction of the HREP and separation of the north and south pools for management purposes allowed stable water levels to be maintained in the north pool, enabling the more desirable native sport (predator) and forage species to establish naturally functioning populations. Additionally, the non-managed species that provide a prey base for some of the managed species may actually allow for a more stable food web than would have been present under the original HREP management plan.

Changes in the fish community following project construction suggest that the goal to establish a viable sport fish community has been accomplished. The actual composition and structure of species found in the north pool of Lake Chautauqua are somewhat different than originally anticipated in project planning and design, in that only five species were identified for stocking after the lake was drained during the construction phase. The fact that the lake was not entirely drained during construction and the overtopping of the levee by the Illinois River have likely contributed to the monitoring results. However, the existing fish community is represented by surrogate species that can serve the same function as the stocked species. Following HREP construction, the fish community has developed into a desirable fishery that has attracted considerable recreational attention (M. Pegg, unpublished data).

b. Larval Fish Monitoring in South Pool. Within the Illinois and Upper Mississippi River floodplains, backwater lakes and seasonal wetlands that flood in the spring, such as the south pool of Lake Chautauqua, can be a valuable asset to riverine fish communities that have evolved to capitalize on these seasonally available areas as spawning and nursery habitat. Although this effort was not included in the original monitoring plan and was not initiated until after construction affecting the south pool was near completion, the opportunity to document a secondary benefit of the HREP and the potential application of information acquired to similar projects justified the addition to the post-construction monitoring plan. Beginning in 1996 and continuing through 2002, data was collected in the south pool to investigate the production and subsequent release of larval and juvenile fish into the Illinois River. Sampling was conducted in both near-shore (within 50 meters of shoreline) and off-shore (> 50 meters from shoreline) habitats. One important component of habitat suitability for young-of-year fish is the availability of edible plankton. An additional consideration for managed floodplain lakes is how the timing of dewatering (drawdown) events affects survival of larval and juvenile fish released to the river. Data collection included information on feeding habits of larval fish and availability and composition of zooplankton food resources in the south pool.

Since 1996, there have not been significant changes in species composition or community structure of larval fish populations in the south pool as forage fish (e.g. gizzard shad) dominated the catch through the study years. Production of sport fish species varied considerably and preliminary analyses showed some dependence on water levels.

Results of the post-construction larval fish monitoring efforts confirm that the south pool of Lake Chautauqua likely provides significant spawning habitat for adult fish in addition to functioning as nursery habitat for larval fish when flooded. The relative contribution of fish produced in the south pool to Illinois River fish populations is not yet known but is believed to be substantial. By some estimates, numbers of larval fish transferred from the south pool to the Illinois River could average as much as 135 million individuals per year (Janvrin et al. 2003). This information suggests that while the south pool is managed specifically for production of moist soil food plants for waterfowl, it also provides a substantial benefit to, at a minimum, the regional fish community.

B. Summary and Interim Conclusions. Results of pre- and post-construction biological monitoring efforts indicate that HREP improvements to water level management and interior drainage infrastructure have increased the Refuge’s capability to provide habitat to a diverse array of migratory waterbird and fish species. Rehabilitation of the cross dike and upper lake perimeter levee has allowed Refuge staff to maintain two distinct types of floodplain habitat types (permanent shallow aquatic and seasonally flooded wetland) at Lake Chautauqua. Construction of pumping and interior drainage facilities has provided greater flexibility in water level management and allowed more effective drainage of the lower lake. High river stages on the Illinois River were and remain the greatest challenge to meeting HREP goals and objectives. However, post-project use of the project area by waterbirds and fish documented through biological response monitoring suggests that the project may benefit a wider array of species than those originally evaluated during planning and design activities.

V. PHYSICAL MONITORING AND PERFORMANCE OF CONSTRUCTED FEATURES

A. Inspections. The Refuge staff conducts frequent project inspections. The O&M Manual requires formal inspections twice a year. The State Dam Safety permit requires a formal inspection once every 5 years, conducted by a registered engineer. The Corps has made several project visits to the Refuge since project inception in the late 1980's. The observations from the combined inspections and project visits are summarized and included below. Some of the project inspections are included in Appendix D. Other inspections are on file at the Refuge office at Lake Chautauqua.

B. Cross Dike and Perimeter Levee. On-site monitoring and inspections by Corps staff and Refuge personnel from 1999 through summer 2004 have revealed that vegetation has become established on the cross dike levee and the 2 riprap bands appear to be functioning very well.

The upper lake perimeter levee is generally in good condition. Erosion along the inside of the levee near the water line has been eliminated due to a USFWS project to reinforce the inside slope with a band of riprap.

The riverside slope of the perimeter levee was reinforced with riprap at 2 locations where erosion was very severe. These areas are no longer in jeopardy. The tree growth along the riverside slope was left in place in order to break wave fetch. Most of the riverside slope has stabilized. Since the levee was raised to a higher elevation, there are portions of the levee that are prone to erosion when the river is within a few feet of the levee crest. USFWS has reinforced select areas with riprap.

The improved lower lake levee constructed by USFWS appears to be functioning very well with minimal post construction erosion. The rock gabion spillway structures are also functioning well. Since construction, the USFWS has constructed a concrete driving surface over the gabion baskets to minimize maintenance and to provide a smoother driving surface.

C. Sheet Pile Cellular Water Control Structure. The cellular water control structure consists of three 10ft by 10ft heavy duty sluice gates and aluminum stop logs. The structure was test operated following construction. As part of the project, a USFWS truck was outfitted with a hydraulically operated jib crane. This was used to install and remove the 10-foot long aluminum stop logs. After a minor modification to the lifting beam, the process of installing and removing stop logs went very well. Both the gas and electric portable operators work well to open and close the gates. The combination of gates and stop logs works well allowing flexibility in operating the structure. The structure has been operated twice for the purpose of flooding the upper lake to minimize erosion damage to the levees or for dewatering the lake. This is required when the river rises above elevation 447.0 feet or the 5 year event flood, (20% probability in any given year). Both times, the operating plan and the gate operation proved effective at preventing overtop erosion.

Maintenance and operation of the structure has been primarily due to minor vandalism. Some of the fence post caps, access chains, and gate parts have been removed. There have been instances of kids climbing over the fences and jumping off of the structure into the lake. This is not allowed and can be dangerous. The USFWS is doing what they can to prevent the vandalism and unauthorized use of the structure. During operation of the structure in January 2005, USFWS noticed that one of the gate pedestal gear casing was cracked. USFWS is investigating the cause of the cracked casing.

D. Pump Station

a. Operation. The pump station is very versatile and easy to operate. The gated control allows the pump station to perform several different functions with minimal complexity. The single largest problem with the pump station is that the large pump, 250 HP and 41,000 GPM, results in a high demand charge for the electrical service. Due to the high demand charge, the USFWS will only use the pump if absolutely necessary. Once the pump is operated during a one month billing cycle and the demand cost already incurred, the operating cost for electricity is minimal.

The pump was sized to dewater the lower lake in 30 days with the initial lake elevation at 435.0 feet. During a pump run in July and August 2000, the pump had the capacity to pump down the 2,000 acre lake about 1/10 foot per day. The capacity to gravity flow out of the lake through either the pump station (5 foot by 5 foot box culvert) or the lower lake stop log structure (4 each 5 foot bays) greatly exceeds the capacity of the pump only. Due to cost considerations, the USFWS relies on gravity flow to dewater the lake. USFWS uses the pump to maintain the lake in a dewatered condition during the growing season.

b. Maintenance

i. Control Panel. The control panel requires very little maintenance and is easy to operate. There were a couple initial electrical problems with the pump. First, the water in the oil sensor was originally connected to the fault circuit. This was removed from the fault circuit since some water in the oil is acceptable. Once the fault circuit shuts off the pump, it must be manually reset and turned on. There is a light that comes on when the sensor detects water. If the light stays on, then maintenance must be performed to change the oil and replace the seals.

During test runs of the pump, the fault circuit continued to trip. After analyzing the circuit, an electrical technician determined that the high temp sensor contacts were fluttering. The pump manufacturer said that this sensor was not required to protect the pump, and the pump could be run without the sensor. According to the manufacturer, this sensor is redundant and that the overload sensors would stop the pump in the event of high temperature. This sensor was disconnected temporarily. When maintenance is performed on the pump, personnel should inspect for loose connections.

The Rock Island District installs time delay circuits into the pump circuitry to prevent the pump from starting when water may be flowing back through the pump. The Lake Chautauqua pump has additional time delay built into the circuit that prevents the pump from cycling on and off too many times per hour.

During a pump run, a Corps electrician noticed that the wires coming from the submersible pump were getting frayed from the kelm grips suspending the wires. A modification was issued to the Stage II contractor to properly suspend the cables so that the cables remain protected.

ii. Trash Rack. The trash racks have not been a problem in terms of operation or maintenance. If they ever require removal, they are designed to unbolt at the top and lift out.

iii. Culverts / Sump. The pump station sump can be dewatered by closing the gates and pumping out the sump with the large pump and then follow with a smaller electric pump to draw the water lower. The lower gates can be dewatered by installing stop logs in the gatewells. The culverts and trash racks cannot be dewatered without a cofferdam.

A modification to the original contract reinforced the float cage to protect the floats. The first float cage came apart due to the force of water within the sump and resulted in damage to the floats.

iv. Pump. Other than the high temp sensor in the pump motor, the pump has worked well. Ideally, the USFWS should run the pump every month. However, due to the high demand cost, the pump is only operated once or twice a year.

E. Stoplog Structure

a. Operation. The stop log structure works well in dewatering or filling the lower lake depending on river levels. USFWS determined that stop logs can only be removed with less than 3 feet of water flowing over them. The USFWS did install lifting devices that assist in removing a whole stack of stop logs with the excavator.

b. Maintenance. Maintenance requirements have been minimal.

F. Drainage Channels. The stage IV contract constructed a channel through the lower lake to connect the pump station to the stop log structure. Lake soundings were obtained to position the channel in the deepest part of the lake. The channel is 19,000 feet long. The lakebed is relatively flat. The dredged material was placed adjacent to the channel to provide a maintenance road for tracked equipment. The channel was dug with a specially designed low ground pressure excavator when the lake was dewatered. The raised berm includes 4 rock fords to allow drainage from the landside portion of the lake into the new channel. The rock is designed to support tracked equipment. The channel was constructed to more completely dewater the lower lake through either gravity drainage and/or pumping. Complete dewatering was necessary to minimize problems with avian botulism. To date, the channel has performed well.

G. Access Road, Parking Area, and Boat Ramp. The access road, parking area, and boat ramp are performing well and have required very little maintenance.

H. Rock Weir and Riprap Areas. The rock weir and riprap areas have been performing well. The riprap around the pump station box culvert leading to the lower lake was damaged when the USFWS burned driftwood that accumulated on the riprap area. The riprap has not been replaced, because the smaller pieces are preventing erosion of the levee.

VI. FUTURE PERFORMANCE MONITORING

a. The purpose of this section is to summarize monitoring and data collection aspects of the project. The primary project objectives are to: (1) increase submergent vegetation in the upper lake; and (2) increase the availability of moist soil plants in the lower lake. Vegetation monitoring is the primary element in determining the success in meeting these objectives. Post construction aerial photographs and ground-truthing of the refuge will be compared to vegetation maps prepared prior to the project.

b. Table 10 presents the principal types, purposes, and responsibility of monitoring and data collection. Table 11 provides a summary of actual monitoring and data parameters grouped by project phase, responsible agency, and data collection intervals. Changes to the monitoring plan should be coordinated with the USFWS, IDOC, and COE.

c. Table 12 presents the post-construction evaluation plan. The monitoring parameters were developed to measure the effectiveness of the stated goals and objectives. The Site Manager should follow Table 12, as shown, to make annual field observations. The annual field observations and the quantitative monitoring parameters will form the basis of project evaluation.

Table 10. Monitoring and performance evaluation matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Post Construction	Performance Evaluation Monitoring	Determine success of project as related to objectives	Corps (quantitative) USFWS (Field Observation)	Field Station or USFWS thru cooperative agreement, USFWS thru O&M, or Corps	LTRM	See table 6-3
	Biological Response Monitoring	Evaluate predictions and assumptions of habitat unit analysis. Studies beyond scope of performance evaluation.	Corps	Corps	LTRM	--

Table 11. Resource monitoring and data collection summary 1/

	Water Quality Data						Engineering Data			Natural Resource Data				
	Pre - project Phase[3]		Design Phase[4]		Post Const Phase[5]		Pre - project Phase	Design Phase	Post Const Phase	Pre – project Phase	Design Phase	Post Const Phase		
TYPE OF MEASUREMENT	**Apr-Sep**	**Oct-Mar**	**Apr-Sep**	**Oct-Mar**	**Apr-Sep**	**Oct-Mar**							**Sampling Agency**	**Remarks**
POINT MEASUREMENTS													Corps	
Turbidity	2W	M	2W	M	2W	M								
Photosynthetically Active Radiation	2W	M	2W	M	2W	M								
Secchi Dish Transparency	2W	M	2W	M	2W	M								
Dissolved Oxygen	2W	M	2W	M	2W	M								
Specific Conductance	2W	M	2W	M	2W	M								
Water Temperature	2W	M	2W	M	2W	M								
Velocity	M	M	M	M	M	M								
Water Depth	2W	M	2W	M	2W	M								
Water Elevation	2W	M	2W	M	2W	M								
Percent Ice Cover		M		M		M								
Ice Depth		M		M		M								
Percent Snow Cover		M		M		M								
Snow Depth		M		M		M								
Substrate Particle Presence	6M	6M	6M	6M	6M	6M								
Substrate Hardness	6M	6M	6M	6M	6M	6M								
pH	2W	M	2W	M	2W	M								
Chlorophyll	2W	M	2W	M	2W	M								
Suspended Solids	2W	M	2W	M	2W	M								
Wind Direction	2W	M	2W	M	2W	M								
Wind Velocity	2W	M	2W	M	2W	M								
Wave Height	2W	M	2W	M	2W	M								

Table 12. Resource monitoring and data collection summary 1/

	Water Quality Data			Engineering Data			Natural Resource Data				
	Pre - project Phase	Design Phase	Post Const. Phase	Pre - project Phase	Design Phase	Post Const. Phase	Pre - project Phase	Design Phase	Post Const. Phase		
TYPE OF MEASUREMENT										**Sampling Agency**	**Remarks**
POINT MEASUREMENTS											
Bulk Sediment and Elutriate[6]		1								Corps	
Boring Stations											
Soil Borings[2]				1	1					Corps	
TRANSECT MEASUREMENTS											
Lake Sedimentation Transects[7]					1	5Y				Corps	
Vegetation Transects[7]									2Y		
Levee System Transects Cross section at 500 ft intervals and profile of cross dike and perimeter levee					1	5Y				Corps	
Hydrographic Soundings						5Y					
AREA MEASUREMENTS											
Vertical Stereo Photographs (1:5000)								1	4Y	Corps	
Land Topographic Mapping (1 ft contours)					1					Corps	

LEGEND FOR TABLE 12

C	=	Continuous
W	=	Weekly
M	=	Monthly
Y	=	Yearly
nC	=	n-Day continuous
nW	=	n-Week interval
nY	=	n-Year interval
1,2,3,...	=	Number of times data is collected within designated project phase

END NOTES FOR TABLE 12

1/ See monitoring plan, Plate 29, for locations of sampling points, transects, areas except as noted.

2/ See soil boring location as-built drawings.

	Current Station Code	Previous Designation	
3/ Water Quality Stations, Pre-Project Phase	W-I126.8T	LCL-1	1987 only
	W-I130.8W	UCL-3	1989 only
4/ Water Quality Stations, Design Phase	W-I124.8R		Initiated 1990
	W-I128.7W	UCL-1	Initiated 1989
	W-I128.8F	LD-1	Initiated 1990
	W-I129.2V	UCL-2	Initiated 1989
5/ Water Quality Stations, Post Construction Phase	W-I124.8R		
	W-I127.9W		
	W-I128.8T		
	W-I128.8W		
	W-I129.4T	UCL-2	

END NOTES FOR TABLE 12 (CON'T)

	Current Station Code	Previous Designation	
6/ Water Quality Bulk Sediment & Elutriate Stations	W-I126.6P	LCL-2	Lower Lake
	W-I126.8T	LCL-1	Lower Lake
	W-I128.7W	UCL-1	Upper Lake
	W-I129.4T	UCL-2	Upper Lake
	W-I129.6F	MD-1	Myer's Ditch
7/ Corps Lake Sedimentation/Vegetation Transects	S-I124.8P V	Lower Lake	
	S-I126.0P V	Lower Lake	
	S-I127.9P V	Lower Lake	
	S-I128.8P V	Upper Lake	
	S-I129.0P V	Upper Lake	
	S-I129.4P V	Upper Lake	

Table 13. Post Construction Evaluation Plan

Goal/Objective	Enhancement Feature	Unit	Year 0 without Alternative	Year X with Alternative	Year 50 Target with Alternative	Feature Measurement Reference Table 6-2	Annual Field Observation by Site Manager
Enhance Migratory Waterfowl Habitat							
Increase areal extent of submergent and emergent vegetation for waterfowl through water control	Aquatic vegetation bed	Acres	200	--	3,250	Perform Vegetation Transects note 7, Table 6-2 and aerial photography	Estimate acres of emergent/ submergent and floating vegetation
	Improved water quality	Mg/l suspended solids	200	--	50	Perform water quality tests at stations note 5, table 12-2	Describe presence of resuspended sediments due to rough fish/wind
	Perimeter levee and cross dike	Linear feet of eroded levee	20,400		0	Perform levee system transects and profiles	Describe effects of erosion, distinguishing between wave and overtopping erosion

VII. POTENTIAL FUTURE PROJECTS

A. La Grange Pool Side Channel Habitat. The existing side channel along the Lake Chautauqua Refuge has silted in and no longer provides a benefit to fish. Flowing side channel habitat is very rare in this reach of the Illinois River and would probably be an excellent investment. This project is currently awaiting prioritization**.**

B. Upper Lake Islands. Island construction within the upper lake could perform several functions. First, it would provide more diversity to the lake bottom for some variability in habitat. The islands could support beneficial mast trees. Riprap and vegetation along island shores could provide fish habitat. The islands could be positioned to break wave fetch within the upper lake and protect the levees and other sensitive areas within the upper lake. The islands would provide protected habitat for target wildlife.

VIII. PROJECT PERFORMANCE AS COMPARED TO GOALS AND OBJECTIVES

The post construction monitoring plan required that submergent and emergent vegetation be monitored. In year 0, there were 200 acres. Today there are nearly 2,300 acres which is well on the way to the Year 50 Target of 3,250 acres. It should be noted that this is only an estimate, however, created by using aerial photography and digital covermapping. Improved water quality is another goal of the project, but has not been measured. A third goal was to minimize the eroded levee areas. As of 2003, there is no area of erosion on the levee. This is the Year 50 Target. This data is summarized in Table 9 and Table 10 below.

Table 14. Post Construction Monitoring Plan

Goal/Objective	Enhancement Feature	Unit	Year 0 without Alternative	Year 7 With Alternative	Year 50 Target w/ Alternative	Feature Measurement Reference	Annual Field Observation by Site Manager
Enhance Migratory Waterfowl Habitat							
Increase areal extent of submergent and emergent vegetation for waterfowl through water control	Aquatic vegetation bed	Acres	200	2,287 (2002)	3,250	CIR aerial photography and digital covermapping	Estimate acres of emergent/submergent and floating vegetation
	Improved water quality	Mg/l suspended solids	200	Not measured	50	Perform water quality tests at station.	Describe presence of resuspended sediments due to rough fish/wind
	Perimeter levee and cross dike	Linear feet of eroded levee	20,400	0	0	Perform levee system transects and profiles	Describe effects of erosion, distinguishing between wave and overtopping erosion

Table 15. Project Goals and Objectives

				Enhancement Potential	
Goals	**Objectives**	**Features**	**Units of Measure**	**Original Projection**	**Actual Features on Site at Year XX**
Enhance Waterfowl Habitat	Increase reliable food production area (moist soil species)	Provide Water Control (Upper and Lower Lake)	Acres of Submergent/Emergent Vegetation	200	
		Barrier Islands (Upper Lake only) [1]	Acres of Submergent Vegetation	0	
Enhance Fisheries Habitat	Reduce sedimentation	Raise levee above minimum management plan requirements [1]	Annual Acre-Feet of Sedimentation [1]	100 [1]	NA

[1] Not included in recommended plan.

IX. GENERAL CONCLUSIONS AND RECOMMENDATIONS

Discussions with Corps and USFWS personnel who are involved with operation, maintenance, and monitoring activities at the Lake Chautauqua Environmental Management Project have resulted in general conclusions regarding project features that may affect future project design. This, combined with an evaluation of project data, resulted in the following conclusions.

A. Level of Protection/Levee Systems. Lake Chautauqua has a significant length of levee that forms the lower lake and the upper lake. The levees are vulnerable to erosion from both the lakeside of the levees and the riverside. Most of the vulnerable areas have been protected with riprap. It is cost prohibitive to riprap the entire levee on both sides. This is why the riprap has been increased in increments based on need. The growth of willows along the levee in the lower lake has created an effective wave break and is protecting the levee from the lakeside. The grass on the levees has become well established and is well maintained. It has been effective at minimizing erosion during high water. Parts of the exterior of the levee are vulnerable depending on river levels, wind speed and direction, and wave fetch. Levee heights are adequate for their intended functions. Although the lower lake levee has overtopped several times, overtop during the growing season, July through September, is not likely. The upper lake levee has overtopped twice since construction in 1998. It overtopped in May 2002 and again in January 2005. The plan to open the cellular structure gates has worked both times. In the lower lake, the two spillways are effective in preventing levee damage and have the advantage of requiring no manual operation.

B. Water Supply Systems/Pump Station. The pump station is fully capable of performing its intended functions. The set-up is very versatile and easy to operate. The biggest single problem with the pump station is the high electric demand charge and the demand charge carry over if the pump is run during peak months. Future designs should consider the exact operating conditions and parameters to ensure the lowest overall cost. In some cases, it may be better to limit the capability of the pump station to keep operating costs more manageable. At Lake Chautauqua, a smaller pump would not meet the initial design criteria of being able to dewater the lower lake within 30 days; however, it would still be capable of maintaining the lake in a dewatered condition following initial dewatering.

C. Water Control Structures. All seven water control structures are performing as designed and are capable of meeting the intended functions. These structures include the cellular water control structure; the riprap weir; the two spillways in the lower lake levee; the stop log structure; the 3 by 3 foot box culvert; and Quiver Creek dam. Deficiencies in original water control structures or structure capacities have been overcome during design and construction of the new stop log structure, pump station, lower lake spillways, and cellular water control structure.

D. Site Access. Site access at Chautauqua is excellent. Access to the pump station and the cellular water control structure is above the 10-year flood event. Access to the cross dike levee, parking area, and boat ramp is exceptional and also above the 10-year flood event. The USFWS has constructed a crushed limestone road along the entire length of the lower lake levee. This greatly facilitates equipment and vehicle access for both operation and maintenance activities.

E.. Adaptive Management. Lake Chautauqua was one of the earliest HREPs planned and designed by the Corps and EMP partner agencies. Lessons learned from Lake Chautauqua have been applied to subsequent HREPs and to other ecosystem restoration efforts on the Upper Mississippi

River System. Construction in large river floodplain environments with saturated, uncompacted sediments is challenging, but possible. Improvements in developing plans and specifications and preparing construction scopes of work allow contractors to be more aware of the difficulties in working in floodplain environments. Flexibility and ease of operation with reductions in maintenance requirements are now a primary focus of project design efforts. Biological response monitoring does not always result in dramatic and attributable changes to targeted organisms, but can provide useful information on relationships between physical and biological factors, and may sometimes reveal evidence of unanticipated benefits to organisms and communities beyond the original scope of project planning and design.

Photograph 5. South Pool September 2002, Bidens sp. (*beggarticks*) in Foreground. Photo by INHS staff.

Appendix A

Project Photos

1. Upper Lake Access Road/levee to the Cellular Structure. North end of project.

2. Cellular Water Control Structure. Upper Lake is on the left.

3. 10ft by 10ft Sluice Gate prior to installation. 74ft diameter sheet pile cell is filled with rock.

4. Picture of Upper Lake from perimeter levee.

5. North Perimeter Levee. Erosion along waterline.

6. North perimeter levee near bend, looking back towards the East.

7. Upper Lake with cellular structure and North perimeter levee in the background.

8. Parking area and cross dike under construction. Upper Lake is to the left in photo.

9. Cross Dike levee looking toward the river. Lower Lake side has a 6:1 slope. Band of riprap protects against wave wash erosion at higher river levels.

10. Cross Dike levee. Minor erosion and debris from spring flooding in 2001.

11. Pump Station under construction. Upper Lake is visible. River is to the left.

12. Pump Station under construction.

13. 5x5 Box Culvert from pump station to the river under construction.

14. Completed 41,000 GPM pump station and electrical platform/transformers.

15. 3ft. by 3ft. box culvert and gate from Quiver Creek to Lower Lake. Constructed by USFWS.

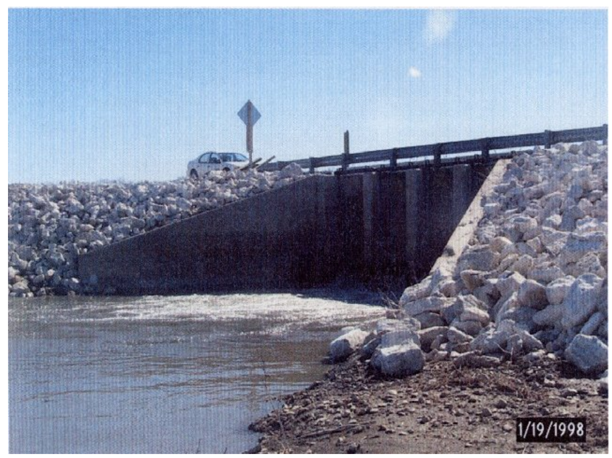
16. Quiver Creek sheet pile dam structure, Sta. 274+60. Constructed by USFWS.

17. Lower Lake levee under construction and view of Lower Lake partially drawn down.

18. Willows that have overtaken large areas of the Lower Lake.

19. Lower Lake levee under construction. View of overflow structure.

20. Lower Lake levee under construction. New stop log structure at south end of project.



21. Completed Lower Lake Stop Log Structure.

22a. Lake Chautauqua Site Visit during Stage IV Construction

22b.

22e

22c.

22f.

22d.

22g.

22h.

22i.

22j.

22k.

22l.

23. Lake Chautauqua. Lower Lake Stop Log Structure

24. Lake Chautauqua. Lower Lake Stop Log Structure. FWS constructed lifting beam for 5 ft wide stop logs.

27. Lake Chautauqua. 41,000 GPM pump station and electrical control platform/transformers. Lower Lake outlet is shown.

25. Lake Chautauqua Lower Lake. Several willows have overtaken much of the Lower Lake.

28. Lake Chautauqua. 41,000 GPM pump station and electrical control platform/transformers.

26. Lake Chautauqua. 41,000 GPM pump station and electrical control platform/transformers.

29. Lake Chautauqua. Cellular Water Control Structure.

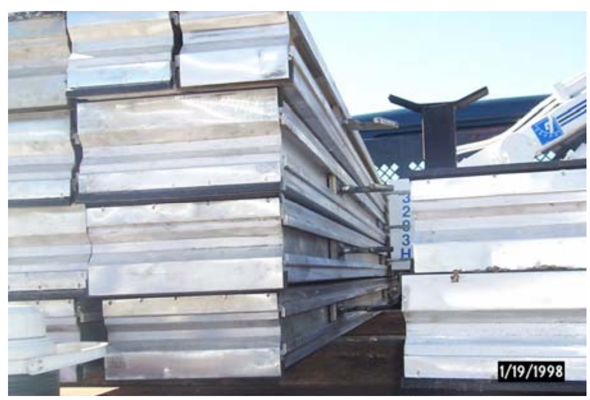
30. Lake Chautauqua. Cellular Water Control Structure. Installation of stop logs.

31. Lake Chautauqua. Cellular Water Control Structure. Installation of stop logs.

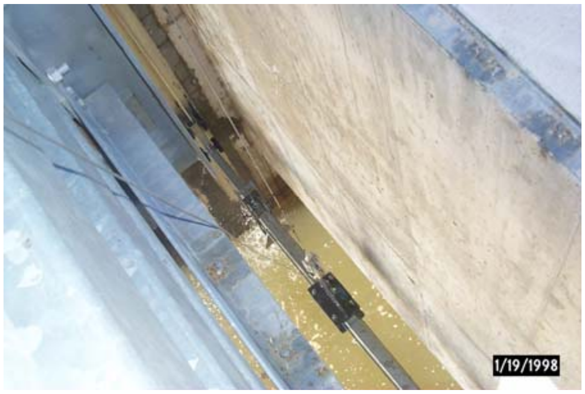
32. Lake Chautauqua. Gas and Electric portable operators for both pump station gates and water control structure gates.

33. Lake Chautauqua. Cellular Water Control Structure.

34. Lake Chautauqua. Lifting beam for 10 ft wide aluminum stoplogs.



35. Lake Chautauqua. 6 inch and 12 inch aluminum stop logs. 10 ft long.



36. Lake Chautauqua. Installation of stop logs into Cellular Water Control Structure.

37. Lake Chautauqua. Small crack where abutment overhangs structure. 1 of 2 locations.

38. Lake Chautauqua. Small crack where abutment overhangs structure. 1 of 2 locations.

39. Lake Chautauqua. Schematic project area map.